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CHOATE PUBLIC HEALTH

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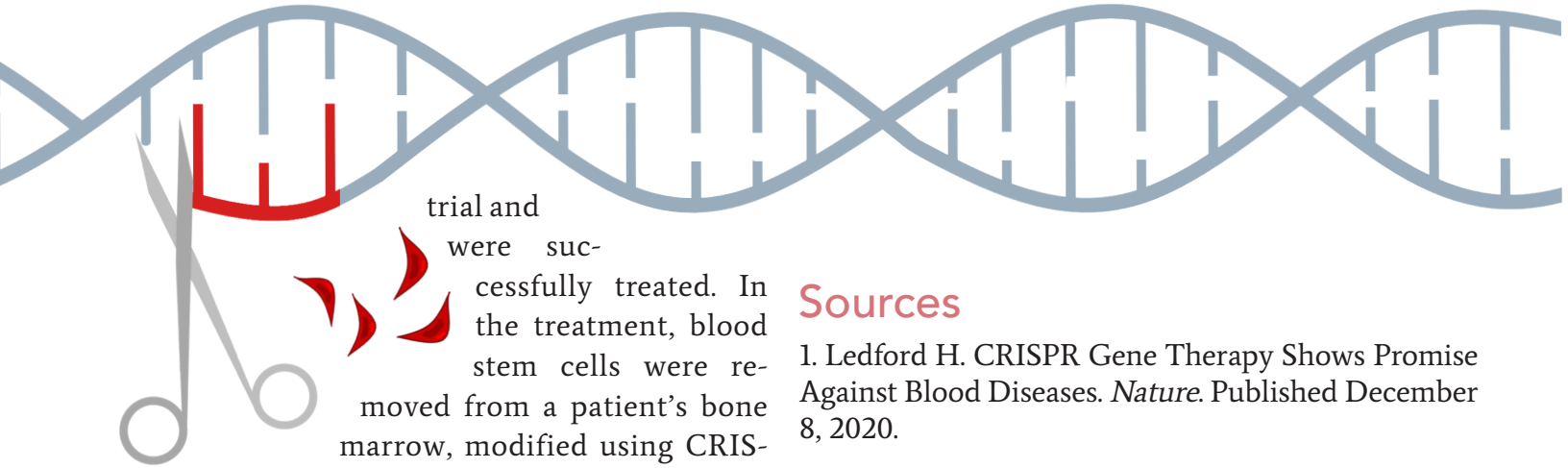
BEATING BLOOD DISEASES WITH CRISPR-CAS9

By Sophia Dubbelde '23

Sickle cell and beta thalassemia are hereditary diseases caused by single gene mutations. In both of these diseases, the mutation affects the production of β-globin, a component of hemoglobin, which is an essential red blood cell protein.[1] Up until now, the only treatments available for these diseases were a bone marrow transplant or gene therapy, a treatment that adds functioning copies of the β-globin gene into blood-producing stem cells. Now, there is an upcoming technology utilizing CRISPR-Cas9 to treat these diseases that "switches on" the production of fetal hemoglobin, which is normally only found in newborns. Researchers believe that the fetal hemoglobin could replace the mutated β-globin for healthier blood cells.[1]

The New England Journal of Medicine published a study using CRISPR-Cas9 that has already reported success with data from two patients, one with β-thalassemia and one with sickle cell.[2] So far, a total of 19 patients have participated in the trial and were successfully treated. In the treatment, blood stem cells were removed from a patient's bone marrow, modified using CRISPR, and then reinserted. The patient was then treated with drugs that remove the remaining blood stem cells that were not modified by CRISPR.[2] Haematologist Davod Rees comments that although this study may be exciting, "it's hard to see this being a mainstream treatment in the long term."[1]

While the treatment presents risks of infection or damage to fertility in the reinjection process, this is the first study demonstrating the use of CRISPR technology to treat heritable diseases. The patient with β-thalassemia has not required the otherwise typical blood infusions after their treatment with CRISPR. In the patient with sickle cell, the CRISPR method also eliminated vaso-occlusive episodes, a common and painful complication of sickle cell disease.[2] Though the CRISPR-Cas9 method may not be ready for mainstream usage yet, it presents an opportunity for patients who do not respond to other treatments. With this success, the field of genome editing may also be used to treat many other genetic disorders in the future.



Graphic by Elton Zheng '22

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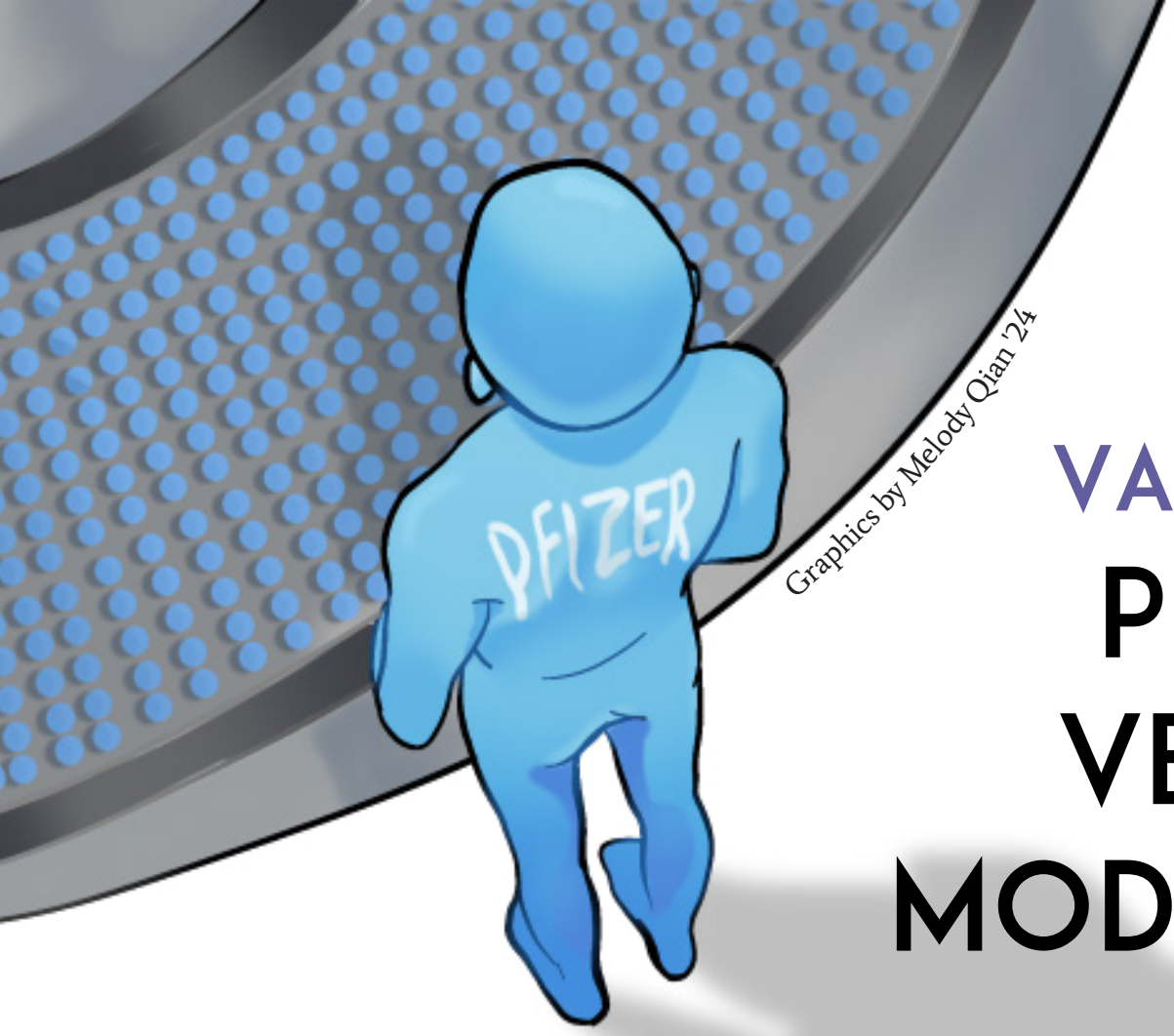

Graphics by Melody Qian '24

BATTLE OF THE VACCINES: PFIZER VERSUS MODERNA

By Sarah Yildirim '23

The novel coronavirus, SARS-CoV-2, has devastated the entire world since December 2019, with almost 84 million total cases in a mere 12 months.[1] Before the outbreak, there was little to no knowledge about the virus, and, as a result, there was no treatment available within a short span of time. But, scientists around the world have worked quickly to develop an effective vaccine. Now, the Pfizer and Moderna COVID-19 vaccines are two effective vaccines that the United States has access to, so what are the slight differences between them.

Both vaccines are RNA vaccines, containing an mRNA sequence. The mRNA sequence gives cells instructions on producing antigens in order to become immune to a specific virus. Unlike most vaccines which insert a weakened version of a virus into the body, RNA vaccines teach the cells to make necessary proteins. The vaccines each require two doses: the Pfizer doses are to be taken within 21 days, and the Moderna doses are to be taken within 28 days.[2]

The Pfizer and Moderna vaccines have both been found to be very effective at reducing the incidence of infection, with the Pfizer vaccine being 95% effective and the Moderna vaccine being 94.1% effective. The Pfizer vaccine is authorized to be used on those who are 16 and older, whereas the Modera vaccine is only authorized for everyone 18 and older, though both have been testing on those between ages 12 and 17. Overall, a key difference between the two vaccines is that the Moderna vaccine was observed to be less effective for those 65 and older, but there was no evident difference when the Pfizer vaccine was used in different age groups. Regardless, both vaccines are highly effective in rapidly controlling the spread of COVID-19.[3]

There have been many reported side effects of the two vaccines. According to Hilary Brueck

and Andrew Dunn from Business Insider, for Pfizer, the common side effects were pain in the area of injection (84%), fatigue (63%), and headache (55%). Compared to the Moderna shot, there were less reported cases of side effects. For the Moderna vaccine, nine in ten people reported side effects. These side effects included pain in the area of injection (92%), fatigue (69%), headache (63%), and muscle pain (60%). Furthermore, younger people were reported to have more side effects than those over 65 for the Moderna vaccine.[3]

Another one of the primary differences between the two vaccines is the way they need to be stored. Compared to the Pfizer vaccine, the Moderna vaccine is much easier to store and distribute. The Pfizer vaccine is required to be stored at approximately -70°C to be effective, whereas Moderna can be stored at just -20°C. The Moderna vaccine can be stored in fridges for up to 30 days and at room temperature for up to 12 hours, but the Pfizer vaccine must be used within five days. Additionally, the Pfizer vaccine must be mixed with another liquid before being administered.

Though Moderna is much easier to store and distribute, it is also much more expensive than the Pfizer vaccine. While vaccine costs are covered in the United States, the two vaccines were sold in government contracts at different prices. One dose of Moderna has been reported to be $38, while Pfizer is priced at $20. A reason for the price difference is that, according to Dr. Zoltan Kis, a research associate at the Future Vaccine Manufacturing Hub, Imperial College London, the Moderna vaccine has an mRNA amount per dose of 100 micrograms, whereas Pfizer is 30 micrograms. The more mRNA amount per dose, the more expensive a vaccine is.[2]

Along with the challenge of storing the Pfizer vaccine, the minimum order number for the vaccine is 975 doses. The issue with this is that some hospitals might need much more or much less than that, depending on a multitude of factors. Moderna's vaccine has a minimum order number of a 100 doses, which is a much more manageable dosage count for institutions to order and plan ahead.[4]

It will take time to see how effective the two vaccines are in the long run. Regardless, the vaccines are bringing us one step closer to a world in which no more lives are lost to this fatal virus.

