



WINTER 2021

CATAPULTA



This issue contains:

- Updates about the COVID-19 vaccine
- Advancements in space exploration
- Seaweed snacks & Hot peppers
- Buff ants



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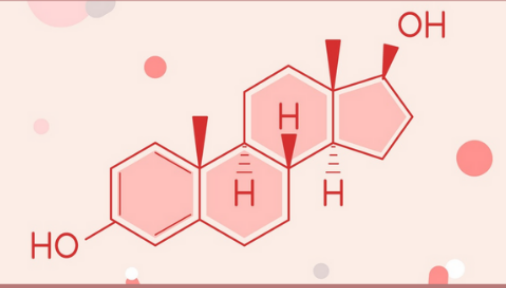
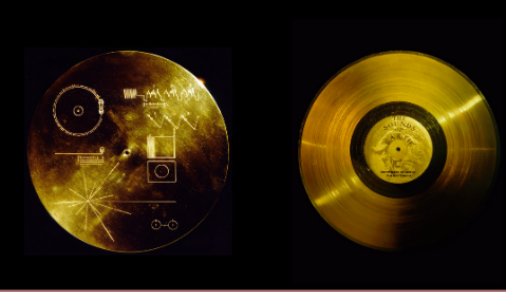


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EDITORS' NOTE

DEAR READER,

AT THE BEGINNING OF OUR LAST ISSUE AT THE START OF THE PANDEMIC, WE WROTE THAT OUR WINTER 2020 ISSUE CAME AT A TIME WHERE "CAUTION, HOPE, AND CONTROVERSY SURROUND THE SCIENTIFIC COMMUNITY." OVER THE LAST YEAR, WE HAVE SEEN THESE SAME SENTIMENTS ECHO MORE INTENSELY NOT ONLY WITHIN THE SCIENTIFIC COMMUNITY, BUT ALSO THROUGHOUT THE WORLD.

SINCE OUR LAST ISSUE, THE "WUHAN CORONAVIRUS OUTBREAK" THAT WE WROTE ABOUT BECAME A GLOBAL PANDEMIC, KILLING MILLIONS AND BRINGING OUR LIVES TO A STANDSTILL. THE PAST YEAR HAS FURTHER EXPOSED THE RACIAL INJUSTICE THAT HAS PERMEATED ALL PARTS OF OUR SOCIETY, INCLUDING THE FIELD OF SCIENCE RESEARCH.

WHILE WE STRUGGLE WITH THE PECULIAR—AND SOMETIMES UNSETTLING—STATE OF OUR NEW DAILY LIVES, HOPE STILL SHINES. A LITTLE LESS THAN A YEAR AFTER THE FIRST CASE OF THE DISEASE THAT BECAME KNOWN AS SARS-COV-2, SCIENTISTS BROUGHT FORTH AN EFFECTIVE VACCINE, CUTTING THE VACCINE DEVELOPMENT PROCESS FROM YEARS AND DECADES TO MERE MONTHS. A NEW BIDEN ADMINISTRATION SIGNALS ITS EMBRACE OF SCIENTIFIC RESEARCH, ELEVATING THE OFFICE OF SCIENCE AND TECHNOLOGY POLICY TO A CABINET-LEVEL POSITION. IN A DISORIENTING WORLD, SCIENCE HAS BECOME OUR ANCHOR.

MIRRORING OUR UNPRECEDENTED SITUATION, WE HAVE RELEASED OUR FIRST ISSUE OF CATAPULTA THIS SCHOOL YEAR IN THE WINTER. WITH THE FALL OF 2020 PRESENTING MANY DIFFERENT CHALLENGES, WE FELT IT FITTING TO PUSH BACK THE PUBLICATION OF OUR FIRST ISSUE, AND TO GIVE EVERYONE SOME GREATLY APPRECIATED SPACE. THAT BEING SAID, JUST AS SCIENCE AND RESEARCH HAVE PERSEVERED OVER DIFFICULT TIMES, OUR PUBLICATION SIMILARLY MUST CONTINUE TO PUBLISH AND BRING LIGHT TO IMPORTANT DISCOVERIES TO THE BLS COMMUNITY.

WE HOPE YOU ENJOY THE ARTICLES OF OUR AMAZING STAFF AND STUDENT WRITERS, AS WELL AS THE WORK OF OUR WONDERFUL EDITORS. THIS ISSUE FEATURES A GOOD MIX OF DEVELOPMENTS ABOUT THE EVOLVING COVID-19 PANDEMIC AND OTHER BREAKTHROUGHS IN THE WORLD OF SCIENCE.

