CATAPULTA

WINTER 2020

EDITORS' NOTE

DEAR READER,

OUR WINTER ISSUE COMES AT A TIME WHERE CAUTION, HOPE, AND CONTROVERSY SURROUND THE SCIENTIFIC COMMUNITY, AND THIS ISSUE TOUCHES UPON ALL OF THESE. IN THE WAKE OF SEVENTEEN-YEAR-OLD GRETA THUNBERG BEING NAMED TIME'S PERSON OF THE YEAR 2019, THE BUSHFIRES IN NEW SOUTH WALES ARE YET ANOTHER REMINDER OF THE FAR-REACHING CONSEQUENCES OF MAN-MADE CLIMATE CHANGE. GENE EDITING COULD HAVE REVOLUTIONARY ABILITIES, BUT IT IS THESE SAME POSSIBILITIES THAT WARRANT THE NECESSARY CARE AND ETHICAL DELIBERATION WHEN APPLYING THESE TECHNOLOGIES ON HUMANS.

AS WE BEGIN THE NEW DECADE, WE CAN LOOK FORWARD TO NEW ADVANCEMENTS IN EVERY FIELD AS THE SCIENTIFIC COMMUNITY CONTINUES TO BUILD ON EXISTING KNOWLEDGE. SCIENTISTS AROUND THE WORLD ARE WORKING TO ADDRESS HEALTH ISSUES, LEARN MORE ABOUT THE WORLD AROUND US, AND REDUCE OUR NEGATIVE IMPACTS ON OUR PLANET.

MISINFORMATION SURROUNDING THE WUHAN CORONAVIRUS OUTBREAK, AUSTRALIAN BUSHFIRES, VACCINES, CLIMATE CHANGE, AND MUCH MORE MAKES SCIENCE EDUCATION MORE IMPORTANT THAN EVER. LUCKILY, ACCESS TO ALL LEVELS IS IMPROVING, AND HIGH SCHOOL STUDENTS HAVE MORE AND MORE OPPORTUNITIES TO BE EXPOSED TO HIGH LEVEL RESEARCH.

WE HOPE YOU ALL WILL ENJOY READING THIS ISSUE AS MUCH AS WE ENJOYED MAKING IT!

BEST,
CHRISTY AND JOHN
EDITORS-IN-CHIEF

P.S. DON'T FORGET TO BUY TICKETS TO OUR ANNUAL PI DAY EVENT! MORE DETAILS ARE ON THE BACKPAGE.

CATAPULTA IS MADE POSSIBLE BY SUPPORT FROM THE BOSTON LATIN SCHOOL ASSOCIATION

WINTER ISSUE STAFF

DAISY WANG: STS SCHOLAR

BY: JOHN LIN - II

In early January, Daisy Wang (I) was named a Regeneron Science Talent Search (STS) scholar. She was selected as one of the three hundred top students in the nation for her project "A Non-Invasive RNA-Based Early Detection Method for Prostate Cancer Using Nanotechnology."

Wang's project revolved around integrating biotechnology and nanotechnology to detect PCA3, a biomarker for prostate cancer, using Surface-Enhanced Raman spectroscopy (SERS) to do so. SERS works by scattering photons in the form of lasers, which collide with molecules and produce a signal, making it possible to detect very small concentrations of molecules. Wang developed a sensitive method to detect PCA3 by measuring the sizes of the molecules through SERS.

Wang explained that "I ultimately chose prostate cancer because the RNA biomarker is overexpressed in over ninety-five percent of prostate cancers, a higher percentage and thus [higher] specificity than the other markers I was looking at," while discussing her motivation behind the project.

The Regeneron STS is a nationwide research competition for high school seniors. The process of becoming a finalist requires a lengthy application, which involves submitting a research paper, letters of recommendation, test scores, personal statements, and extracurricular activities. Out of the over eighteen hundred students who applied, three hundred, including Wang, were selected as semifinalists, or Scholars, in early January. A few weeks later, the top forty finalists, who will compete in Washington D.C. for a chance to win 250,000 dollars, were also announced. As an STS scholar, both Wang and the Science Department at BLS will receive two thousand dollars.

When asked about how the recognition feels, Wang commented, "I honestly feel no difference despite the title. Sure, I'm honored, but I will continue to conduct research simply because I enjoy it."