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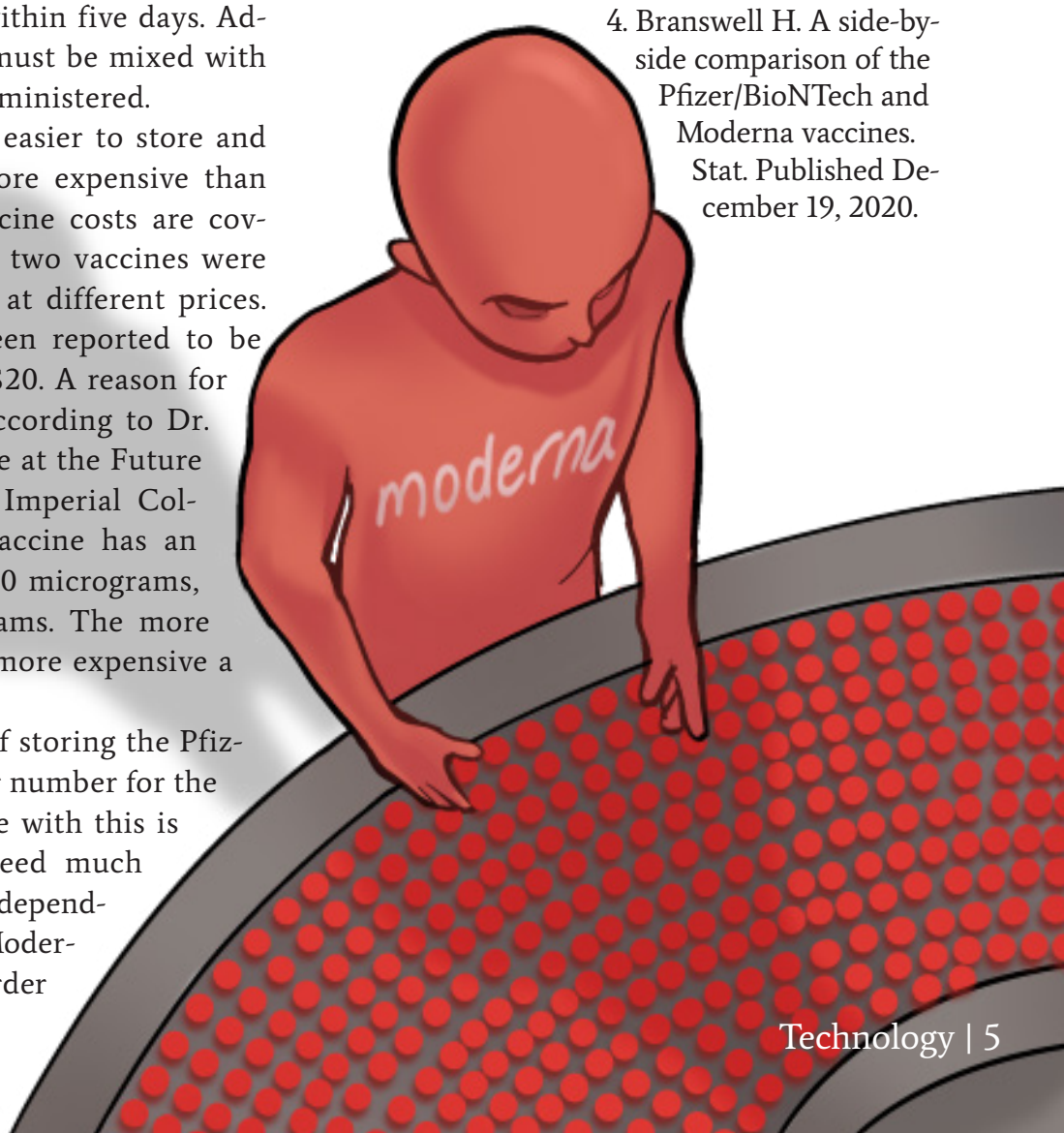
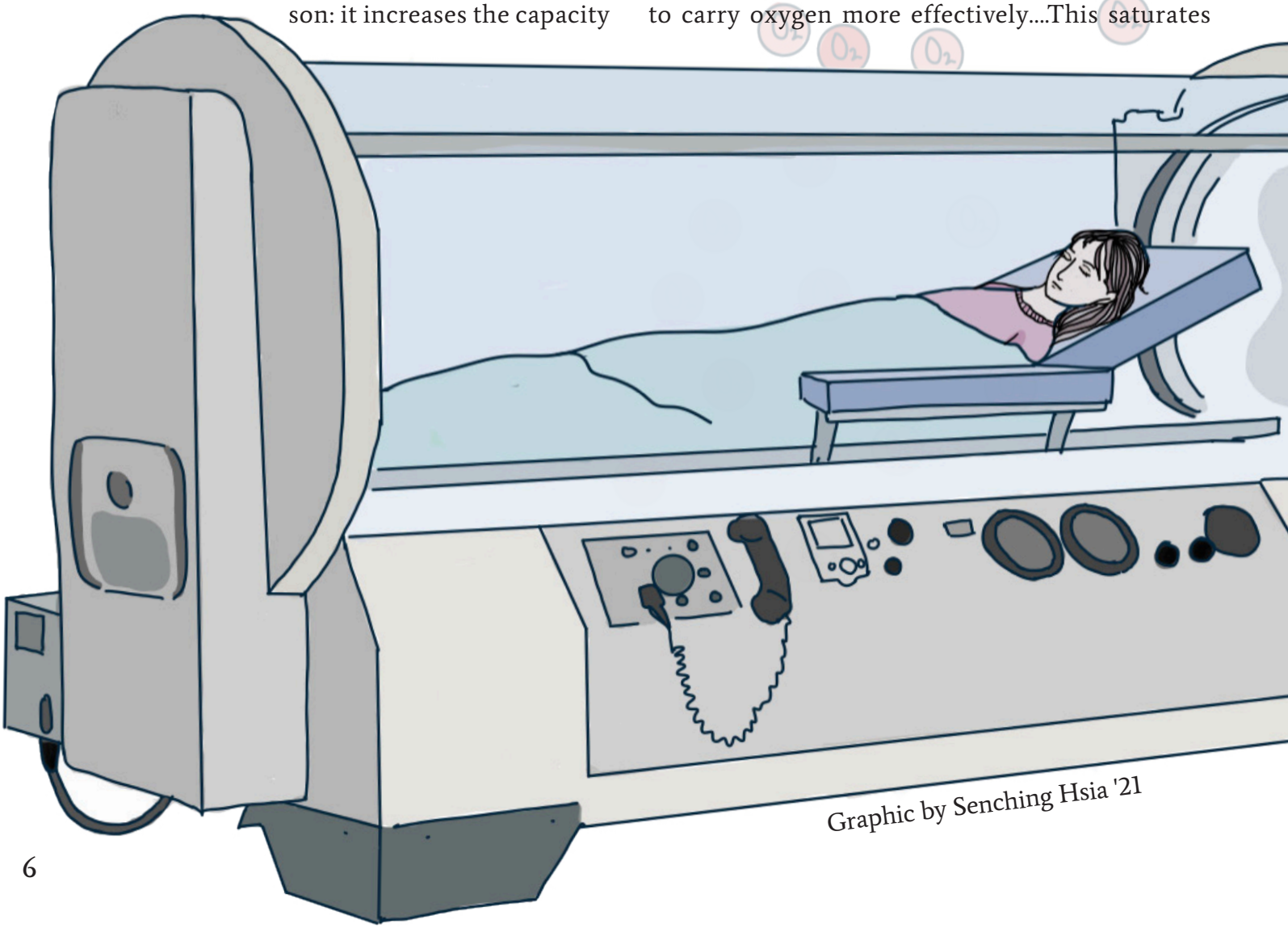


HBO: AN OXYGEN IN

By Sofia Mu

Using hyperbaric oxygen, or HBO, as therapy is a non-invasive approach that involves breathing pure oxygen in a pressurized environment.[1] The treatment is often used for decompression sickness, which refers to the various injuries that may occur when an individual experiences a rapid decrease in pressure underwater.[2] Along with decompression sickness, HBO can be used for wounds that do not heal on their own because of diabetes or other medical conditions, air in blood vessels, and any serious infections.

Hyperbaric oxygen is effective for one key reason: it increases the capacity of oxygen a person's blood can carry. Normally, we all require a certain amount of oxygen for our organs to function properly. By providing extra oxygen through routine treatments, the temporary high oxygen levels can trigger the body to resume production of normal oxygen levels, even during the elapsed time between treatments.[1] Rob DeLeon, a lead hyperbaric technician at the University of Michigan Medical Center explained the outcome: "The increased atmospheric pressure, along with the patient receiving 100% oxygen....allows both your blood and blood plasma to carry oxygen more effectively....This saturates



Graphic by Senching Hsia '21

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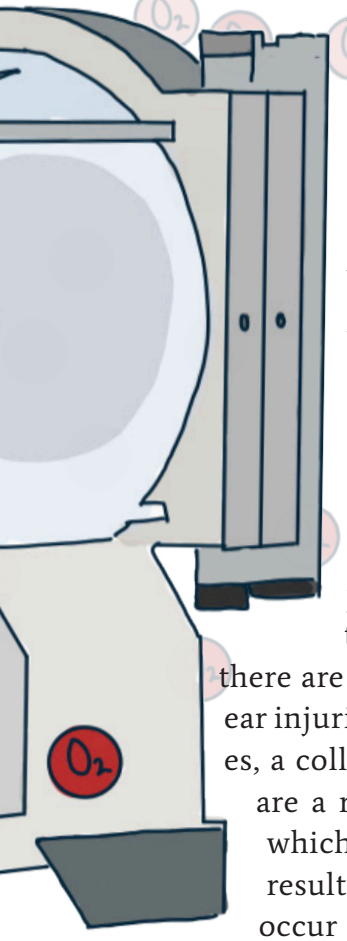
the body with oxygen and improves the body's effectiveness in healing wounds."[3]

The most common way that HBO is administered is through the use of a chamber, which is suitable for only one person. The patient will lie down on a table that slides into a clear plastic chamber. HBO treatment can also be done in groups of people to minimize the cost, as therapy can cost up to $250-$450 per session.[4] In groups, members will sit in a pressurized room that resembles a hospital ward in individual beds. Oxygen is delivered through a mask over the face or through a lightweight, thimble-shaped covering over the head.[1] The air inside is about two or three times more pressurized than normal air, which sometimes can lead to a "fullness" sensation in one's ears that can be solved by "yawning." An average session can last up to two hours. To maximize the benefits of HBO, medical professionals recommend around forty scheduled sessions.



There are very few serious complications associated with HBO treatment, and many experts claim HBO to be a relatively safe procedure. However, there are still a few risks, such as middle ear injuries, seizures, and in extreme cases, a collapsed lung. Middle ear injuries are a result of changing air pressure, which can rupture the eardrum and result in leaking fluid. Seizures can occur because of too much oxygen, and a collapsed lung may occur due to changes in air pressure. Thus, always remember to consult a medical professional to make sure you are not prone to these risks before considering HBO.

The big question now comes down to: how effective is HBO treatment for certain conditions versus others? According to Nayan Patel, a biomedical engineer at the Food and Drug Administration (FDA), "Patients may incorrectly believe that [hyperbaric treatment] devices have been proven safe and effective for uses not cleared by FDA," such as autism, diabetes, and asthma, the results of which are highly contested.[5] While the long term effects of using HBO have not been fully seen by scientists yet, it appears to be a low-risk procedure that can provide many benefits for minor conditions.