BEST,
JOHN AND NATALIA
EDITORS-IN-CHIEF

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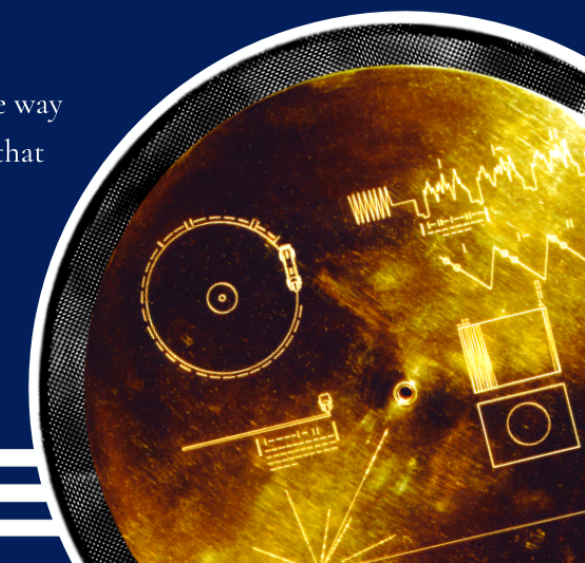
A Check in With Space to Keep Our Minds Off of Earth

The Voyagers, two devices originally sent into space to collect data on the planets Jupiter and Saturn, are entering the 43rd year of their voyage through space. They are not only documenting everything they encounter — from stars and asteroids to the distances and durations they travel — but are also transporting the Golden Record.

The Golden Record is a twelve-inch gold-plated copper disk containing songs, natural sounds, messages from Presidents, and information about earth's location — all intended to answer the question: “what is life on Earth like?” The Voyagers are not only an informational tool for us, but also one for any alien life they could encounter by sending the Golden Record to them. It was not until 1989, however, roughly a decade after launching, that one of the Voyagers even reached Neptune. Currently, they are both at the edge of our solar system, and, even while 14 billion miles away from Earth, still detecting energy flow from our sun.

Recently, new data has captured the first bursts of cosmic electron rays from interstellar space. Coronal mass ejections, “large expulsions of plasma and magnetic fields from the Sun's corona” (Space Weather Prediction Center), send these particles to the edges of our Solar System. According to the Space Weather Prediction Center, “[Coronal Mass Ejections (CMEs)] can eject billions of tons of coronal material and carry an embedded magnetic field (frozen in flux) that is stronger than the background solar wind interplanetary magnetic field (IMF) strength. CMEs travel outward from the Sun at speeds ranging from slower than 250 kilometers per second (km/s) to as fast as nearly 3000 km/s” (Space Weather Prediction Center).

The Voyagers have detected that the shock waves from CMEs flow all the way to the edges of our solar system. This is the first interstellar shock wave that has carried such electrons from interspace we have recorded. Scientists believe that this is just the beginning of what the Voyagers will witness on the other side of the Milky Way. To read more about their journey in the past, present, and future, visit [https://voyager.jpl.nasa.gov/!](https://voyager.jpl.nasa.gov/)



BOVINE SEAWEED SNACKS



Livestock produce the equivalent of 650 million cars in methane emissions and are responsible for fifteen percent of the world's greenhouse gas emissions. Out of the 1.5 billion cows in the world, each produces around a hundred kilograms of methane per year on average. Methane is particularly harmful, as it is 34 times more powerful than carbon dioxide in terms of its effect on the climate.

Two types of red seaweed — *Asparagopsis taxiformis* (*A. taxiformis*) and *Asparagopsis armata* (*A. armata*) — could significantly neutralize the amount of methane that some livestock, like cows, emit in their burps and farts.

In a study published in the *Journal of Cleaner Production*, lab results found that adding a small amount of *A. taxiformis* to a cow's daily feed — around 0.2 percent of its total intake — can reduce the amount of methane produced by the cow by ninety-eight percent. In comparison, most previously proposed solutions only decreased methane emissions by twenty to thirty percent.

When fibrous plants enter the cow's rumen, or first stomach, microbes begin fermentation of the food and use the resulting hydrogen and carbon from the fermentation to produce methane. Ninety-five percent of that methane is released

through burping, and the other five percent by flatulence.

Types of seaweed from the *Asparagopsis* genus have unique gland cells that produce and store an organic compound called bromoform. When the seaweed is freeze-dried, powdered, and added to cow feed, the compound blocks hydrogen and carbon atoms from making methane.

Scientists noticed an interesting biological response: cows make more propionate, a fatty acid that supports the metabolic production of glucose, which causes the cow to grow faster or release more milk. As a result, farmers raising livestock on *Asparagopsis* can save money by using less feed.

Construction of two dual farms and processing plants of the red seaweed are set to begin in southern Australia next year. Each farm is expected to produce about four hundred dry tons of milled seaweed per year, which would be enough to feed up to twenty thousand cows.

In the United States, a similar startup called Symbrosia uses a land-based aquaculture system to grow the seaweed. Once dried and processed, the *A. taxiformis* product is called SVD. The company is selling carbon offset subscriptions online, which will help fund for the implementation of a seaweed program on a cattle or sheep farm.