WUHAN EPIDEMIC

BY: CONRAD HOCK - I

In a matter of weeks, the coronavirus, more specifically the 2019 novel coronavirus (2019-nCoV), has grown from a minor, relatively localized outbreak to a global health crisis. Cases were first reported in December 2019 in Wuhan, the capital city of China's Hubei province. By mid-January, it had spread to other Chinese cities and a few other Asian countries. Now, it has reached Europe, Australia, and even the United States, with cases having been reported in several cities including our very own Boston, Massachusetts.

The source of the coronavirus is unclear, but it likely originated from animals—possibly bats. Nevertheless, the CDC has confirmed that it can spread via human interaction. As of February 8, 2020, more than thirty-four thousand cases and over eight hundred deaths—with almost all cases and deaths occurring in China—have been reported. It has already surpassed the death toll of the 2003 outbreak of Severe Acute Respiratory Syndrome (SARS), which was caused by a different strain of coronavirus.

In an effort to reign in the crisis, the Chinese government has initiated an aggressive campaign within Wuhan to isolate the sick in improvised quarantine centers. Many airlines have opted to cancel all flights to and from China for the time being. As China is one of the world's most important contributors to trade and commerce, this decreased travel will likely have various economic consequences. Despite its rapid growth, the Wuhan coronavirus is rather preventable and relatively innocuous. Outside of Wuhan, the death rate is nearly zero percent. Furthermore, the CDC recommends that we "wash hands often with soap and water for at least twenty seconds." It specifically "does not recommend that people who are well wear facemasks."

Possibly more pervasive than the coronavirus itself has been the stigma toward Chinese communities that it has spawned. It is crucial that we seek treatment and make scientifically informed choices rather than assigning blame and furthering racist narratives.

WORLD'S FIRST GENETICALLY MODIFIED TWINS

BY: DAVID QIAN - I

There have been many arguments regarding the ethics of genetic modification in humans; however, it has all been hypothetical up until recently. Dr. He Jiankui, a Chinese scientist, and two collaborators misled doctors into implanting gene-edited embryos into two women, one of whom birthed twins. They have pleaded guilty to genetically editing babies, and Dr. He has been sentenced to three years in prison and fined three million yuan, or 429,000 dollars. Dr. He used embryos with sperm from fathers who were infected with human immunodeficiency virus (HIV) and eggs from healthy mothers. HIV attacks T-cells and causes acquired immunodeficiency syndrome (AIDS). He claimed that he conducted the gene modifications to make the babies resistant to developing AIDS, a heritable disease, with the greater goal of working toward reducing AIDS cases in Africa. Despite his reasons, experts still agree that there are better and safer ways to prevent HIV infections. Dr. He's actions have perpetuated negative stigma towards gene editing technology, which has the potential to be an effective method to treat disease. There are still many unreleased details about the case, such as whether the target gene affected any other part of the genome and how Dr. He was able to execute his research in secret. Even though there has been a lot of disagreement about the morality behind Dr. He's actions, his work is nevertheless a milestone in the progression of genetic modification.

THE AUSTRALIAN FIRES

Fires in Australia are not uncommon. Every summer, which lasts from December to February in the Southern Hemisphere, fires sweep through the dry grasses of the country's plains. However, the size and number of the fires this year have been unprecedented and are cause for alarm. Furthermore, history tells us that the worst fires occur from late January to early February, so Australia may not have seen the worst of it yet.

The initial spark of these fires is usually natural, for example, lightning strikes on especially dry grass. The widespread damage of the fires, however, has been exacerbated by the environmental effects of man-made climate change, which include extreme heat and dryness: the perfect storm for these fires. While some have pointed to a headline suggesting that 183 arsonists have been arrested, this number is misleading. For certain cities, incidents of arson throughout 2019 were counted despite many of them happening before the fires started. This number also includes all cases of arson, regardless of whether they are connected to the bushfires or not. The hashtag #ArsonEmergency, which was used to propagate the misleading headline, has been linked to groups that deny climate change.

The climate in Australia is becoming more and more extreme. In 2019, the country experienced both the driest spring on record and the hottest nationwide average temperature for the month of December at 120 degrees Fahrenheit. Powerful winds have helped the fires spread faster, affecting a much wider area. Conditions like these help explain why the nation is suffering from the worst fires on record.