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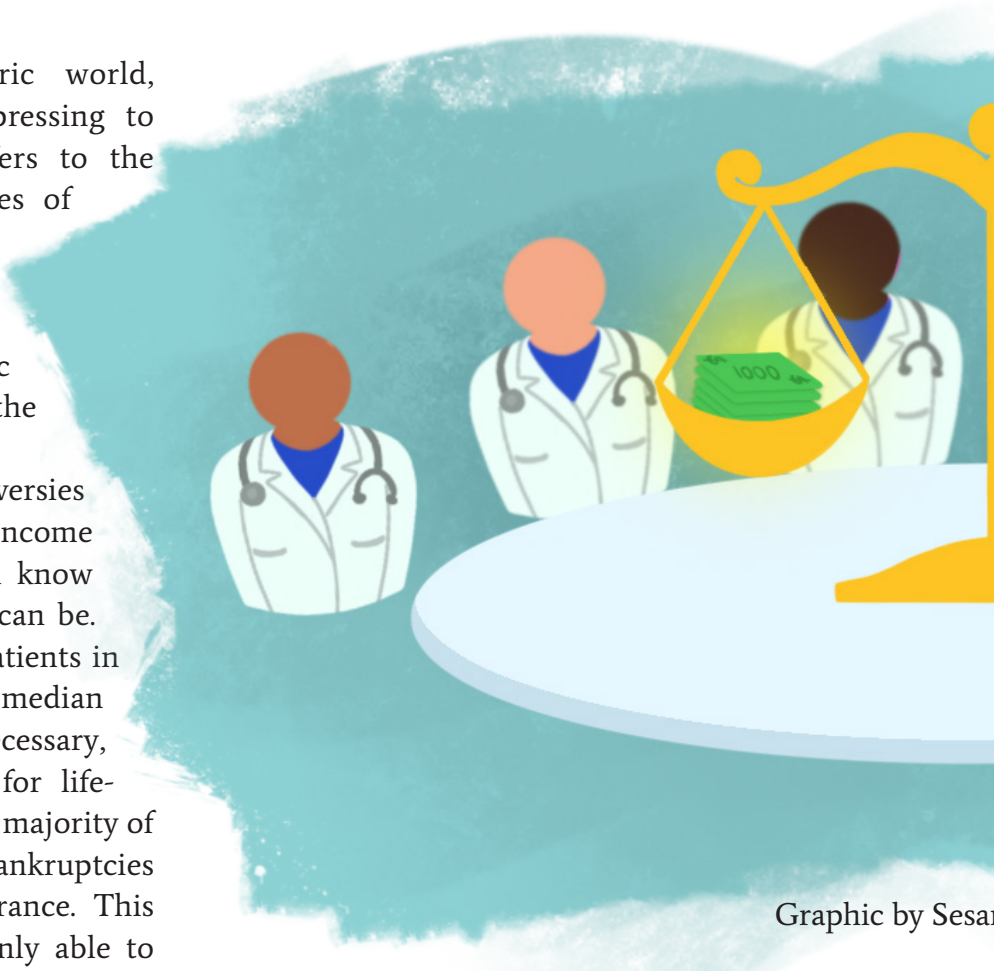
DEBATING BIOETHICS IN

By Clarenc



Graphic by Sesa

In the modern healthcare-centric world, bioethics has become increasingly pressing to address. The study of bioethics refers to the ethical implications and consequences of health-related life sciences.[1] Broadly speaking, bioethics encompasses many important issues such as medical ethics, environmental ethics, and public health ethics. With that said, what are the largest bioethical issues at hand today?

First, one of the biggest controversies in public health is the impacts of income disparity on patient treatment. We all know how expensive healthcare in America can be. The average hospital stay for cancer patients in 2015 was $31,390, around half of the median household income.[2] Especially for necessary, but extremely expensive, treatments for life-threatening diseases such as cancer, the majority of lower-income patients suffer personal bankruptcies due to medical bills, even with insurance. This results in rich people, who are not only able to afford these treatments but also able to afford better treatments, living on average 10 to 15 years longer than poor people.[2] Even more, these health disparities are only expected to enlarge with time. As new technologies such as exoskeletons, implants, and artificial limbs designed to augment human capabilities are developed, the rich will have greater means to pay for these technologies and further increase their biological advantage over the poor.[2] In the end, the disparity question becomes: is it really ethical for the rich to buy their way into a longer and healthier life while the health of lower-income families are constantly placed at risk?

Another great debate in public health is physician aid-in-dying (PAD). According to the University of Washington School of Medicine, PAD is a practice in which patients are provided a lethal dose of medication by a physician to allow them to end their life.[3] PAD is distinguished from euthanasia by the patient themselves administering the fatal dose as opposed to a third party such as a doctor. There is no consensus around the nation surrounding PAD; while the practice is legal in Oregon, Washington, and Vermont, it is considered illegal in many other states. Not only do courts contradict each other on this issue but also physicians themselves, as surveys show that only half of the physicians tested believe that PAD is ethically justifiable.[3] Arguments for PAD involve respecting individual

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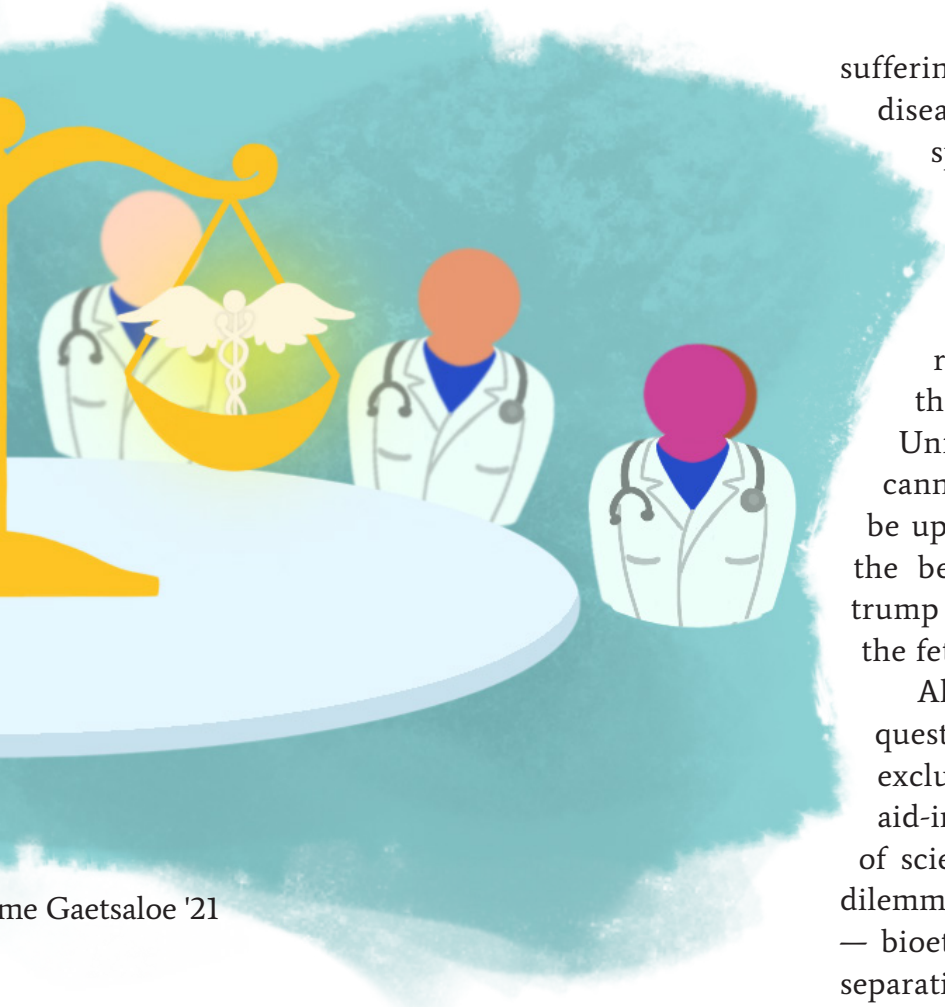

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liberty and autonomy and showing compassion to those who are suffering, while arguments against PAD include the sanctity of life and the physician's oath of providing only benefit.[4] Debates will only continue as the question of whether physician aid-in-dying is ethically permissible is further considered.

A final issue of bioethics is the argument over the morality of embryonic stem cell research. Stem cells are widely seen as the key to medical advancement. Stanford Medicine states that once we understand stem cells, "[We] will be able to replace damaged tissues and help the body regenerate itself, potentially curing or easing the suffering of those afflicted by disorders like heart disease, Alzheimer's, Parkinson's, diabetes, spinal cord injury, and cancer."[4] However, stem cells are normally obtained from human fetuses, provoking several serious questions concerning the moral status and treatment of fetuses — are they really considered "human?" If not, where is the line drawn between fetus and human? Unfortunately, many of these questions cannot be answered by science itself and will be up to the general public to decide whether the benefits derived from stem cell research trump ethical considerations for the status of the fetus.[5]

All in all, bioethics hopes to answer our many questions in public health, including but not exclusive to, healthcare disparities, physician aid-in-dying, and stem cell research. As the field of science continues to develop — new ethical dilemmas arising and current debates intensifying — bioethics looks to be ever-more important in separating right from wrong.

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PANDEMIC-ERA PUBLIC TRANSPORTATION: A NECESSARY RISK?

By Renee Jiang '22

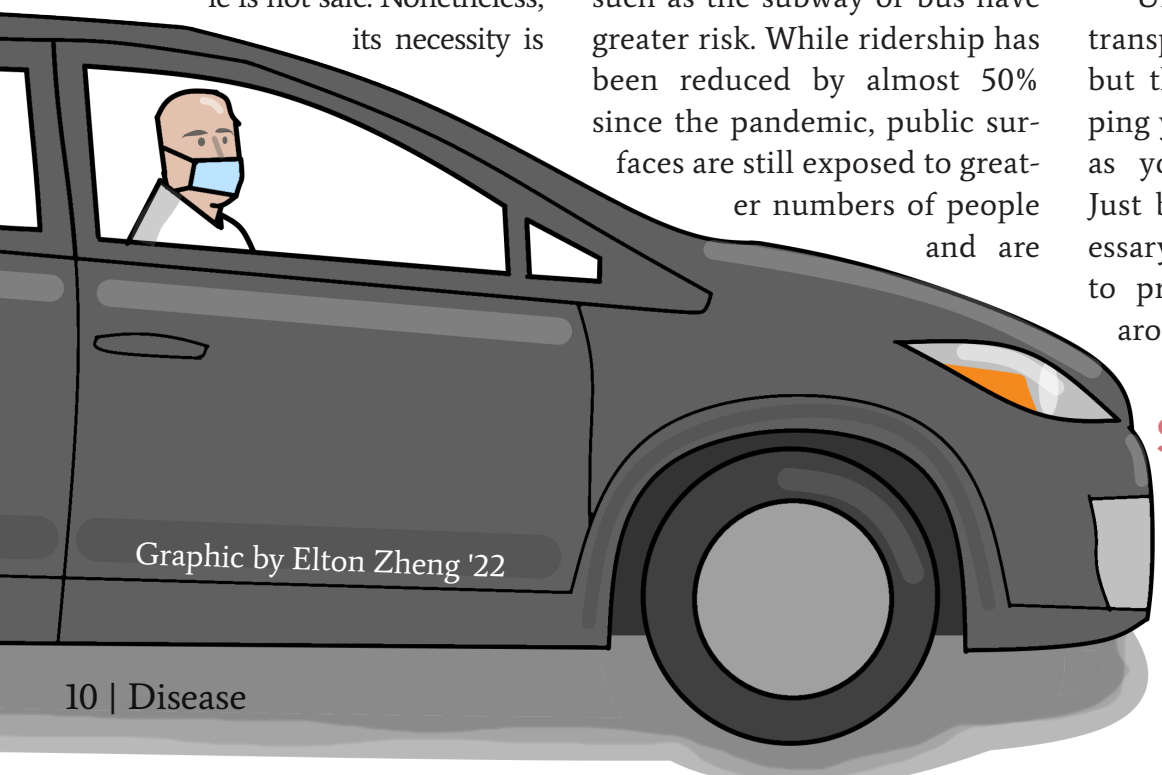
As the COVID-19 pandemic continues to halt many aspects of everyday life, the safety and necessity of public transportation is continuously brought into question. A topic of great controversy, the use of public transportation during this pandemic has been deemed by many as unsafe and inconsiderate to others' health. At the same time, public transportation is also necessary to millions of people around the world. This calls into question: should we be taking public transportations such as the subway or Uber at all?