HAMBURGERS WILL SOON BECOME ECO-FRIENDLY IF GLOBAL COMPANIES SUCCEED IN MAKING SEAWEED A BOVINE SNACK.

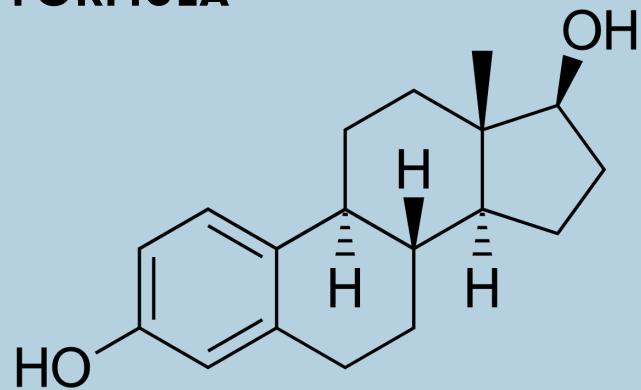
DO MEN GET SICKER? THE ROLE OF ESTROGEN IN COVID-19 SYMPTOMS

BACKGROUND

COVID-19 IS EXTREMELY DANGEROUS BECAUSE OF ITS CONTAGIOUSNESS. INTERESTINGLY, HOWEVER, FEWER WOMEN HAVE DIED COMPARED TO MEN.

Cases reported from different countries show that the number of cases per sex remains fairly similar, but the overall ratio of male to female mortality worldwide is one to three. While there is no definitive answer yet, the most supported hypothesis seems to suggest that estrogen, a biologically female hormone, plays a role. Estrogen has anti-inflammatory effects that prevent symptoms like the cytokine storm (sometimes called the “last stand” of

ESTROGEN'S STRUCTURAL FORMULA



the immune system), which severely damages the lungs and is a main cause of death from COVID-19. An experiment done in the University of Iowa animal care facility studied the effects of estrogen on SARS-infected male and female mice. Even though the mice were infected by SARS and not SARS-CoV-2, both the structure and the inflammatory response of the viruses are similar.

▶▶▶ **A FEW MAJOR DIFFERENCES ARE THAT SARS-COV-2 SPREADS FASTER, YET STILL HAS A LOWER MORTALITY RATE OF 2.3 PERCENT COMPARED TO THE TEN PERCENT OF NON-COVID.**

Because SARS had a higher death rate, this type of experiment might prove to have even greater effects if replaced with the SARS-CoV-2 virus.

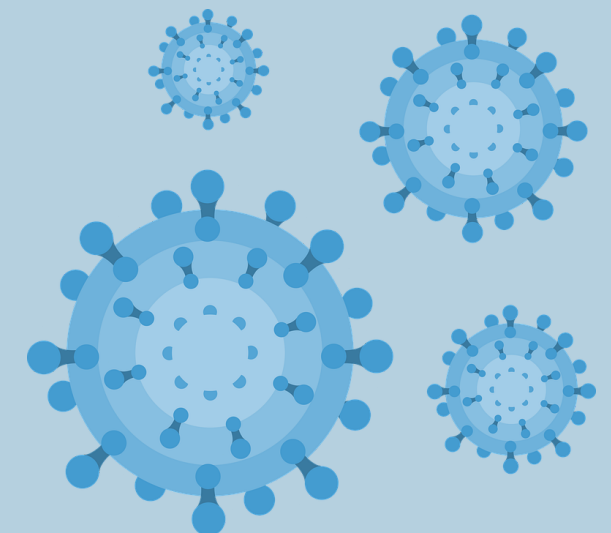


EXPLANATION OF THE EXPERIMENT

Researchers gave the same dosage of the virus to each mouse, comprising 5000 PFU (plaque-forming unit) of SARS MA15. They found that male mice with their testicles intact (WT male) and female mice without ovaries had a poor survival rate compared to the control (female mice). The scientists performed more experiments on female mice to determine whether estrogen was the key factor in survival, giving them either corn oil (control), ICI 182 and 780 (an estrogen receptor antagonist), or tamoxifen (an estrogen modulator). Female mice that took tamoxifen had significantly higher survival rates, indicating that estrogen seemed to serve a protective function. If estrogen can mitigate the symptoms, as the experiment suggests, it will drastically increase the survival rate of those infected with COVID-19. This is crucial because while the Pfizer-BioNTech coronavirus vaccine is safe and effective according to the FDA, distribution will take a very long time, and people are still dying.



BEING ABLE TO MITIGATE DEATHS WOULD BE A HUGE TURNING POINT IN DEALING WITH THE PANDEMIC. THIS ALSO MIGHT LAUNCH MORE SERIOUS RESEARCH INTO THE PROPERTIES OF ESTROGEN, WHICH COULD UNCOVER HOW IT WORKS AS AN ANTI-INFLAMMATORY AND PROVIDE A NOVEL DRUG TO DEAL WITH INFLAMMATIONS.



