CATA PULTA

SPRING 2022

applying science to socioeconomics: INTERVIEW WITH RYAN AHMED

thalidomide: how a destructive drug shaped the FDA

the history of anatomy

the science continues...

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DEAR READER,

TIME FLIES, DOESN'T IT? SIX YEARS AGO, WIDE-EYED SIXIES ALEX AND SANJANA WANDERED INTO COMPUTER LAB 016 AND BEGAN THEIR CATAPULTA JOURNEY BY MAKING MEDIOCRE EDITS TO THE SEASONAL ARTICLE SUBMISSIONS. NOW, WE WRITE OUR FINAL EDITORS' NOTE AND REMINISCE ABOUT ALL THE MEMORIES FROM OVER THE YEARS.

WE WANT TO THANK EVERYONE WHO HAS BEEN A PART OF OUR CATAPULTA JOURNEY -- OUR PREDECESSORS, SUCCESSORS, AND FACULTY SUPPORT. IT HAS BEEN A PLEASURE TO CARRY OUT OUR ROLE IN GROWING THIS CLUB AND TO BE A PART OF THIS COMMUNITY. AS WE HEAD OFF TO COLLEGE AND BEYOND, WE HOPE THAT CATAPULTA MAY CONTINUE TO ENCOURAGE ITS READERS TO TAKE THEIR LOVE OF LEARNING TO THE NEXT LEVEL. BUT FOR NOW, HAPPY READING!

WARM WISHES,
ALEX CHOU AND SANJANA SINGH

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DATA IN DNA

Imagine every bit of your life recorded in the palm of your hand. From every painful struggle to every exhilarating success. Well, imagine no more—recent biological innovations have brought this supposed fiction to reality.

Since 2012, research initiatives have allowed data to be stored in DNA. A decade ago, George Church and other researchers inputted a 53,000-word book in groups of DNA. They replaced each word with nucleic acids—the language of DNA—containing nitrogenous bases adenine, cytosine, guanine, and thymine. This was made possible as each letter—A, C, G, or T—could represent a 1 or 0, similar to binary code.

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PERMAFROST THAWING

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GLACIAL ICE IS NOT THE ONLY THING THAT CAN SIGNIFICANTLY AFFECT THE FUTURE OF AN ENVIRONMENT. PERMAFROST–GROUND THAT HAS BEEN FROZEN FOR AT LEAST TWO YEARS–GENERALLY CONSISTS OF A COMBINATION OF SOIL, ROCKS, AND SAND HELD TOGETHER BY ICE AND REMAINS FROZEN YEAR-ROUND. ABOVE THIS FROZEN GROUND IS THE ACTIVE LAYER, A COAT OF SOIL THAT REMAINS FROZEN FOR ONLY A PORTION OF THE YEAR AND CAN VARY IN THICKNESS DEPENDING ON THE TEMPERATURE OF ITS SPECIFIC LOCATION. WHILE PERMAFROST MAY NOT SEEM LIKE A CONSIDERABLE ISSUE, ITS THAWING COMES WITH MANY REPERCUSSIONS TO THE ENVIRONMENT: AS GLOBAL TEMPERATURES INCREASE DUE TO CLIMATE CHANGE, THE RATE OF PERMAFROST THAWING INCREASES AS WELL.

LIVING BUILDING MATERIALS

Biotic building materials may be the future of civil engineering. This field combines material science, chemistry, bioengineering, and architecture. From recyclable cement substitutes to self-healing concrete to bricks made of fungi, the discipline investigates innovative solutions for modern problems.

With 8% of all carbon emissions coming from the cement industry alone, it is no surprise that scientists are exploring methods to reduce this number. To do this, the Living Materials Laboratory of the University of Colorado at Boulder has created a 100% recyclable cement-free building material made of living cyanobacteria—microorganisms similar to algae that can photosynthesize and grow without any carbon emissions.

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CHIMERAS AMONG US

As described by Homer in the *Iliad*, the Chimera of Greek mythology was a fire-breathing monster that comprised an assortment of exotic body parts, including a dragon's tail, goat's torso, and lion's head. She terrorized the people of Lycia until slain by the hero Bellerophon, who suffocated the beast with the melted lead of a spearhead. Although a Frankenstein of such animals might seem like fantasy, it may surprise us to know that Chimeras are very much real.