The simple answer is no. Public transportation during this pandemic is not safe. Nonetheless, its necessity is unquestionable, and thus, careful choices should be made.

In this case, the safest public transportation would be rideshare options such Uber or Lyft. These companies require face masks and safety checks for all drivers, and personal contact is limited through plastic barriers between the front and back seats. Moreover, most drivers have been sent disinfectant for cleaning their cars after each ride. Still, keep in mind that rideshare options are still moderate-risk, so take the necessary precautions and limit the amount of times you travel.

More affordable options such as the subway or bus have greater risk. While ridership has been reduced by almost 50% since the pandemic, public surfaces are still exposed to greater numbers of people and are not disinfected as frequently.[1] Furthermore, social distancing on public transportation is not strictly enforced, making the risk of contracting coronavirus much higher. Despite these setbacks, many public vehicles do come with heating, ventilation, and air conditioning (HVAC) filters, which help slow down the spread of disease particles.[1] Given this reality, it is essential to protect your own safety by taking precautions, such as bringing along disinfectants, staying six feet apart, and avoiding high-risk surfaces such as poles and seating.

Ultimately, taking public transportation often is not safe, but there is also nothing stopping you from travelling as long as you understand the risks. Just be sure to follow the necessary safety guidelines in order to protect yourself and those around you.



Graphic by Elton Zheng '22

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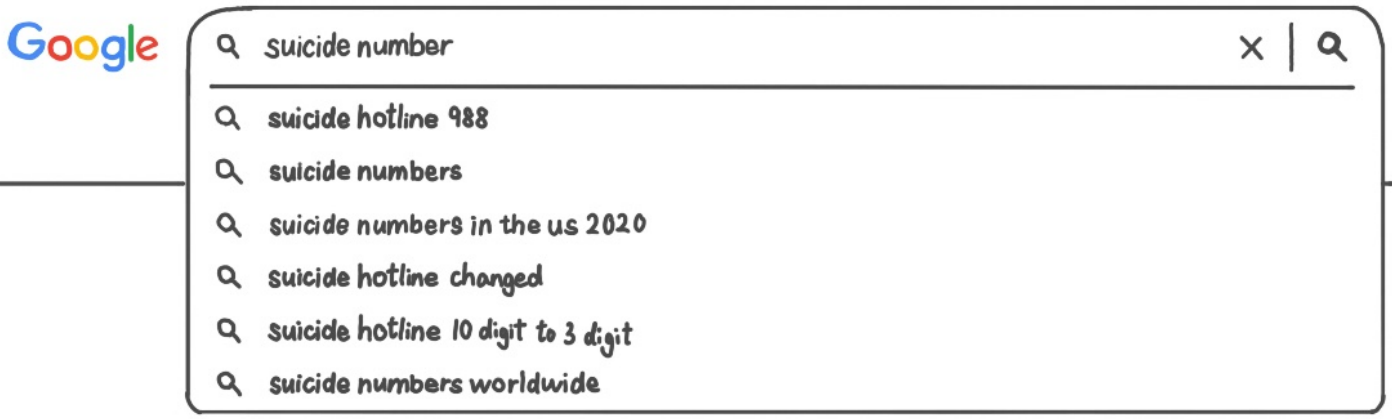

988, WHAT'S YOUR EMERGENCY?

By Maddie Chia '23

The American Foundation for Suicide Prevention is grateful for the National Suicide Hotline Designation Act that was recently signed into law by former President Trump. CEO Robert Gebbia rejoiced, saying "We are thrilled, because this is a game changer." The previously ten-digit suicide hotline number will be changed into an easy-to-remember three-digit number: 988.[1]

Calls to suicide prevention centers have doubled from 2014 to 2018, and even more so in recent years.[2] Especially during the pandemic, many experts are projecting that suicide rates may rise as long term effects set in, resulting from fear, anxiety, and self-isolation amongst other reasons.[3] It has been recorded that during the pandemic, calls to the suicide hotline have increased, peaking at 6% in July.

The new three-digit number will be an enormous aid in helping those suffering from mental health problems and seeking the help of others during this difficult time. Gebbia highlights, "When you're in crisis and you're already emotionally upset, the hardest thing to do is find the number that's a 10-digit number and call it."[1] Hopefully, the shortened number will be easier to remember in times of emotional distress. Similar to the nature of 911 calls, the number will be so deeply ingrained in our memory that whatever situation we are in, we are able to easily remember the number and dial it — 988. The hotline is expected to be up and running by July 16, 2022.

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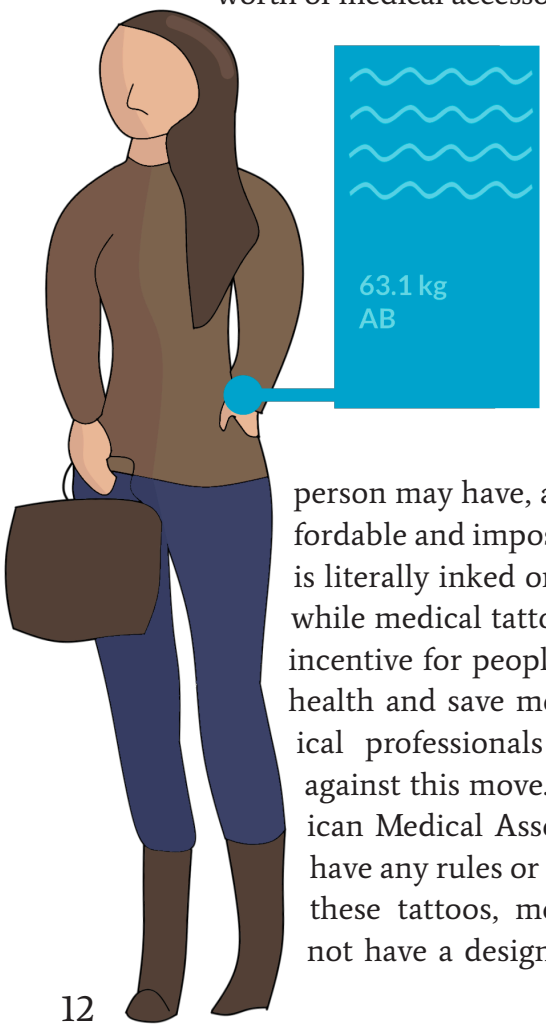
REBRANDING TATTOOS FOR HEALTH

By Rajeev Roy '23

Across the globe, medical emergencies occur almost every second. When these emergencies arise, there is often one significant issue: paramedics cannot find a patient's medical history or pre-existing conditions to help identify the problem quickly. Nowadays, many professionally approved items, such as medical wristbands or necklaces, provide important patient information to help paramedics and medical professionals treat patients in emergencies. Nonetheless, these medical accessories still raise concerns for many, as they are expensive and can be lost easily. As a result of losing hundreds of dollars worth of medical accessories, many people have been reported to switch over to medical tattoos.

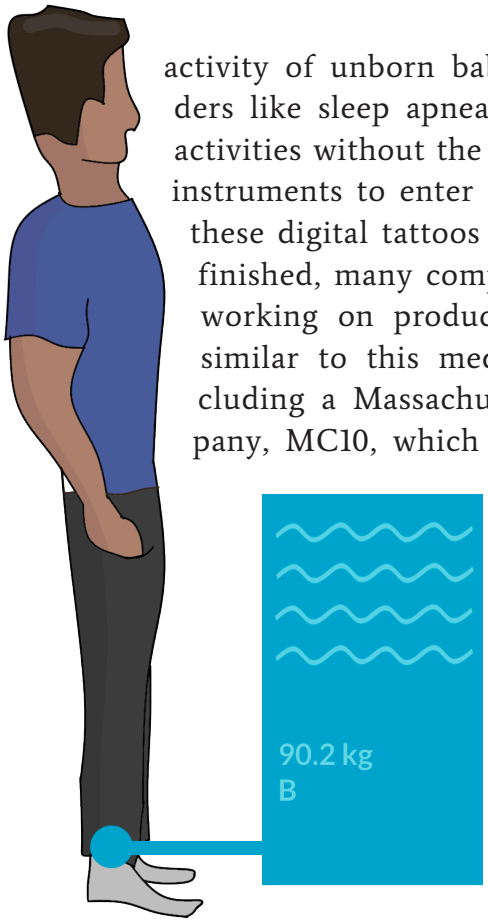


Medical tattoos can be used to inform medical professionals of any issues or medical complications a person may have, all while being affordable and impossible to lose, as it is literally inked onto the skin. Still, while medical tattoos provide much incentive for people to protect their health and save money, many medical professionals have cautioned against this move.[1] Since the American Medical Association does not have any rules or regulations about these tattoos, medical tattoos do not have a designated place on an individual's body. Oftentimes, they can be difficult for paramedics to locate in medical emergencies.[2] Additionally, medical professionals have no obligation to follow these tattoos because of the lack of rules and regulations. Currently, the only tattoo that is medically accepted is for patients who undergo radiation therapy, as freckle-sized tattoos are needed for radiologists to pinpoint a location on the patient's body.

With modern technology, it is already possible to monitor and record patients' data in daily life, so researchers are focused upon making these measurements more accurate and efficient. For the past decade, innovative propositions have been developed to resolve this issue, mostly based on the idea of placing or attaching measurement tools onto a patient's skin. There are three facets to this idea: weaving technology into clothes, digital tattoos, and eventually, even digestible nanobots.

Currently, people around the world are working on these three frontiers and have been able to accomplish many things in this field with the recent improvements in 3D printing, circuit printing, reduced size of electronics, and improved flexibility of electronics. HexoSkin, an up-and-coming smart clothing company, has created clothing items with technology woven into the fabric that can record the heart rate, number of steps, pace, and even calories burned.[3] The company is on the leading edge of medical clothing and is continuing to improve their products.

Many research groups have also begun to work more on "digital tattoos," which can help health care experts document and diagnose critical health issues like heart arrhythmia, heart



activity of unborn babies, sleep disorders like sleep apnea, and even brain activities without the need for medical instruments to enter the body. While these digital tattoos are still far from finished, many companies have been working on products that are very similar to this medical fantasy, including a Massachusetts-based company, MC10, which is known for its considerable advancements in digital tattoo technology. John Rogers, a leading engineer in this field, and his team have set the base for flexible technology on which MC10's operations are built on. The first marketed product of MC10 was its BioStampRC sensor — a waterproof, bandaid-like item that sticks to the skin and can analyze movement, muscle activity, and heart activity. The product, released in 2016, was also fitted with Bluetooth receptors and a miniature battery. Since then, the company has developed silicon patches containing metallic interconnects and flexible rubber-like polymers to form a system that senses, measures, analyzes, and communicates information, all while being a fraction of the width of a human hair. These patches are also being developed to function without batteries, thus eliminating the need for charging.

In addition, a Harvard and MIT research group has also been working on bio-sensitive inks that adjust colors due to any changes that may occur in the body, such as the concentration of glucose and sodium, pH levels in the skin, and even blood pressure. This is a challenging task, but this research group has so far successfully designed a green ink that intensifies as the sodium concentration levels increase in the body of the wearer and another green ink that turns brown as the glucose level increases, which would be useful for diabetic users. Newly-developed pink ink tests that turn blue as pH levels increase have been effective, but the ink is still in its early stages of testing.

Ultimately, these many medical ink solutions are still in the works and researchers continue to work hard to find more innovation in their field. In the near future, we can hopefully see even better products in the realm of medical tattoos that can dramatically alter and improve the process of analyzing and diagnosing patients for medical professionals.