ANTS IN SHINING ARMOUR

A recent study published this November has revealed that a certain leaf-cutter ant species carries protective mineral body armor. Researcher Hongjie Li and evolutionary biologist Cameron Curie made the discovery in his lab at the University of Wisconsin, while examining small crystals that were recently found on the skeletal frame of *Acromyrmex echinator* worker ants.

Intrigued by this, they had to examine the exoskeleton more closely. Using mouthwash, electron microscopy, and other imaging techniques, they determined that the coating on the exoskeleton was a layer of magnesium-rich calcite $\text{CaMg}(\text{CO}_3)_2$. The researchers discovered that this coating doubled the hardness of the cuticle, the protective outer layer of insects, despite making up merely seven percent of the exoskeleton.

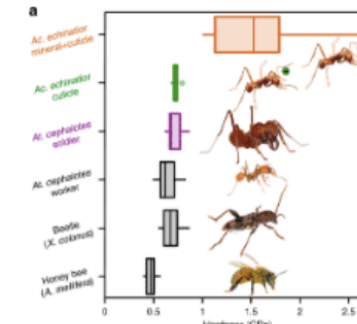
They found this layer only on the epicuticle (outermost layer) of mature worker ants. Li's explanations for this are the environmental and behavioral factors of young and mature ants. Young ants stay in their habitat in order to avoid the risk of attack from predators, while mature ants leave their fungal garden habitats to find resources or carry out tasks necessary to the nest's survival.

The finding of a mineral coating on the ants' exoskeleton is not unexpected. Many of their distant relatives in the arthropoda phylum, such as crabs and lobsters, also have calcium carbon exoskeletons. This discovery, along with Li's subsequent experiments, unveiled answers about how an ant's external microbes might increase its chance of survival. These leaf-cutter ants cut up leaves to sustain the growth of fungi, their source of food. Some leaf cutter ant species have a microbe that secretes chemicals to kill harmful fungi growing in their fungus gardens. Like the mineral exoskeleton coating, this bacterium is coated on the ant.



A friendly *Acromyrmex echinator* ant

Comparison of exoskeleton hardness (in gigapascals) with other insects



Li set up an experiment to test if the coating on the ant would give it an advantage over other ant species. He and his colleagues raised twenty pupae and separated them into two groups: one with the mineral layer and the other without it. Placing the worker ants against *Atta cephalotes* ants revealed that ants without the coating were killed, while many of the ants with the coating survived. When fighting against the *Atta cephalotes* soldier ant, the ants with biomineral armor lost substantially fewer body parts than the ants without the armor.

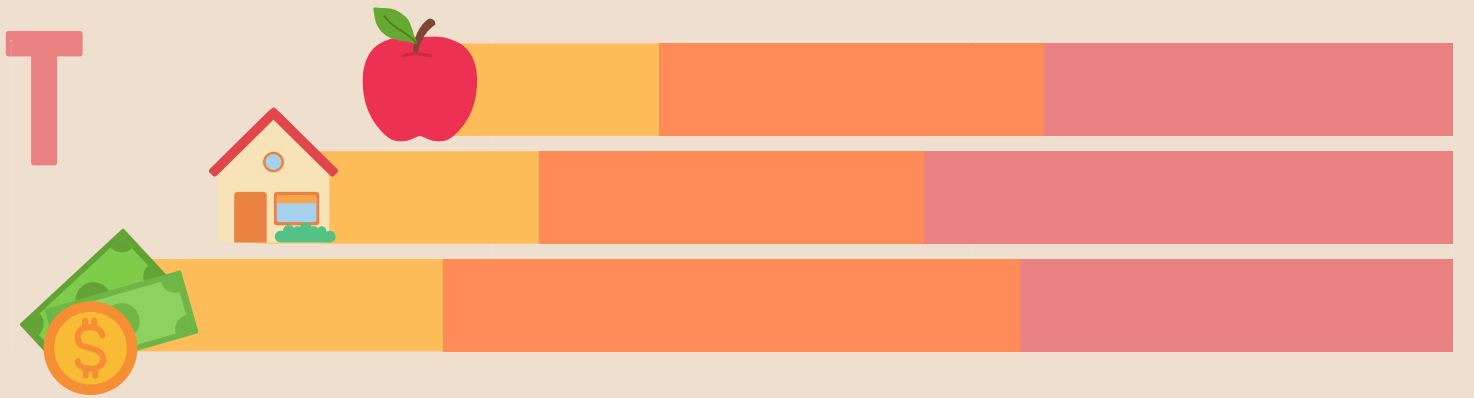
The researchers then tested the effect that an infectious fungus would have on the ants with the coating compared to ants without it. Within four days, only half of the ants with the mineral armor died, while a majority of the ants without the layer died. Although it appears that the strength of the coating enhances the ants' chances of survival in both experiments, genetic, environmental, or other factors may have affected the results.