In 2016, a hunter from Idaho killed and bagged a mountain lion. In addition to the set of teeth in its mouth, the lion was found to have a full set of canines growing out from the left side of its forehead. Aside from the teratoma theory—which describes how tumors from stem cells may form a new body part—biologists suspect that the deformity may have been caused by conjoined twins, one of which absorbed the other. In this case, the twin's teeth were the remnants of it that had been absorbed into the body of the hunted mountain lion, its fraternal twin (with nonidentical DNA).

PROJECT ICARUS

When faced with droughts, floods, food insecurity, or other natural disasters, animals often flee their habitats. The Max Planck Society in Germany is leading a project with the mission of creating an "internet of animals" to help researchers understand these changes.

The Max Planck Society uses the International Cooperation for Animal Research Using Space—or ICARUS for short—to track the migratory patterns and behavioral changes in fruit bats, great apes, antelopes, and songbirds, among other animals. ICARUS is an example of an Internet of Things (IoT) system, which is a network of objects tracked with sensors or other kinds of technology in order to collect or connect data. In the case of ICARUS, animals are equipped with tiny tags. These tags do not impede animals' normal activities or movement and only weigh around 5 grams. The tag includes a lithium battery, radio, GPS, and control module with sensors that detect magnetic fields, temperature, humidity, and pressure. This means that scientists can assess the location of each animal, whether they are dead or alive, the speed at which they are traveling, and various data from each animal's environment. Furthemore, these sensors are solar powered, which means that they are easily rechargeable.

What happens, however, if one twin is completely engulfed by another? In this case, a genetic phenomena known as chimerism occurs, in which an organism contains the DNA code of two or more individuals. Chimerism can occur in a variety of organisms. In humans, this happens in three main ways:

1. **Tetragametic/Fusion Chimerism**: Fraternal twins fuse together in the womb during an early development stage. This timing allows for chimeras to develop normally without issues of conjoinment or excess limbs, since the cells form a single chimera.

2. **Twin Chimerism**: One twin dies later in development than in fusion chimerism and is then absorbed by the other twin inside the womb, leaving the survivor with 2 different sets of DNA.

3. **Artificial chimerism**: A result of a bone marrow transplant in which the stem cells contained within the transplant develop into red blood cells. The donor's cells then become part of the recipient's body, which makes the recipient the host of two different sets of DNA and thus a chimera.

4. **Microchimerism**: During pregnancy, some cells from the fetus are carried in the mother's blood to different organs. The mother will then have both her and her child's DNA for a period of time.

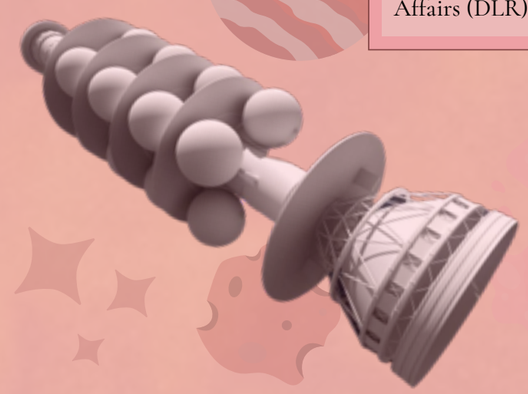
The viral picture of a cat with half of its face covered in black fur and studded with a green eye while the other half was orange with a blue eye is an example of Chimerism. Other physical signs of Chimerism may include two different colors of hair on either side of the head, patchy skin, or intersexuality. It is even possible that an animal with Chimerism can have one organ made with instructions from one genome and another with a totally different one! Chimerism is generally very rare in general, although it can be quite common in cats. In the history of modern medical literature, only about 100 cases of Chimerism in humans have been recorded. However, this may be partially due to the fact that people are often unaware that they have this condition. So are you, by any chance, a Chimera?

This data is then sent 600 kilometers upward to ICARUS' location on the International Space Station. After obtaining the data, the International Space Station (ISS) sends it to a control center back on Earth to Project ICARUS scientists. This data is then stored in an open-source database called Movebank, hosted by the Max Planck Institute of Animal Behavior and partially funded by NASA.