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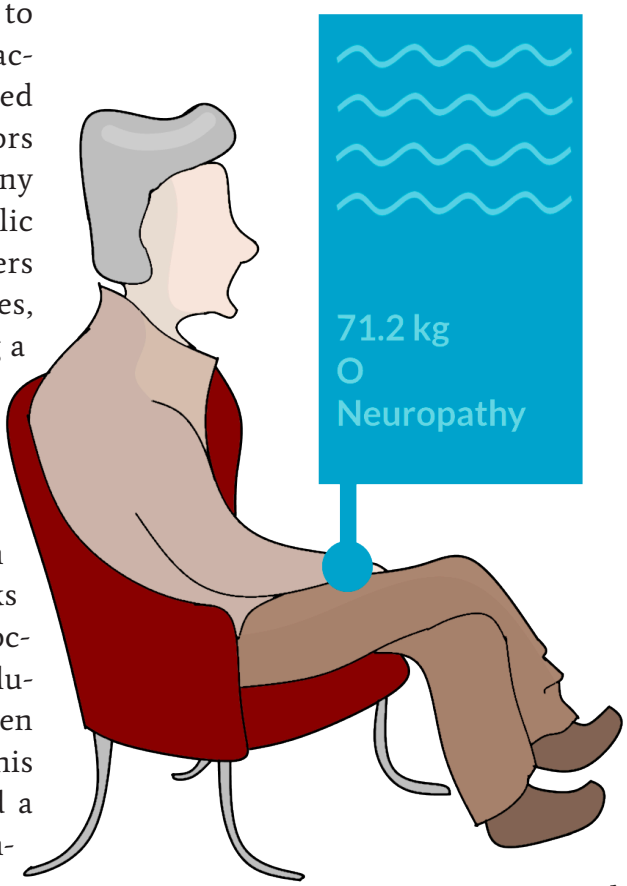

Graphics by Elton Zheng '22

AMONG THE DUST AND FO

By Amanda Benneh '24

While many would consider access to clean air quality as a given in modern times, this is not the case for many countries around the world. India's battle with air pollution has been ongoing for years. In fact, out of 30 cities in the world with the worst air pollution, 21 from India make the list, with six in the top ten.[1] In addition, the World Health Organization (WHO) and the United States Environmental Protection Agency ranked New Delhi as the world's most polluted city in 2014 and 2016, respectively.[1] The sight of foggy air and dusty surroundings has become a part of the new normal that can be seen progressively taking over the country as the struggle for cleaner air continues across the globe.

Air pollution is caused by a number of factors responsible for specific dangerous emissions into the air. So how did India become one of the most polluted countries in the world? 51% of pollution is caused by industrial pollution, 27% by vehicles, 17% by crop burning, and 5% by fireworks.[2] Another part of that percentage includes thermal energy plants, which often work by heating up fossil fuels. As such, they emit greenhouse gases and ash including carbon dioxide, nitrogen oxides, and sulfur dioxide. Alongside these gases, the ash produced from these thermal energy plants directly harms the environment as the particles gather together to produce the thick air that is often present in larger cities such as Gurugram, New Delhi, and Ghaziabad.

A root problem is poverty in several distinct regions in India. In many instances, poorer

G OF INDIA'S POLLUTED AIR

households use wood and biomass cakes for cooking, which, in large amounts, can cause dangerous levels of pollution. A report by the WHO stated that 300,000 to 400,000 people die of indoor air pollution and carbon monoxide poisoning in India.[3] The severity of these effects continue to grow as public transportation, construction, vehicle exhaust, agricultural fires, and dust increase throughout the country. These types of pollutants have not only an effect in the air but also a tremendous impact on the health of those who breathe it in.

India often experiences a "pollution season" when the effects of population experience a sharp increase. In November of 2019, for example, the government of India was forced to close schools, sports activities, and other events due to the danger posed to sensitive groups — which include the youth, school children, and many adults with underlying health conditions. The 2013 Global Burden of Disease Study revealed that about 620,000 deaths occured due to air-pollution caused diseases, the fifth largest killer in India.[3]

In an attempt to alleviate the effects of air pollution in the country, many policies have been put in place. In order to create a National Air Quality Index (NAQI), 32 sensors have been installed throughout the country to measure the concentration of fine particles in the air.[3] Further, in January 2019, the Indian government formed an organization called the National Clean Air Program (NCAP), which spans over a five year time period and aims to build a pan-India air quality monitoring network. The program focuses on 102 polluted Indian cities and aims to reduce PM2.5 levels by 20-30%.[4] Other policies include control measures to decrease the amount of unleaded petrol, sulfur content in diesel, and benzene content in fuels.[4] Vehicular policies implemented by the government continue to have a positive result, and according to recent studies, there has been a significant improvement following government initiatives to combat the outbreak of air pollution in India. By continuing on this path and increasing awareness among its population, the air pollution problem in India can slowly be alleviated.

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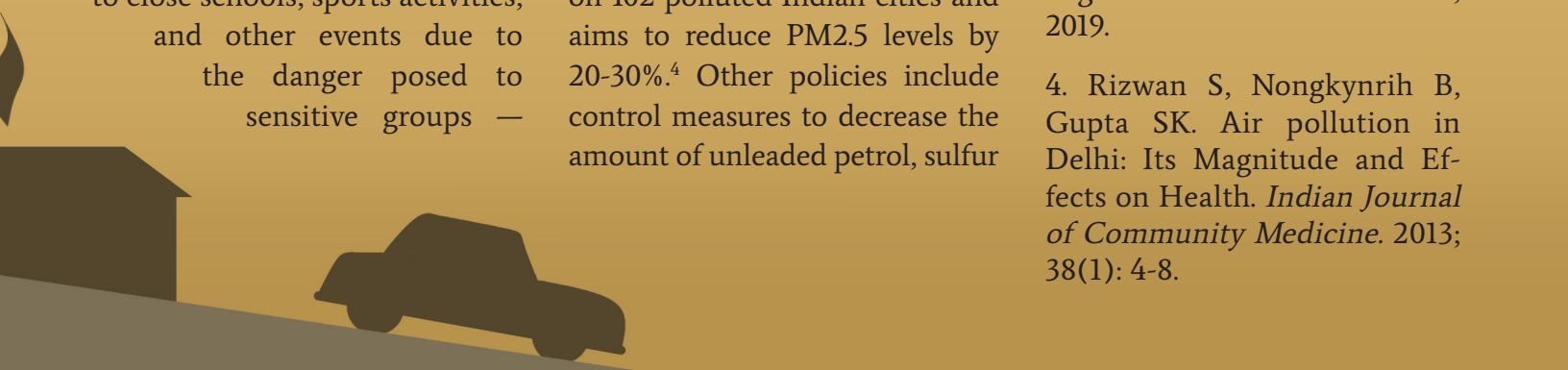
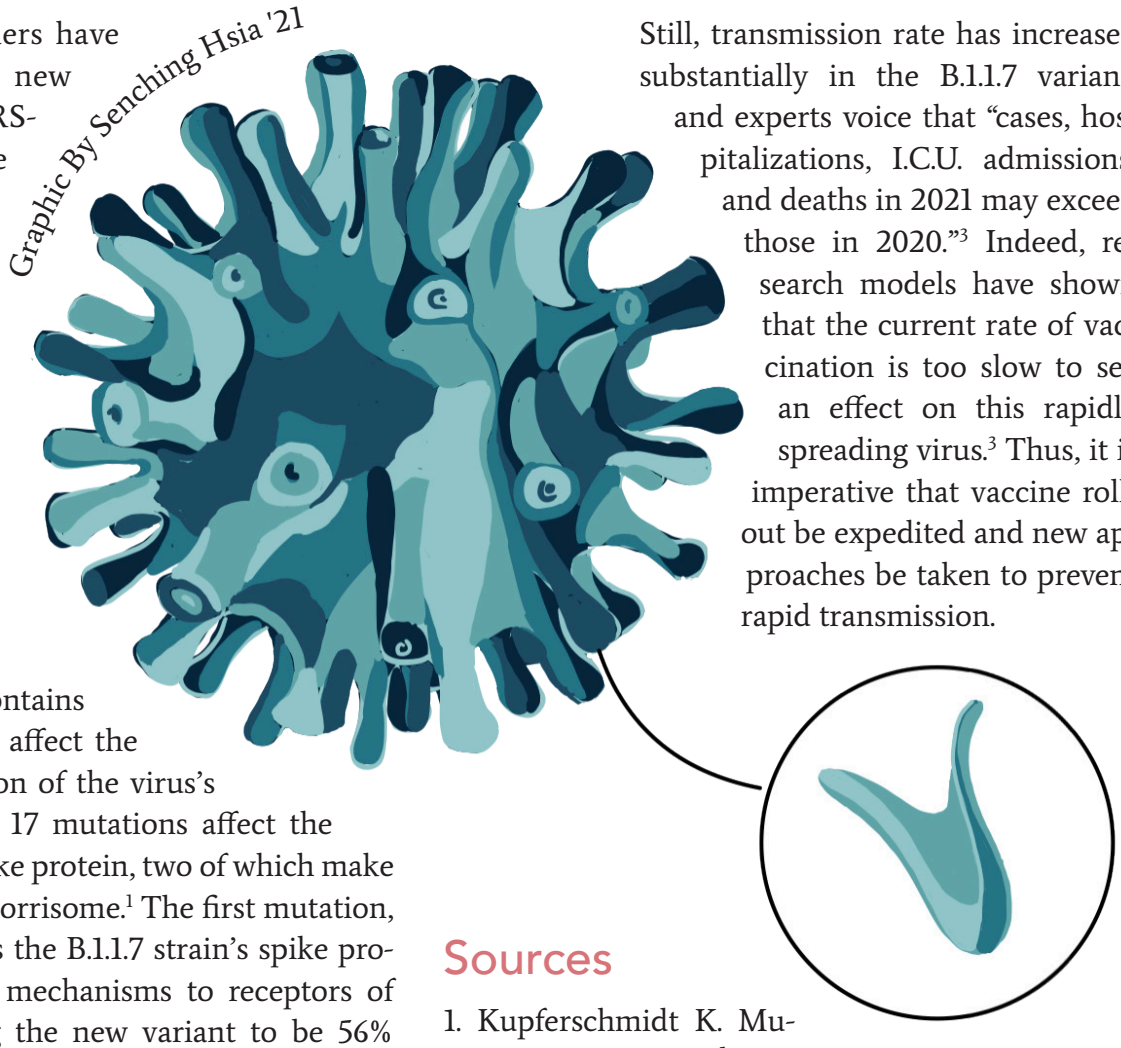


Graphic by Elton Zheng '22

COVID-19 MUTATIONS: SHOULD WE BE WORRIED?

By Ava Lee '23 & Joy Bang '22



Recently, researchers have identified multiple new strains of the SARS-CoV-2 virus since it first emerged in December 2019 in Wuhan. The identification of a new variant of the virus in the U.K. just last December has particularly worried the scientific community and healthcare officials.

The new variant, dubbed as B.1.1.7, contains 17 mutation sites that affect the amino acid composition of the virus's proteins. Eight of the 17 mutations affect the composition of the spike protein, two of which make this strain especially worrisome.[1] The first mutation, named N501Y, confers the B.1.1.7 strain's spike proteins' tighter binding mechanisms to receptors of human cells, allowing the new variant to be 56% more transmissible.[1] The second mutation called 69-70del deletes two amino acids of the spike protein, which will help the virus elude immune responses.[1]

Fortunately, vaccine experts assure that the mutated strain of the virus should not evade the antibodies induced by the vaccine.[2] Director of the National Institute of Allergy and Infectious Diseases, Dr. Anthony Fauci, explained, "Even though you have one part of the virus that's changed, it's very likely that the other components of the vaccine-induced response will protect you."[2]

Still, transmission rate has increased substantially in the B.1.1.7 variant, and experts voice that "cases, hospitalizations, I.C.U. admissions, and deaths in 2021 may exceed those in 2020."[3] Indeed, research models have shown that the current rate of vaccination is too slow to see an effect on this rapidly spreading virus.[3] Thus, it is imperative that vaccine rollout be expedited and new approaches be taken to prevent rapid transmission.