Still, these biomineral crystals may have further implications and could be used to make strong coatings in the future. This discovery is a step forward in learning more about the interactions between biominerals and living organisms.



*An "artist's" interpretation

THE MOST IMPORTANT FACTOR OF HEALTH



When Luke Mathew, a program coordinator at Northeastern University's Center for Community Health Education Research and Services, asks his students what determines an individual's health, the most common answers he receives are diet, exercise, and abstinence from drugs and alcohol.

Mathew explains, however, that, "health is much more complex. What the data affirms is that

INDIVIDUAL BEHAVIOR, THE CHOICES WE MAKE ON A DAILY BASIS, ONLY ACCOUNT FOR ROUGHLY THIRTY PERCENT OF OUR OVERALL HEALTH."

While clinical care, physical environment, and biological genes each account for an additional ten percent, "it is the social determinants of health which influence our overall health the most."

SO WHAT ARE THE SOCIAL DETERMINANTS OF HEALTH?

"They are the foundational pillars of our health," says Mathew, "primary (social determinants of health) [...] include housing, education, transportation, and employment."

The effects of the social determinants of health are clear in Boston. Take two neighborhoods: Back Bay and Roxbury. The former is one of Boston's nicest neighborhoods and home to many of Boston's most expensive properties. The latter, on the other hand, is a noticeably lower-income neighborhood with crime rates nearly double the national average. Despite being just one and a half miles apart, residents of Back Bay live on average to be ninety-two years old, while residents of Roxbury's average is only fifty-nine years old, a stark thirty-three year difference. This is because of the better quality housing, education, employment, and economic opportunities that Back Bay residents have access to while Roxbury residents do not.

Populations that are at a disadvantage for the social determinants of health will face more difficulty

attaining health coverage — not only will they be less healthy because of their social, economic, and environmental circumstances, but even more so because of how inaccessible clinical care is for them.

Now more than ever, these effects are visible. Institutional racism in education, welfare, and banking, among others, has left minority and immigrant populations unable to achieve social mobility and financial stability. They struggle to afford proper treatment for underlying conditions like asthma, diabetes, as well as lung and heart disease, which they are more likely to develop.

The social determinants of health also impact accessibility to healthcare coverage. As Allison Scobie-Carroll, the Senior Director of Social Work and Family Services at Boston Children's Hospital, explains, "the social determinants of healthcare continue to drive many healthcare outcomes that are outside the scope of what healthcare alone can address [...] We know that people who are living in areas without adequate access to economic opportunities, transportation, equal education and structural inequities of all kinds are particularly disadvantaged in accessing affordable, culturally informed [health] care."

Since symptoms of COVID-19 are exacerbated from these underlying conditions, minority groups are the people that have been recorded most often to fall victim during the pandemic. At the beginning of the pandemic, Chicago's African American population, despite only making up thirty percent of the city's population, accounted for seventy percent of its coronavirus deaths. To date nationally, Native Americans, Blacks, and Hispanics are around five times more likely to be hospitalized due to COVID-19.

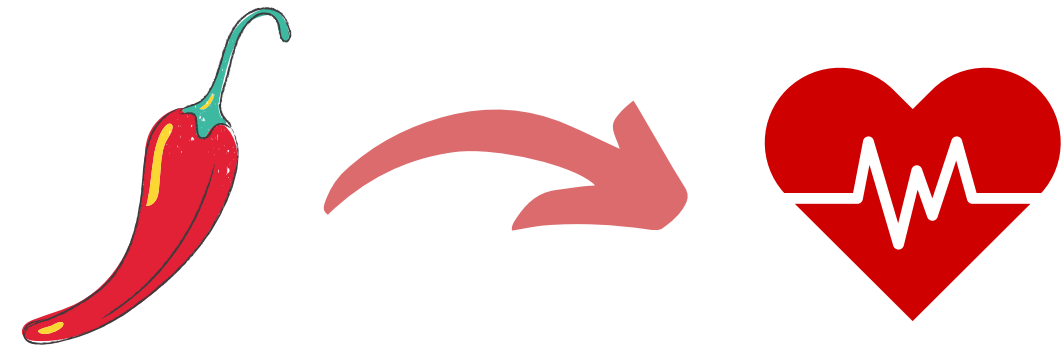
The ongoing pandemic undoubtedly serves as a reminder of the significance of health in our society. Every move we make now is with our health in mind. But what is the number one key to being healthy? It is not eating a well-balanced diet. It is not exercising regularly. It is not getting eight hours of sleep, and it is not abstinence from drugs and alcohol. Revealing deep racial health disparities, the

THE CORONAVIRUS PANDEMIC HAS MAGNIFIED THE IMPACT THAT THE SOCIAL DETERMINANTS OF HEALTH HAVE ON LIFE EXPECTANCY, DURING BOTH NORMAL TIMES AND DURING THIS UNPRECEDENTED PUBLIC HEALTH CRISIS.