As of January 2020, almost eighteen million acres have burned down, roughly the size of Panama. New South Wales is the most affected state with about twelve million acres being burnt. Thousands of homes have been destroyed, and it is estimated that half a billion animals have been affected by the fires. Because of how often fires occur in Australia, many animals have adapted to surviving fires. Examples include beetles laying their eggs in charred wood, and mammals burrowing underground during the blaze. Some have suggested that wombats, a species of short-legged marsupials, herd other animals into their own holes to protect them, but this is inaccurate. The wombats simply tolerate these animals who are seeking shelter and have been known to do so in the past as well. On the other hand, they are more possessive about their feeding grounds.

Despite these adaptations, almost a billion animals have been directly killed by the fires, and nearly a third of koalas have died. Although some animals escape, many still die from the lack of food and shelter. To make matters worse, the clearing of land from the fires have allowed invasive species such as feral cats and red foxes to hunt down the dwindling native species.

Recent severe storms of hail and rain have helped slow down the fires. Not only does the precipitation put out fires, but it also counteracts the drought affecting the region, making unaffected areas less likely to catch ablaze. However, massive rainfall has also affected firefighters, making it more difficult for them to do their jobs, resulting in damage to buildings and landslides on highways.

Although these storms and firefighting efforts have significantly reduced the number and size of the fires, it is likely that things will get even worse as the peak of the fire season draws nearer.

THE FATHER OF COMPETITIVE ROBOTICS

The Woodie Flowers Award of the For Inspiration and Recognition of Science and Technology (FIRST®) Robotics Competitions commends adult mentors in high school robotics for their effective communication in engineering and design. Dr. William Murphy, who founded the award in 1996, rightfully named it after the former co-chair and distinguished advisor of the FIRST Executive Advisory Board: Dr. Woodie Flowers. Dr. Flowers was also the Pappalardo Professor Emeritus of Mechanical Engineering at the Massachusetts Institute of Technology (MIT).

After earning his Ph.D., Flowers joined MIT's faculty as an assistant professor of mechanical engineering. Under Flowers' administration, the class evolved into a hands-on experience for undergraduate students, culminating in a final robotics competition. Flowers stated that even as the class developed, the core of the course remained unchanged. "Some of the stuff that stayed the same is the wonderful way you compete like crazy but help each other out," he said. Flowers would later coin the phrase "gracious professionalism" to describe the idea of being kind and respecting and valuing others, even in the heat of competition.

Dean Kamen is the founder of FIRST, a non-profit that creates STEM programs for America's youth. Flowers collaborated with Kamen to develop a robotics competition for high school students. The inaugural FIRST Robotics Competition was held in 1992, giving high school students from around the world an opportunity to design and build their own robots.

Over the past three decades, FIRST Robotics has grown into a global movement, enabling over 660,000 students from over one hundred countries each year to cultivate a passion for science and engineering. Flowers' mantra of "gracious professionalism" remains the focus of FIRST.

On October 12, 2019, Flowers passed away due to medical complications.

From pushing his students to embrace ambiguity to tirelessly giving all of his effort to help them articulate their ideas and bring them to life, his role in shaping students' lives went far beyond the scope of design and engineering. In fact, many of his students who pursued the field of education have modeled their curricula and teaching style after his.

Throughout the thirty years Flowers was at FIRST, the engineer and teacher was an incredible supporter of its mission, a friend to everyone he met, and an inspiration to students, alumni, mentors, volunteers, supporters, and staff. The Woodie Flowers Award recipients—past, present, and future—will carry on his legacy as mentors who inspire young people through the art and science of engineering and design.

END OF ALLERGIES

Our immune systems are complex networks of cells and proteins that protect us from illness. Whenever a foreign cell enters our body, our immune systems attack the cell to keep us healthy. However, sometimes our immune systems mistake harmless cells for harmful ones and attack them.

This is what happens when someone has a food allergy. When one's immune system attacks these food proteins it sends immunoglobulins, or antibodies, to fight the alien cells. Antibodies are y-shaped proteins that bind to and neutralize foreign cells. This process releases chemicals that cause the symptoms that we associate with allergies, such as hives, itchiness, nausea, sore throat, trouble breathing, and even death.

According to a study conducted by the Children's Hospital of Chicago and Northwestern University, about ten percent of Americans, over thirty-two million people, have a food allergy. Currently, the only treatment is building up one's resistance to the allergen by consuming small amounts of it under medical supervision. This long, tedious process has proven unsafe and only somewhat effective, usually taking over a year with frequent allergic reactions, sometimes without success.