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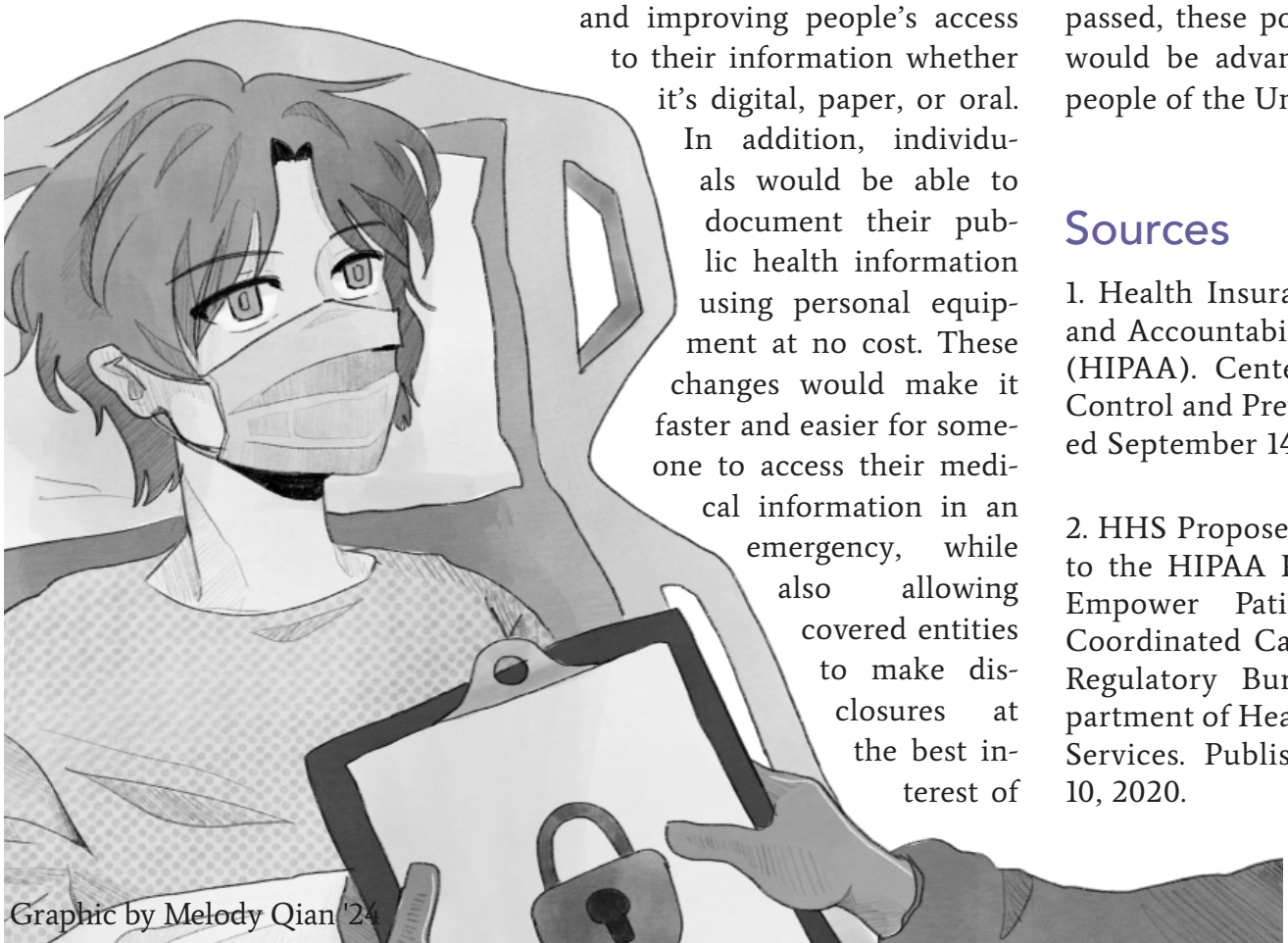
POTENTIAL CHANGES TO HIPAA: MEDICAL PRIVACY MADE PRACTICAL

By Ixchel Hernandez '23

With technology constantly changing and improving the medical world, it's now more important than ever to know how medical records are being protected and how to access them. The people who manage medical records in the United States are obliged to follow the Health Insurance Portability and Accountability Act of 1996 (HIPAA). All healthcare providers, health plans, healthcare clearinghouses, and business associates must comply with the rules under the Act, such as the Privacy Rule, as "covered entities." The Privacy Rule allows people to control how their medical information is used while allowing these covered entities to help them in any health situation.

In December, the U.S. Department of Health and Human Services (HHS), announced potential changes in HIPAA.[1] These changes include making it easier for entities to disclose information during health emergencies and improving people's access to their information whether it's digital, paper, or oral. In addition, individuals would be able to document their public health information using personal equipment at no cost. These changes would make it faster and easier for someone to access their medical information in an emergency, while also allowing covered entities to make disclosures at the best interest of the individual instead of their personal judgment. Lastly, it would reduce the administrative responsibilities of HIPAA but still allow them to protect someone's information. Alex Azar, United States Secretary of of Health and Human Services, said, "As part of our broader efforts to reform regulations that impede care coordination, these proposed reforms will reduce burdens on providers and empower patients and their families to secure better health."[2] If passed, these potential changes would be advantageous to the people of the United States.



Graphic by Melody Qian '24

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THE MANY LAYERS OF SKIN GRAFTING

By Bella Capuano '21

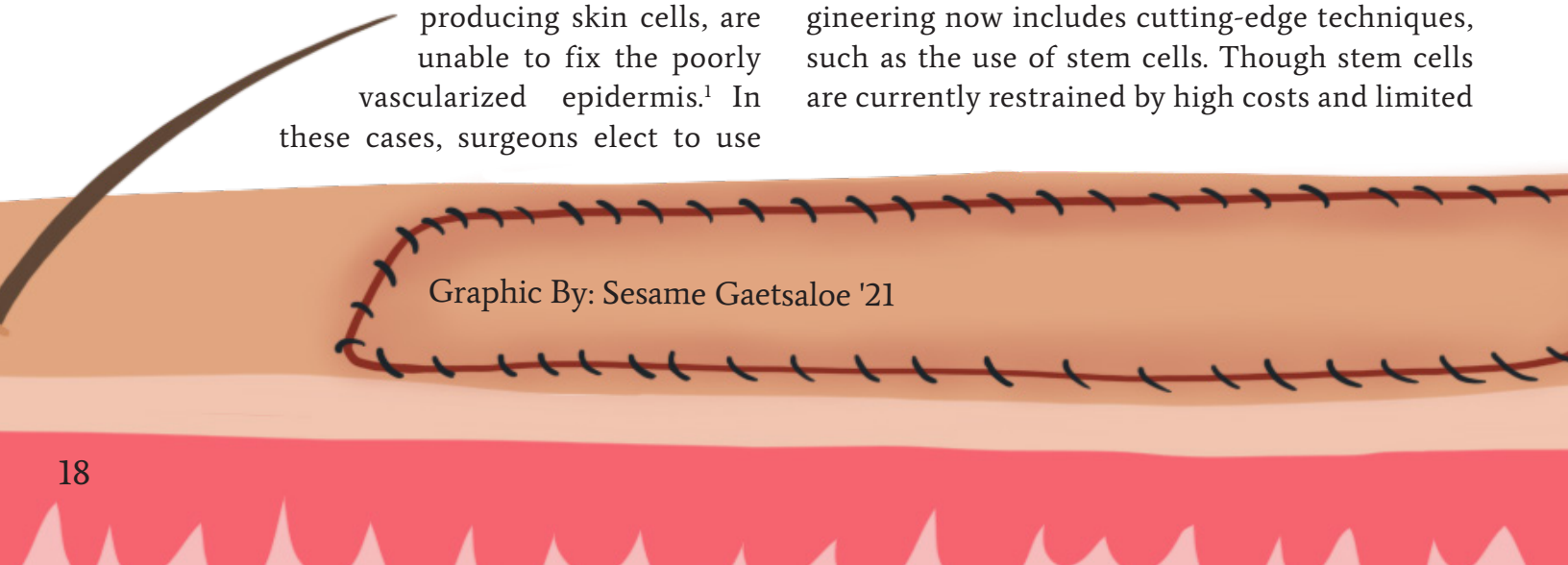
Transplanting skin might seem like a strange concept, but skin grafting is actually a critically important procedure for the treatment of many health conditions. The procedure is one in which skin from a patient's own body or another being's body is transplanted to replace damaged skin caused by severe burn, illness, or injury.

In normal situations, human skin serves many vital roles: protecting the body from infections, maintaining the balance of fluids leaving and entering the body, and synthesizing vitamin D. The skin consists of three main layers: the epidermis, the dermis, and the hypodermis. The epidermis is the top layer of skin, the dermis is the middle layer, and the hypodermis is the innermost layer.

Traditionally, there are four main skin grafting techniques: autografts, allografts, xenografts, and tissue-engineered skin substitutes. When an injury to the skin extends deep into the dermis, keratinocytes, the cells responsible for producing skin cells, are unable to fix the poorly vascularized epidermis.[1] In these cases, surgeons elect to use autografts, or the person's own skin tissue, as the graft. The benefit of an autograft is that there is no risk of the patient rejecting the graft, since it comes from the same body.[1]

Allografts and xenografts, on the other hand, require graft donors from another person or mammal, respectively. When there is not enough donor tissue, allografts and xenografts are typically used.[1] Allografts are harvested from dead tissue donors and stored for when they are needed. However, the possibility of the immune system rejecting the foreign graft adds to the difficulty of these transplants.[1] Allografts are helpful as a short term solution and prepare the skin well for when an autograft can replace the allograft.[1]

In its early years, skin tissue engineering emerged from laboratories as a biodegradable matrix material to act as the dermis. Advancements in science led to keratinocyte culture techniques that better emulate skin.[1] Skin tissue engineering now includes cutting-edge techniques, such as the use of stem cells. Though stem cells are currently restrained by high costs and limited



Graphic By: Sesame Gaetsaloe '21

effectiveness, their ability to differentiate into a variety of tissues has proven to be more effective than many other skin substitutes, indicating much future potential.[1]

Stem cells also play a role in wound healing as bone-marrow-derived stem cells help repair dermal fibroblasts in wounds to the skin.[1] Bone-marrow-derived stem cells are advantageous because they have clinically been tested and can be used in allogeneic settings, indicating that these stem cells can be transplanted from other humans.[1]

Other types of stem cells are also being used in research, such as embryonic stem cells and induced pluripotent stem cells. Embryonic stem cells (ESCs) can be differentiated into keratinocytes and fibroblasts, key components of the skin and integumentary system that are not present in grafts.[2] Using embryonic stem cells, however, raises ethical concerns of using embryos in research.[2] Induced pluripotent stem (iPS) cells are artificially derived from non-potent stem cells by enabling the cell to express certain genes.[1] Originating in 2006 with mouse cells and 2007 with human cells, iPS cells improved skin grafting because they overcame the challenges of immune rejection and the ethical implication of using embryos.[1] Both stem cell types can be made into skin cells and then transformed into nerve cells and eventually muscle cells.[2]

Groundbreaking studies such as that of Michele de Luca prove that there is much promise for the future of the skin grafting field. Her clinical trial and research focused on a seven-year boy named Hassan who suffered from a rare genetic disease known as junctional epidermolysis bullosa (JEB), which results from a genetic mutation of the protein laminin-332.[3] The protein always forms the top and bottom layers of the skin to connect, but Hassan's lack of functioning laminin-332 had led to painful blistering of skin whenever friction was applied.[3] As a result, JEB had stripped 80% of his skin away.[4] De Luca and her team took unaffected skin cells from the child's groin and, using epidermal stem cells, modified Hassan's skin to include laminin-332.[4] After many surgeries, 80% of Hassan's epidermis was successfully replaced, becoming the largest genetically modified graft to date with nearly 400 million cells grafted.[3] At the end of the two-year study, Hassan's regenerated skin stuck to underlying layers, and smooth skin took the place of numerous blisters.