HOT PEPPERS FOR A LONGER LIFE

Capsaicin (C₁₈H₂₇NO₃) is the chemical compound found in peppers that makes them spicy. Likely developed as an evolutionary defense mechanism, capsaicin wards off predators with its intense spice.

We experience spiciness through a series of chemical reactions. TRPV₁, also known as the “capsaicin-receptor,” is an injury-sensing protein. Just as we have proteins in our hands that tell us a stove is hot, there are proteins in our mouths that act similarly. A variety of stimuli, like high acidity, high temperature, and the presence of certain chemicals, like capsaicin, can activate the TRPV₁ receptor. In response to these conditions, TRPV₁ sends a cascade of signals to the brain that elicit the inflammation and pain that we associate with the taste of spice. After this reaction occurs, it numbs the pain signals in our mouth as the brain sends endorphins to the affected area.



Recent studies have led researchers to believe that capsaicin has even more health benefits than previously imagined. A recent retrospective observational study by the Cleveland Clinic compiled data from nearly five thousand different studies on over 570,000 people concerning the impacts of chili peppers on health. After thorough analysis of the data, the researchers confidently reported three shocking statistics.

They found that the participants who ate peppers tended to experience relative reductions of cardiovascular illness, cancer, and all-cause mortality by twenty-six, twenty-three, and twenty-five percent, respectively, and generally lived longer lives.

Dr. Bo Xu, M.D., a cardiologist at the Cleveland Clinic and the study’s senior author, notes that the researchers, “were surprised to find that [...] regular consumption of chili pepper was associated with an overall risk-reduction of [...] mortality.” But while the research suggests that peppers increase our life expectancy, the study has some limitations.

Even with the promise that the study shows, more work must be done. In the scientific community, causal relationships cannot be determined without empirical results.

Xu says, “The exact reasons and mechanisms that might explain our findings [...] are currently unknown.” Before one can link capsaicin to these health benefits, we need concrete evidence through experiments and clinical trials. Many uncertainties exist, such as which doses and types of peppers are most beneficial.

Further investigation into how the peppers decrease health risks is needed, but there is strong evidence that they do improve our health. If the research is proven in labs, we could see capsaicin supplements in the near future. There is undoubtedly great potential in this study. For now, the next time you see a hot pepper, give it a try! Or, if peppers are not for you, try cherries and paprika, which have lower levels of capsaicin.



Although the chemical tricks our brains into thinking the peppers are dangerous, capsaicin is not actually harmful to humans. In fact, it has long been known that the chemical has many health benefits. It has been used in pain relief medication and as a treatment for arthritis and headaches. While not everyone enjoys the flavor of hot peppers, we can all appreciate the multitude of health benefits they provide.

THE PROCESS OF VACCINE CREATION

With the COVID-19 pandemic raging for over nine months now, people around the world are eagerly awaiting the end of lockdowns, social distancing, and mask-wearing. Luckily, recent news shows that it is very likely we will see the emergence of at least one effective, mass-produced vaccine in the near future.

Almost an entire year of the pandemic may feel like an excruciatingly long time for a vaccine, but this rate of vaccine development is unprecedented. The development of a new vaccine typically takes ten to fifteen years. Because of the rapid spread and dire consequences of COVID-19, this timeline is a luxury the world can ill afford right now. Companies around the world are racing to find a solution in record time. Still, as imperative as it is to produce a vaccine quickly, it is equally important for it to pass rigorous safety checks and several stages of testing before being released to the public. In the United States, there are four stages of vaccine development:

1. PRECLINICAL STAGE
2. ANIMAL TESTING
3. CLINICAL HUMAN TRIALS
4. FDA EVALUATION

PRECLINICAL STAGE

The preclinical stage of vaccine development is the first, most basic level of development. Companies begin research in the lab. They typically develop multiple vaccine candidates that they believe will be safe for patients and effective against the virus. Most vaccines do not have one hundred percent efficacy, but researchers strive to make them as effective as possible. Researchers rely heavily on past research on other viral diseases to help expedite the development of vaccine candidates.

ANIMAL TESTING

After the company selects the most promising vaccine candidate, it is first tested on animals such as mice and monkeys for safety. With SARS-CoV-2, the FDA helped expedite the development process by prioritizing clinical trials (on humans) rather than going through extensive animal testing trials.

CLINICAL TRIALS

Following animal testing, the vaccine must go through extensive testing on a controlled set of individuals who are monitored and observed frequently. There are three phases of clinical trials.