But what can scientists do with this data? First, data collected from ICARUS can inform scientists of abnormal changes in animal behavior. Because animals have keen senses, their movements can warn scientists of incoming natural disasters, such as volcanic eruptions or incoming tsunamis. ICARUS can also help scientists understand animals' behavioral patterns and aid with their preservation. For example, a rapid decrease in the population size of a certain species may serve as a warning regarding the stability of its environment.

Currently, Project ICARUS has tagged 900 different animal species, though it has recently encountered trouble obtaining new data. Previously, ICARUS's antenna was attached to the exterior of the Russian ISS module, but since September, the team has run into difficulty obtaining data from the Russian Space Agency.

However, this does not worry the team! ICARUS has always only been a proof of concept, a rapid prototype that can be used to prove its feasibility. The team plans on creating smaller, cost-effective satellites and is currently making plans with NASA. The team's long-term goal is to make ICARUS a GRACE-I project: a joint project among the Helmholtz Association, NASA, the German Agency for Space Flight Affairs (DLR), and the Max Planck Society that will be launched in early 2027.



PERMAFROST THAWING

ANOTHER LAYER TO THE CLIMATE CRISIS

(CONT.)

Permafrost across the globe contains an abundance of greenhouse gases, chemicals, microbes, and dead organic matter. These materials together are called organic carbon. Organic carbon, a typically uncommon component in ecosystems, does not decompose, allowing it to remain within the permafrost, even after it has been frozen for thousands of years. According to NASA, microbes more than 400,000 years old have been found in thawed permafrost. The reintroduction of these ancient microbes could easily lead to human and animal illness.

Permafrost contains greenhouse gases like carbon dioxide, methane, and nitrous oxide, which are driving forces behind global warming. It is estimated that 1,700 billion metric tons of carbon—51 times the amount of carbon released worldwide in 2019— are contained within the world's permafrost. While this amount is not being released all at once, the amount that is being discharged due to permafrost thawing still has major consequences for the environment. If more significant amounts are freed within such a short time period, our planet will be in a predicament.

Permafrost's rapid thawing has the ability to affect nearly every part of our world. Permafrost thawing in the Peatlands, a wetland ecosystem in Scotland, has contributed to 18% of Scotland's carbon emissions alone. In other areas, thawing permafrost has created large sinkholes and road damage, underscoring its capacity to impact man-made infrastructure. Almost 25% of the land in the Northern Hemisphere has permafrost beneath it, leaving a significant area of our planet especially vulnerable to the more local effects of thawing. For example, thawing permafrost near the arctic coast has already led to the flooding of villages in that area, forcing residents to relocate.

IN NORTHWESTERN CANADA, THE FOUR SQUARE MILE TOWN OF TUKTOYAKTUK COULD BE ENTIRELY GONE BY 2050 IF PERMAFROST CONTINUES TO THAW AT ITS CURRENT RATE.

Current trends predict an enormous surge in the amount of carbon released from permafrost within the next century. Currently, rising temperatures and increased rainfall in the Arctic are only accelerating the rate of permafrost thawing, creating a positive feedback loop that dangerously quickens the thawing process: global temperatures rise, permafrost melts, greenhouse gases are released, and temperatures continue to rise even faster, restarting and magnifying the cycle. Though little attention has been brought to this issue, the melting of global permafrost continues to pose significant repercussions. While nations across the planet have united in efforts to keep the global temperature rise under 2 degrees celsius through initiatives like the Paris Climate Accord, permafrost thawing could be a driving factor that keeps this goal beyond our reach.