Despite the many advancements in skin grafting over the years, there remains much to be discovered and avenues to go down. Nonetheless, skin grafting technology is an exciting prospect and something to look out for as the field continues to grow and evolve.

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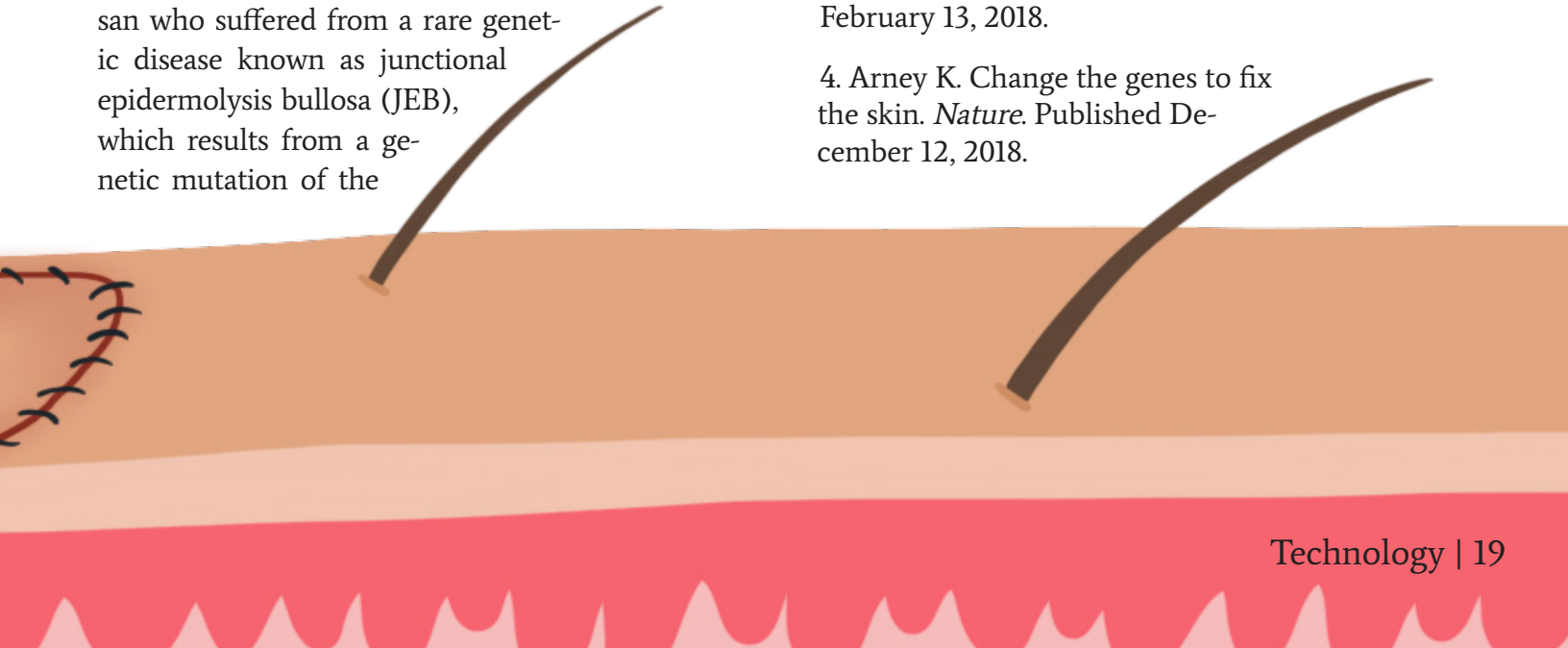


EXAMINING THE ME

By Chloe

Gender discrimination is a major issue in our healthcare system. According to a 2019 Today survey, 20% of women reported that their symptoms have been ignored or dismissed by healthcare providers, and 17% have said that they feel they have been treated differently because of their gender. These statistics stand in stark contrast to the 14% and 6% reported by men, respectively.[1]

What is gender bias?

Gender bias in healthcare occurs when a patient is assessed, diagnosed, and treated at a lower quality because of their gender. When healthcare providers do not offer equal medical care for the same complaints as a result of a patient's gender — especially if sex is not a factor that affects the manifestation of the disease — patients are at risk of not receiving proper treatment.[2]

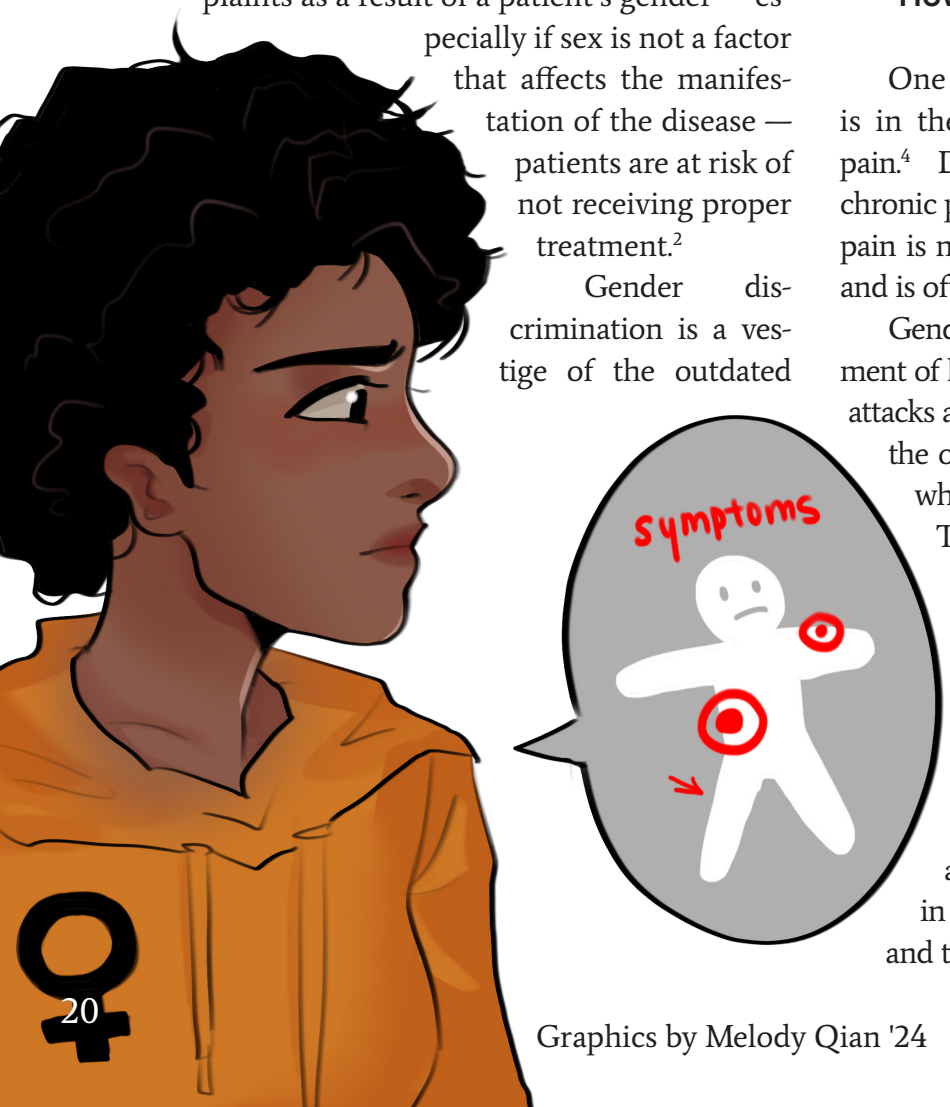
Gender discrimination is a vestige of the outdated medical belief that the sole difference between male and female physiology is their reproductive organs. Since women are born with all the eggs they will ever produce, they were excluded from early clinical trials for novel drugs to prevent possible adverse effects to their reproductive health.[1] As a result, diseases that present differently in women are often misdiagnosed because they are not fully understood.

On the other hand, physicians may fail to diagnose a certain problem because it is stereotypically more prevalent in another gender. For example, hypothyreosis is more common in women so providers may overlook this diagnosis for men.[3]

How does gender bias present itself in the medical field?

One way gender bias presents itself in medicine is in the way providers receive reports of patients' pain.[4] Despite the fact that women comprise most chronic pain diagnoses, many women report that their pain is not taken seriously by their medical providers and is often dismissed as being emotionally triggered.[5]

Gender bias also shows up in the diagnosis and treatment of heart attacks. Although mortality rates of heart attacks are greater for women, studies have shown that the odds of survival are the same for both genders when women receive the same therapies as men.[2] That is, the increased danger of heart attacks in females lies not in the medical condition itself, but rather the response to it. In addition, heart attacks for women can be much less painful and alarming than for men. Though the public often only learns of symptoms that typically present in men, it is important for women and medical professionals to learn about the different symptoms of heart attacks in females to ensure a more prompt diagnosis and treatment.



Graphics by Melody Qian '24

DICAL GENDER BIAS

Chan '23

Even more, a recent study indicated that women experience longer waiting times at hospitals, averaging 11% longer door-to-doctor times and 15% longer door-to-imaging times than men.[5]

What can be done?

The first step moving forward would be fully recognizing and addressing gender bias in the healthcare industry. Explicitly encouraging the discussion of gender bias would allow for a platform where healthcare workers would be comfortable speaking up about their concerns. It is also important that patients are aware of patterns of discrimination in order to know how to ask the right questions for optimal treatment for their complaints.[2]

Although clinical trials have begun including a much more diverse subject pool, there still remains much research to be conducted with the often-excluded female subjects. More nuanced information about the female body would help illuminate disparities that were previously unknown and can prevent female patients from being misdiagnosed and mistreated.

In addition, to ensure that all genders are offered equal treatment and evaluated without bias, medical providers should use standard checklists and clinical guidelines that would promote an evidence-based practice and limit providers from relying on their intuition and making assumptions based on the patient's gender and/or biological sex.[1]

While gender discrimination in its many forms are detrimental, these effects are compounded in the healthcare industry. Although acknowledging gender bias is a step forward, this issue won't go away with increased awareness alone. Action needs to be taken — and soon.