Following animal testing, the vaccine must go through extensive testing on a controlled set of individuals who are monitored and observed frequently. There are three phases of clinical trials. The first phase is the smallest, conducted on only twenty to one hundred volunteers. There is little diversity in the ages or health of these individuals. Rather, this stage focuses on observing the general side effects of the vaccine in the body, the immune response, and the optimal dosage.

If no concerning factors are observed in Phase 1, companies move to Phase 2 of the trial. During this stage, roughly a couple hundred participants are tested. There are different groups within the participants, and the researchers observe the effect of the vaccine on different demographics, and whether the optimal dosage of the vaccine differs according to the health and age of the individual.

Phase 3 is the final and largest stage of clinical trials, and the last step in the development process. They select a few thousand volunteers across different age and health demographics to participate in this trial. The focus of this phase is to ensure that the vaccine is safe to administer to all types of people. Half of the participants are given the vaccine while the other half are given a placebo — a harmless saline solution, usually in a double-blinded study in which neither the participant nor the investigator is told whether they were given the vaccine or a placebo.

This is done to compare the effect of the vaccine on the recipient by comparing it to a control group by observing how many people in each group will naturally contract the virus and get sick. Phase 3 is also crucial for determining the efficacy of the vaccine.

APPROVAL

Finally, before they can release the vaccine to the public, the companies must submit their results from their research and trials to federal organizations such as the FDA and the European Commission for their approval. The FDA determines whether the vaccine has been sufficiently vetted and is safe for distribution. They review the data to determine the purity, safety, potency, and effectiveness of the vaccine. Besides the results of the clinical trials, FDA scientists also study the vaccine's physical, chemical, and biological properties as well as the manufacturing process. If they determine that the vaccine's benefits outweigh the potential risks, the FDA will approve the vaccine, and grant a license, allowing the public to use it.

Usually, each phase of the vaccine trial takes several months or years. In order to expedite the COVID-19 vaccine, many companies combined Phase 1 and 2, which significantly accelerated the development.

The U.S. federal government initiated Operation Warp Speed (OWS), a collaboration between different government agencies such as Health and Human Services, Agriculture, Energy, and Veterans Affairs, as well as the private sector to help speed up the development.

Currently, there are three companies at the forefront of COVID-19 vaccine development: Pfizer, Moderna, and AstraZeneca. Operation Warp Speed selected all three to be funded for Phase 3 clinical trials. Both Pfizer and AstraZeneca formed partnerships with public institutions to speed up the development. These public-private partnerships are unusual and are part of the reason COVID-19 vaccines have developed so quickly.

Pfizer and Moderna have completed Phase 3 trials and have applied for emergency use authorization to the FDA and EC. The U.K. approved

Pfizer/BioNTech's vaccine for emergency use and started vaccinating its citizens on December 8, 2020. The FDA is expected to announce its ruling on the Pfizer vaccine on December 10, 2020, followed by Moderna's vaccine a week later. Interestingly, both Pfizer/BioNTech and Moderna's vaccines are based on an entirely new vaccine technology called mRNA vaccine. Both companies claim 95 percent effectiveness in their Phase 3 trials, with few side effects.

Naturally, the vaccine will take time (several months at the least) to distribute out to the world's population, but with the emergence of many promising vaccines, these will be the first steps toward fighting back against this global pandemic and restoring our normal life. We can all look forward to the day when the pandemic (and remote school) is a thing of the past.

VACCINE

**PFIZER
MODERNA**

DECEMBER 2020

ASTRAZENECA

JANUARY 2021

JOHNSON & JOHNSON

FEBRUARY 2021

**NOVAVAX
SANOFI/GLAXOSMITHKLINE**

SPRING 2021

LIKELY AVAILABILITY

EVENT

DATE

**NOVEL CORONAVIRUS IDENTIFIED IN
WUHAN, CHINA**

JAN 7, 2020

**GENETIC SEQUENCE OF VIRUS
RELEASED BY CHINESE AUTHORITIES**

JAN 11, 2020

**START OF PHASE 1/2 TRIAL
45 PARTICIPANTS)**

MAY 4, 2020

**START OF PHASE 3 TRIAL
(43,661 PARTICIPANTS)**

JULY 27, 2020

SUBMITTED FOR FDA AUTHORIZATION

NOV 20, 2020

FDA AUTHORIZATION GRANTED (EXPECTED)

DEC 10, 2020

**VACCINATION OF HIGHEST RISK AMERICANS
(FRONTLINE WORKERS AND SENIOR CARE
FACILITY RESIDENTS) (EXPECTED)**

BY JAN 15, 2021

**AVERAGE AMERICAN LIKELY TO GET
VACCINE (FRONTLINE WORKERS AND
SENIOR CARE FACILITY RESIDENTS)
(EXPECTED)**

**BY JULY 2021
(ACCORDING TO
DR. ANTHONY
FAUCI)**

THE SCIENCE BEHIND THE COVID-19 VACCINE

As Pfizer, Moderna and other research laboratories pave the path to the end of the pandemic, recent developments for the COVID-19 vaccine shed light on a new type of vaccine development, known as the messenger RNA (mRNA) vaccine.