A recent Stanford study, led by Sharon Chinthrajah, M.D., and Kari Nadeau, M.D., Ph.D., has conducted promising research in this field. Interleukin-33 (IL-33) is an immune signaling molecule that stimulates numerous immune system responses, ultimately causing an allergic reaction. The study compares the activation of a singular IL-33 molecule and its activation of all the other responses to touching a pile of timber with a lit match. If that match does not touch the pile then the pile of timber does not get lit on fire. But if it does, all of the timber will burn. Similarly, if IL-33 is not activated, there is no allergic reaction. They continue this analogy by saying that their treatment, called etokimab, is like plunging that match in a bowl of water. In theory, etokimab could inhibit all features of allergies.

In clinical trials, Chinthrajah and Nadeau established the effectiveness of their treatment. The trial consisted of twenty adults with severe peanut allergies. Fifteen people received an etokimab injection while five others received placebos, harmless, effectless medicines often given to the control group of an experiment. Fifteen days later they were all fed 275 milligrams of peanut protein, the equivalent of one nut. Out of the fifteen people given etokimab, eleven had no allergic reaction whatsoever. Of the placebo recipients, all had severe reactions. Then the researchers waited until forty-five days had passed since the injection and tested seven of the original fifteen etokimab recipients: four of them had no reaction.

The long term effects shocked researchers, and it seems that there could be a permanent cure to food allergies in the near future. The impact of this research is so wide-reaching that all allergies could be terminated in the near future. Researchers say that there are applications of the treatment with seasonal allergies, eczema, and asthma, among others. While the treatment is still in the experimental stage, the longevity and success rate of etokimab will only increase.

POLLEN, A COMMON ALLERGEN

HOPEFULLY, WE CAN ELIMINATE ALL ALLERGIES AND THE DANGERS ASSOCIATED WITH THEM IN THE NEAR FUTURE.

RIVER CLEANUP

By 2050, the amount of plastic in the ocean will outweigh the amount of fish. While there is evidence that people are reusing and recycling more than ever, what can be done about the plastic already in the ocean?

One of the leading contributors to this problem is the heavily polluted rivers that flow into our oceans. According to Surfers Against Sewage, "every day approximately eight million pieces of plastic pollution find their way into our oceans."

EVERY DAY APPROXIMATELY EIGHT MILLION PIECES OF PLASTIC POLLUTION FIND THEIR WAY INTO OUR OCEANS

Bans on plastic bags in grocery stores and plastic straws in restaurants will not do enough to reverse these numbers. There needs to be effort and innovation from all directions to tackle this mass of plastic.

According to Fast Company Magazine, the majority of the trash in the ocean comes from around one percent of the rivers in the world, with these rivers located primarily in Asia.

The Ocean Cleanup project, founded by Boyan Slat, has been working on developing technology to remove large quantities of these plastics from rivers before it can be taken out to the ocean's garbage patches—large collections of garbage in the ocean—and harm marine life. These garbage patches can be as large as 600 thousand square miles and are detrimental to all sea life. To fight the pollution of these rivers, The Ocean Cleanup project fastens solar-powered machines to riverbeds, which suck plastic into their large holding facilities. The plastic is recycled once the facilities are filled. This method can remove anywhere from 100 to 200 thousand pounds of trash per day in large rivers.

The two main parts of the problem are the excess production of plastic and the maltreatment of used plastic.

Large pieces of plastic, such as Styrofoam cups or plastic wrappers, can be taken out of the water with machines such as the one made by The Ocean Cleanup. The most harmful substances for ocean ecosystems, however, are microplastics. Microplastics, as defined by the National Ocean Service, "are small pieces of plastic less than five millimeters long which can be harmful to our ocean and aquatic life." Fish and other organisms swallow these particles because they are mistaken for one of their main food sources: plankton. When a fish gets eaten, the microplastics that have built up in its body are transferred to its predator. These toxins work their way up the food chain through biomagnification and kill off many of the ocean's animals. Because plastics take hundreds and thousands of years to breakdown, they stay in the waters.