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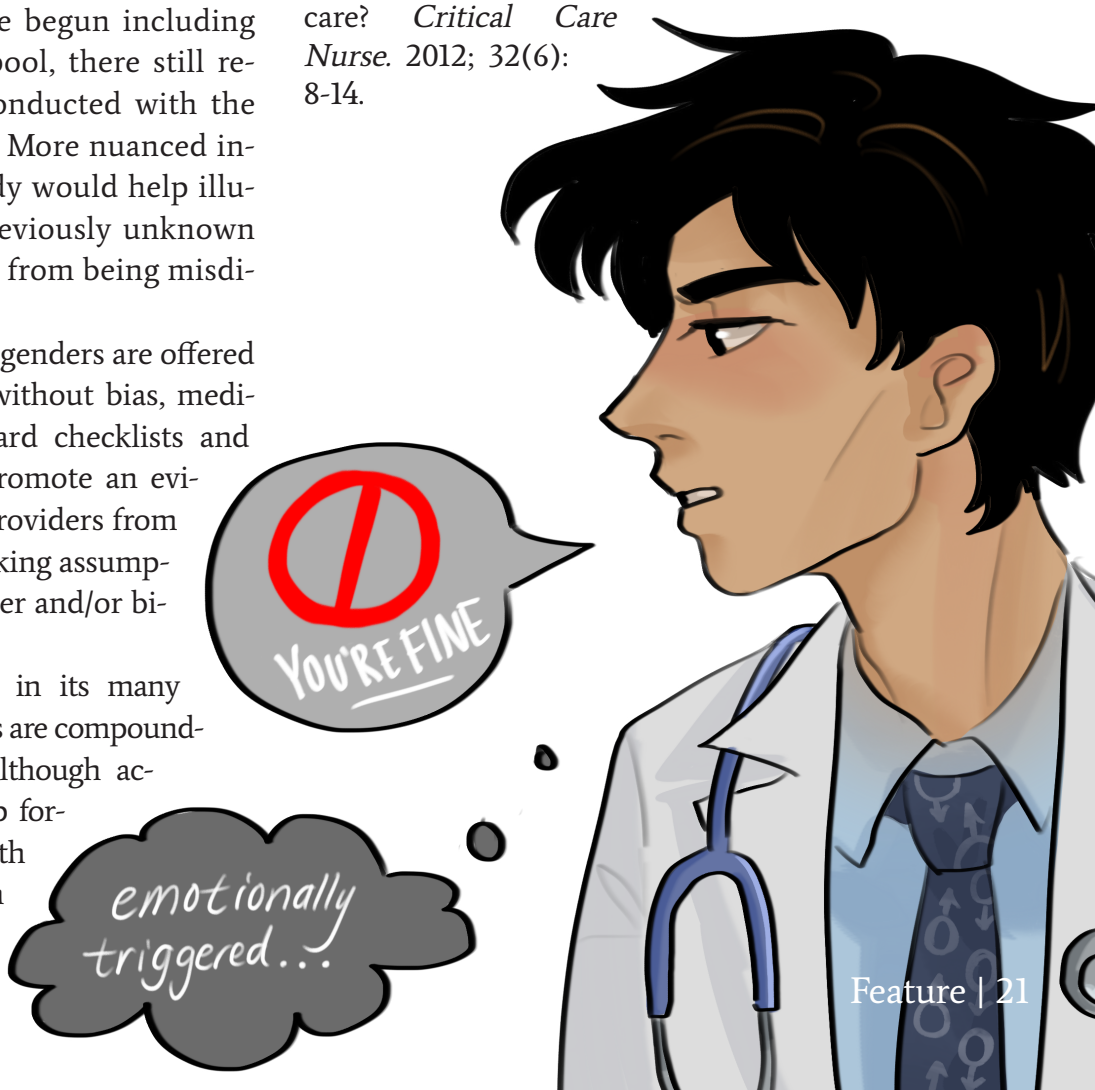


DISCOVERY OF HEPATITIS

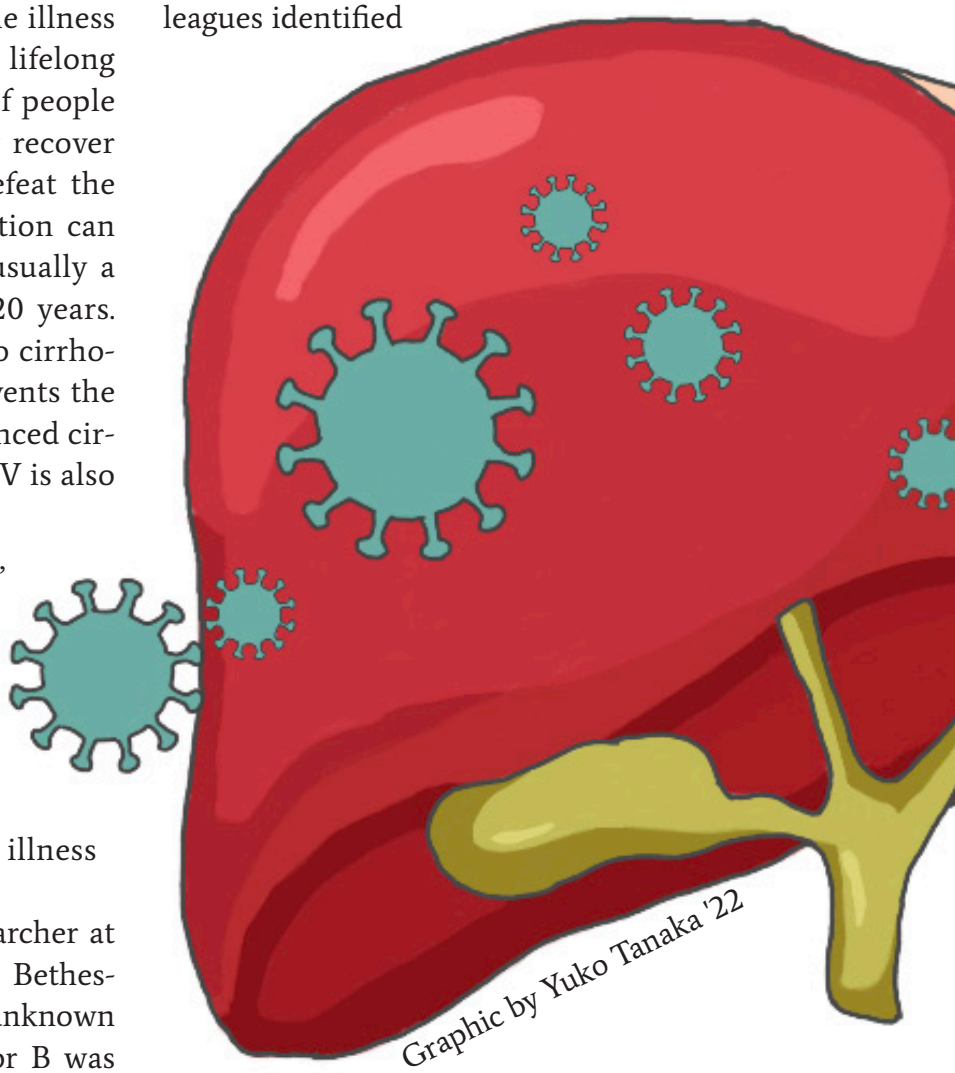
By Prim Tangk

Hepatitis C is a liver disease caused by the hepatitis C virus. It is spread when contaminated HCV blood enters the bloodstream of an uninfected person. The virus can cause both acute and chronic hepatitis C, and the severity of the illness ranges from mild symptoms to a serious, lifelong illness.[3] Within six months, 15% to 45% of people infected with acute hepatitis C can fully recover as their immune systems successfully defeat the infection. However, for others, the infection can turn into chronic hepatitis C, which is usually a "silent" infection during the first 10 to 20 years. Chronic hepatitis C can eventually lead to cirrhosis, or scarring of the liver. Cirrhosis prevents the liver from functioning properly, and advanced cirrhosis can cause liver failure. As such, HCV is also a major cause of liver cancer.[1]

Before the discovery of hepatitis C, hepatitis A and B had already been identified. Hepatitis A is transmitted through polluted water or food and has a minimal long-term impact on patients. Hepatitis B is transmitted through virus-contaminated blood and bodily fluids and can lead to a chronic illness similar to hepatitis C.[4]

In the late 1960s, Harvey Alter, a researcher at the U.S. National Institutes of Health in Bethesda, Maryland, began to suspect that an unknown pathogen that was neither hepatitis A nor B was causing post-transfusion liver disease. Many patients who had received blood transfusions were diagnosed with post-transfusion liver disease with an unexplained cause. Alter and his colleagues investigated this mysterious illness, and their research demonstrated that blood from these patients could also transmit the disease to chimpanzees. Alter and his team also found that this unknown infectious agent had the characteristics of a virus.[5]

At Chiron Corporation in Emeryville, California, Houghton and his colleagues identified



Graphic by Yuko Tanaka '22

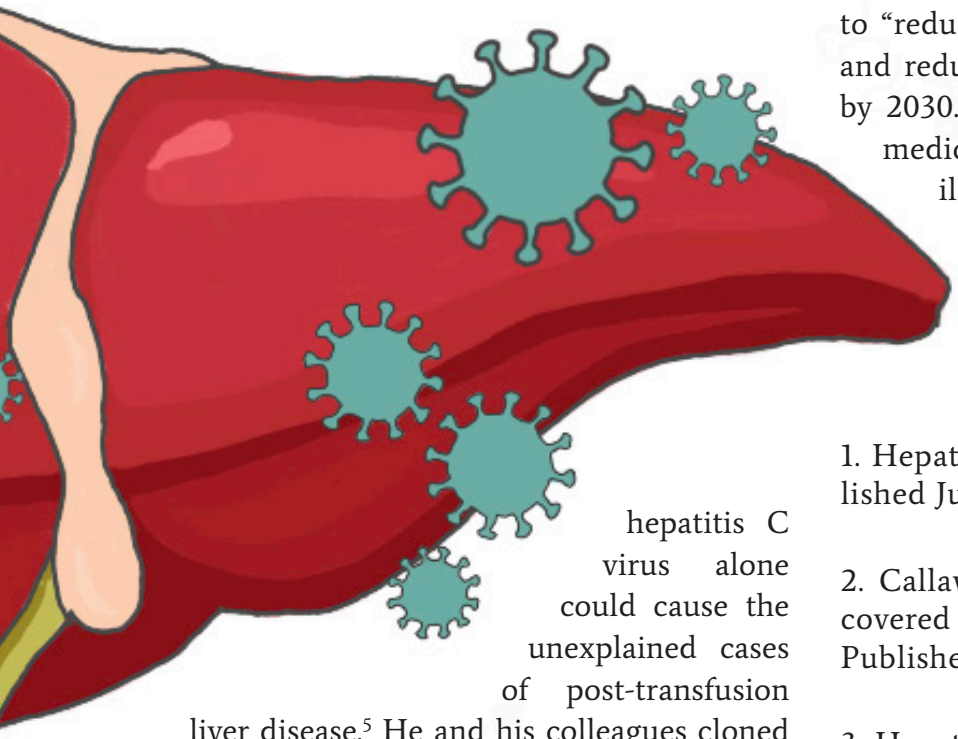
hepatitis C using molecular biology, an unprecedented method at the time. The team took genetic material from infected chimpanzees and used human antibodies to screen for the genetic sequence of the virus. In 1989, the team was able to successfully show that this virus was a new type of RNA virus

C AWARDED NOBEL PRIZE

aravakoon '24

that belongs to the Flaviviridae family.[5] From this finding, a blood test that can screen for hepatitis C was able to be developed.[4]

The third scientist sharing the prize, Rice, then at Washington University in St. Louis, demonstrated that hepatitis C virus alone could cause the unexplained cases of post-transfusion liver disease.[5] He and his colleagues cloned hepatitis C and injected these clones into chimpanzees. At first, the virus did not replicate, but when the clones were compared, Rice noticed that they contained genetic mutations that made them defective. Once these clones were corrected, the chimpanzees showed symptoms of hepatitis C.[4]



Alter, Houghton, and Rice's discoveries have paved the way for effective testing and treatment for hepatitis C. The discoveries "made possible blood tests and new medicines that saved millions of lives," the Nobel committee said.[6] Thanks to their contributions, modern drugs can now cure more than 95% of people who become infected.[1]

Although most infected with hepatitus are cured, many still do not survive. In 2016, approximately 399,000 people died from the disease.[1] To this day, access to hepatitis C diagnosis and treatment remains low, and there is still ongoing research for a vaccine. The WHO has set a goal to "reduce new viral hepatitis infections by 90% and reduce deaths due to viral hepatitis by 65% by 2030."[1] With future developments in modern medicine as well as increased awareness of the illness, especially from this Nobel Prize award, the world may finally see the end of this hepatitis C epidemic.

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