This new vaccine uses mRNA, the genetic material used to code certain proteins, in order to confer immunity. With COVID-19, scientists developed the vaccine by utilizing the mRNA sequence that creates the spike protein specific to the SARS-CoV-2 virus. From there, the vaccine undergoes three steps to achieve immunity. First, they inject the vaccine into the upper arm muscle cells, allowing the mRNA, protected in a lipid bubble, to enter the bloodstream. Next, the mRNA of the spike protein is taken up by a body cell, which in turn undergoes translation (creating the protein from the mRNA) to display the spike protein on the surface of the body cell. Finally, our immune system will detect this unusual spike protein in our body cells and will present the spike protein to helper T-cells, which signal B-cells to produce antibodies against the spike protein

At the end of this process, the immune system will recognize live SARS-CoV-2 virus by the spike protein and produce antibodies against them, marking these viruses for destruction. The vaccine tricks the body into thinking there is an infection by

a harmless piece of the virus's genetic material (mRNA); this allows the body to produce antibodies. When there is a live virus, the immune system will be trained to combat against the infection. Traditionally, vaccines used a weakened version of a virus to trigger an immune response, but the development and manufacturing of this type of vaccine takes many years. Because mRNA can easily be reproduced in the lab, this novel method has expedited the development of the COVID vaccine, reducing it from years to months.

POINT OF CLARIFICATION:

The vaccine CANNOT infect someone with COVID-19. The mRNA vaccine only contains information to make the spike protein, which by itself, is harmless; you cannot get the virus from the vaccine because there is no information in the vaccine to produce the entire pathogen.

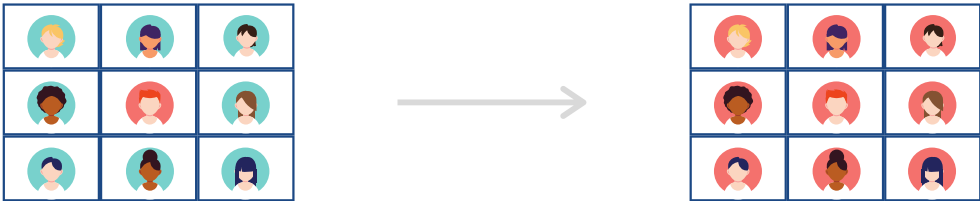
As the first mRNA vaccines are being approved, the COVID-19 vaccine is one of the fastest vaccines ever to be produced and signals a potential turning point in vaccine development.

PUZZLE

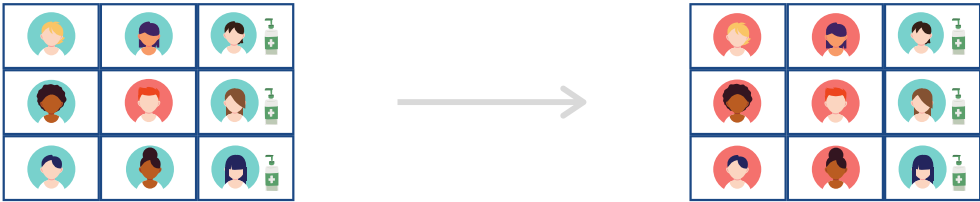
COVID-19 has unfortunately reached the small island of Catapulta. Because it's a small, close-knit island that heavily relies on tourism, the occupants live close together and do not have much funding to combat COVID, pooling their own funds each week. The vaccine is out in a month, but until then, the islanders will have to rely on other methods to combat the spread.



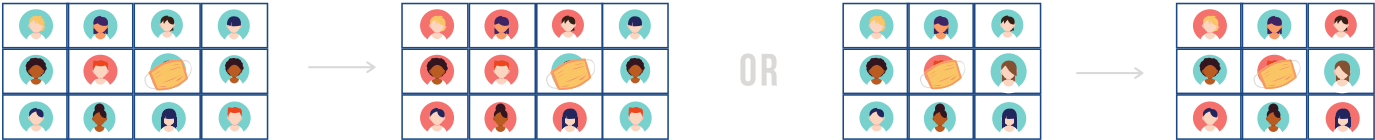
VIRUS: SPREADS AROUND TO ADJACENT SQUARES



\$50 - HAND SANITIZER: STOPS SPREAD TEMPORARILY OF 1 ROW/COLUMN; LASTS 1 WEEK



\$100 - MASKS: WEARER IS IMMUNE AND DOESN'T SPREAD THE VIRUS TO TOUCHING SQUARES; LASTS 2 WEEKS



You can only spend \$1000 dollars a week, and 4 weeks until the vaccine arrives. What's the least amount of money you need to spend to contain the virus?