Eighteen-year-old Fionn Ferreira recently discovered a solution that could help remove the microplastics from our oceans. After learning that microplastics are nonpolar, he tried adding other nonpolar molecules, like vegetable oil, to the plastics, as they are attracted to each other. However, even though the microplastics were attracted to the oil, there was no way to recover the oil from the water. After further research he came upon ferrofluid, a magnetic liquid. Made of oil and magnetite, ferrofluid maintains its nonpolarity but can also be easily extracted with a magnet. The Irish teen tested this method in water containing ten of the most common types of microplastic particles. From the data collected, he concluded that this method can remove anywhere from eighty-five to ninety-two percent of microplastics in a given sample of water, which is higher than the extraction rate using filtration. While this was only done on test samples, it is a starting point for application on an industrial scale.

Even with all of the new innovations, an alarming amount of plastic is still added to the oceans every day. However, with the transformation of laws regarding plastic production in factories and usage in cities, the crisis may be stopped with enough support.

SUPER PUFF EXOPLANETS

Using the Hubble Space Telescope, the National Aeronautics and Space Administration (NASA) has affirmed the existence of a new type of planet called the "super-puff" that has the

DENSITY OF COTTON CANDY.

Exoplanets are planets outside the Solar System, and three were recently discovered in the Kepler-51 star system. They owe their fluffiness to the hydrogen and helium in their composition, which cause the planets to balloon outward. These gas giants have a density below 0.1 grams per cubic centimeter and masses only a few times greater than Earth but are almost as big as Jupiter.

To solve this puffy mystery, researchers at NASA used the Hubble's infrared lens, which can determine a planet's temperature and composition. They looked at the starlight passing through two of the planets' atmospheres, hoping to find the planets' chemical compositions by measuring the intensity of the light. The chemical signatures, however, were obstructed by clouds, and the researchers found nothing.

Using computer simulations instead, NASA speculated that the super-puffs are mostly hydrogen and helium but are covered by clouds of photochemical haze, a type of smog produced when UV light reacts with nitrogen oxides, salt crystals, or other gases. Moreover, it is possible that gases like methane surround these planets, with lighter gases puffing the planets up. An external layer of methane could explain the haze in the ultraviolet light of the Hubble Space Telescope, which would mean that the planets are similar to Saturn's moon, Titan.

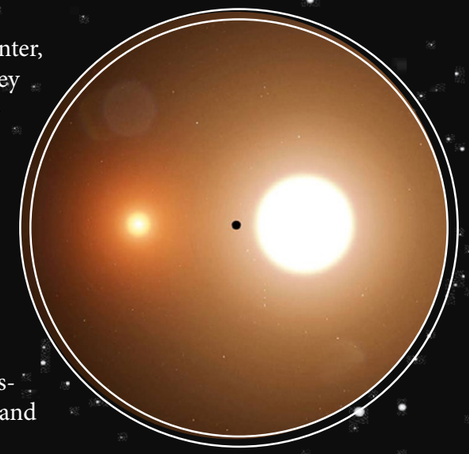
The two observed Kepler-51 planets also seem to be bleeding or quickly leaking gas. For instance, one of the planets deposits tens of billions of tons of gas into space every second. If the pattern continues, the planets could shrink over the next billion years, losing all their puffiness and ending up like "mini-Neptunes," small planets that resemble Neptune and are common throughout the galaxy, unlike the Kepler-51 planets.

The eventual conversion of these super-puffs could explain why these exoplanets do not exist in our solar system. The star that the puffs orbit is only five hundred million years old, compared to Earth's 4.6-billion-year-old Sun, indicating that its planetary system is in early development. A more developed planetary system, such as ours, would be unlikely to house super-puffs.

TEEN FINDS 13TH CIRCUMBINARY PLANET

WHILE MOST HIGH SCHOOL STUDENTS SPEND THEIR SUMMERS AT INTERNSHIPS TO GAIN EXPERIENCE, SEVENTEEN-YEAR-OLD WOLF CUKIER GAINED A LOT MORE THAN JUST AN EXPERIENCE. LAST YEAR, HE DISCOVERED A WHOLE PLANET.

During his internship at NASA's Goddard Space Flight Center, Cukier examined data from the Transiting Exoplanet Survey Satellite (TESS). TESS is used by NASA to discover exoplanets around nearby stars. The satellite's four cameras capture images of the sky every thirty minutes, and scientists use these images to examine the brightness of stars.



When an exoplanet transits, or passes across, a star, it causes a drop in the star's brightness. TESS uses transit photometry, which measures the periodic drop in a star's brightness as an orbiting planet passes by the star. Periodic or repetitive drops of starlight recorded by TESS would indicate the existence of a planet orbiting a star. This data is later reviewed and flagged by scientists.

Cukier's job was to examine the data taken by TESS. He was looking at data for the eclipsing binary star system TOI 1338. In binary star systems, two stars orbit one another around their center of mass. When in our line of sight, these binaries eclipse each other. Because the planet's transit for the smaller star is too faint to detect, TESS was only able to detect the planet's transit for the larger star.

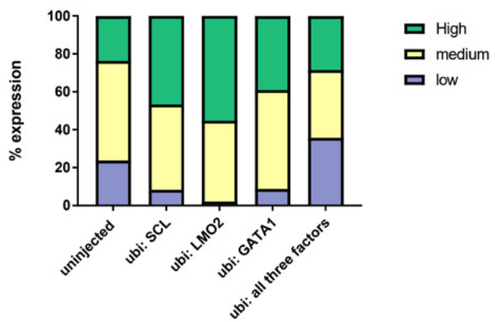
Cukier noticed that the timing of the transit was not right. He believed that there was an existence of a planet in this system causing a dip in the brightness. After going through a verification process, the planet was verified and named TOI 1338b, marking the first time TESS discovered a circumbinary planet. TOI 1338b is 6.9 times larger than Earth and is the thirteenth circumbinary planet ever discovered.

In the future, more planets are expected to be discovered with TESS, and a bright future awaits Wolf Cukier as he plans to study astrophysics in college.

EXPERIENCE IN A REAL SCIENTIFIC LAB

This past summer, I was fortunate enough to work in a research lab at Boston Children's Hospital with eleven other students from across the city. For two weeks, I studied possible treatments for anemia, or a lack of red blood cells, by injecting different transcription factors, which regulate gene expression, into the DNA of zebrafish embryos. We were trying to find which combination of transcription factors produced the most hemoglobin, a protein found in red blood cells that is responsible for dispersing oxygen in the body. I was able to see the effects of the treatments by observing the adolescent fish, since they had been modified previously to produce green fluorescent protein (GFP). GFP acts as a biomarker, since it attaches to hemoglobin and glows green under ultraviolet light. Some of what I did in the lab were commonplace procedures like running gel electrophoresis (a technique which measures the lengths of DNA strands), calculating the purity of solutions, injecting embryos, and inserting DNA into E. coli bacteria.

However, there was more to do than just simple lab procedures. The other elements of the project were participating in a journal club, sitting in on lab presentations and meetings, and having a regular workday of nine a.m. to five p.m. During the journal club, we spent an hour and a half reading articles relevant to our project from highly regarded scientific journals such as Nature. By the end of the two weeks, the group studying anemia presented our results to the entire lab, including the principal investigator (PI). This was a big deal, as this was an experiment they had not done before; we were the pioneers. Our PI, Dr. Len Zon, was the first person to clone the gene GATA1, which we used in our study. We coincidentally found that the GATA1 gene was the most toxic of the transcription factors used, leading to the most deaths among the fish, while the genes SCL and LMO2 were significantly less toxic.



The graph shows the percentage of high, medium, and low expression of genes coding for hemoglobin found in each group of modified fish. Our research found that LMO2 was the most effective at producing additional hemoglobin, which contradicted our hypothesis that a combination of all three transcription factors in one fish would be the most effective.

Personally, this experience opened my eyes to the possibilities of a major and possibly a career in the field of genetic research.

"IF THIS SOUNDS INTERESTING TO YOU, MAYBE WORKING IN A LAB IS SOMETHING THAT YOU COULD DO IN THE FUTURE."

HAVE YOU GOTTEN A FLU SHOT YET?

The fall season in New England not only means crunchy apples, orange pumpkins, and colorful leaves, but also the start of the flu season. The flu season lasts from the beginning of fall to the end of spring, with a peak between December and February. Common symptoms include headache, runny nose, sore throat, body ache, fatigue, and fever. Every year, many patients are hospitalized, and some even die because of the flu.

What does the flu virus look like? An influenza virus is composed of surface proteins and ribonucleoprotein (RNP) segments. Ribonucleic acid (RNA) and proteins are the components of each RNP segment that are responsible for encoding the virus surface proteins—the hemagglutinin (HA), neuraminidase (NA), and M proteins.

How does a flu virus infect a respiratory tract cell? When a sick person sneezes or coughs, tiny droplets come out that carry the flu viruses, which may land on other people's noses, mouths, eyes, or hands. Once the flu virus enters the respiratory area, the virus's HA proteins hook onto the surface of a human respiratory tract cell via the sialic acid receptor. The structure of the influenza virus's HA protein fits into the sialic acid receptor, enabling the influenza virus to enter the human cell and easily infect it.

There are many different types of influenza viruses, including A, B, C and D. Influenza A (primarily subtypes H1N1 and H3N2) and B viruses are the main cause of the influenza epidemic across the country every winter. The other two do not cause any severe illnesses. The deadly 1918 influenza pandemic (also known as the Spanish flu) involved the H1N1 influenza virus, a dangerous subtype of Influenza A.

Because of the casualties caused by the pandemic, the US hastened to find a solution, leading to the introduction of the first approved flu vaccine in 1945. The vaccine is designed to prevent influenza A and B viruses from infecting human cells by preparing your immune system with weakened or inactive forms of flu viruses. Your white blood cells use the surface proteins—the HA, NA, and M proteins—of the weakened flu virus to produce antibodies, which tag the virus and make it easier for the immune system to do its job. If the actual flu comes around, your immune system will be prepared.

Because the virus mutates quickly, updated vaccines are necessary every year. The flu shot is more accessible than ever before, offered in a variety of places for little to no-cost. It is highly recommended by health-care professionals that everyone 6-months old and older should have the flu vaccine before the flu peak. Stay healthy during this flu season!

YOU ARE THE GREATEST THIEF IN THE WORLD.

ONE DAY, YOU ARE TASKED WITH STEALING THE MACGUFFIN, WHICH IS NOTORIOUSLY DIFFICULT TO CRACK. YOUR INFORMANT TELLS YOU THAT THE PIECES OF THE MACGUFFIN ARE STORED IN FOUR SEPARATE SAFES, AND NOT ONLY DO EACH OF THE SAFES HAVE DIFFERENT PASSCODES, BUT IF A SAFE IS BROKEN INTO, THE OTHERS RECALIBRATE THEIR PASSCODES TO MATCH PRESET CONDITIONS. FOR EXAMPLE, LET'S CALL SAFE 2'S PASSCODE B. IF SAFE 1 IS BROKEN INTO, SAFE 2 WILL RECALIBRATE ITS PASSCODE TO B1. YOU WILL NEED PASSCODES A, B1, C2, AND D3 TO GET THE MACGUFFIN. LUCKILY, THESE SAFES ALWAYS FOLLOW THE FOLLOWING RULES.

ONE

THE SAFE PASSCODES ALWAYS ADD UP TO 987.

$A+B+C+D=987$
$B1+C1+D1=987$
$C2+D2=987$
$D3=987$

TWO

EACH CODE IS A DISTINCT THREE-DIGIT NUMBER, WITH NO REPEATING DIGITS. THE PASSCODE OF A SAFE IS ALWAYS SMALLER THAN THE FOLLOWING SAFE.

$A<B<C<D$
$B1<C1<D1$
$C2<D2$

THREE

A IS LESS THAN B1, WHICH IS LESS THAN C2, WHICH IS LESS THAN D3.

$A<B1<C2<D3$

FOUR

OF A, B1, C2, AND D3, ONE OF THE PASSCODES WILL BE A PERFECT FOURTH POWER, ANOTHER A PERFECT CUBE, AND ANOTHER A PERFECT SQUARE.

KNOWING THESE RULES, YOU TELL YOUR INFORMANT THAT YOU WON'T HAVE ENOUGH TIME BECAUSE THERE ARE 6 POSSIBILITIES. AFTER DIGGING AROUND, THEY TELL YOU THE FINAL CONDITION, WHICH WILL LEAVE YOU WITH ONLY 2 DIFFERENT COMBINATIONS AND GIVE YOU ENOUGH TIME TO STEAL THE MACGUFFIN.

THE DIFFERENCE BETWEEN A AND B1 IS LESS THAN THAT OF B1 AND C2, WHICH IS LESS THAN THAT OF C2 AND D3.

WHAT ARE THE FINAL 2 POSSIBILITIES FOR THE COMBINATION?

PI DAY

3. 13. 2020
DINING HALL
2:30PM