3D PRINTING

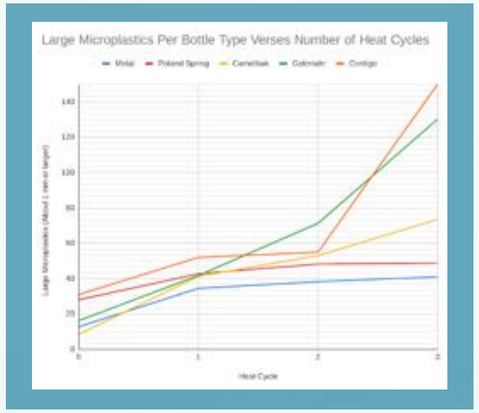
MICROPLASTICS

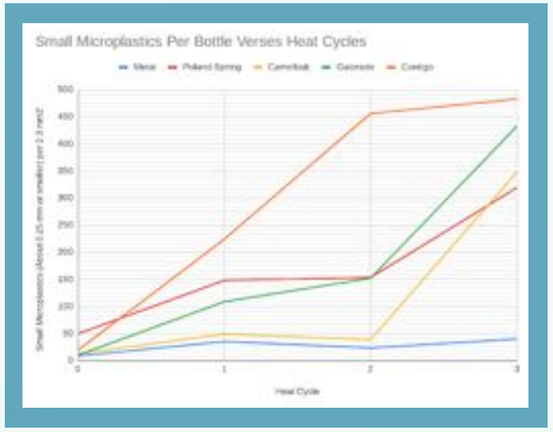
Studying the environmental toxins and their impact on human health is important to preventing disease and achieving sustainability in the future. Currently, about 400 million tons of plastic are produced each year.

> Since plastic takes a long time to decompose, it might not be surprising that current approximations estimate around 5 billion tons of plastic in landfills and the environment.

Microplastics are miniscule plastics (less than 1 mm in size) that may be produced when plastics degrade. The dangers of microplastics remain unknown, though their high surface area means that toxic chemicals like bisphenol A (BPA) are more likely to leak out in these substances.

My project evaluated the amount of small (<0.25 mm) and large (>1 mm) microplastics produced by water bottles after experiencing heat exposure. In my experiment, several different kinds of water bottles were exposed to heat, and I tracked levels of microplastics over time. My results demonstrated that, although all water bottles had microplastics at the start, the amount of microplastic increased after they were heated, supporting my hypothesis.





In both small and large microplastics, the control metal water bottles showed small rises in microplastics. In plastic bottles, however, exposure to heat increased the number of small microplastics up to 44 times the baseline, with the oldest water bottle having produced the most. This trend was observed for larger microplastics as well. Some bottles (Gatorade and Contigo) reached over 2 billion small particles per 500 mL. The Poland Spring water bottle started out with the most microplastics before heating, and CamelBak produced the most microplastics with heating.

In the future, I would like to further investigate the potential toxicity of microplastics and their health risk—after all, we drink millions—or even billions—of them every day!

CHERNOBYL

What Caused the Worst Nuclear Disaster in History?

On April 26, 1986, at 1:23 am, the No. 4 reactor at the Chernobyl Nuclear Power Plant exploded. What at first seemed like a normal fire quickly turned into a horror story that gripped the world and changed nuclear history forever. But to understand how this disaster happened, one must first understand how a nuclear reactor is run.

Nuclear fission, the process in which atoms split and release energy, produces intense heat. A typical nuclear reactor, the heart of a nuclear power plant, splits uranium atoms and is shielded from the heat by a liquid, usually water, which absorbs the heat energy. As water boils, turning into steam, a turbine is spun, creating relatively large amounts of clean electricity. The uranium used by the reactor is transformed into ceramic pellets and stacked into fuel rods in a process known as fuel assembly. A nuclear reactor contains hundreds of fuel rods, though varying in number depending on power level. While the reactor is active, these fuel rods are cooled with water to absorb excess energy and can be inserted into or removed from the reactor to alter reaction rate.

Continued improvement of this technology has allowed for many types of nuclear reactors to be made. Currently, the United States of America uses pressurized water reactors (PRW) and boiling water reactors (BWR) in power plants. The four reactors used at the Chernobyl Power Plant, which was fully shut down over twenty years ago, were all RBMK-1000 reactors. RBMK-1000s pose the risk of losing their coolant and, under certain circumstances, thus rapidly increasing their reaction rate instead of shutting down. Additionally, this type of reactor has a positive void coefficient, meaning it is over-moderated and has poorly designed control rods.

Since the Chernobyl accident, RMBKs in Russia have undergone major modifications. However, the innate design flaws of reactor number 4 was not completely at fault for the Chernobyl disaster. The day of the explosion, there was a scheduled test for the electrical systems, which involved turning off the emergency core cooling systems that were used to moderate the assemblies. At 2:00 PM the day before, the scheduled time for

the test, the emergency cooling systems were turned off. The test was delayed because the plant's director did not show up, but the workers neglected to turn the emergency cooling systems back on. According to PBS, the cause of the explosion itself was "the result of a fatal combination of ignorance and complacency." In an attempt to make up for lost time due to the test delay, plant workers reduced the power level too rapidly. This caused a large buildup of nuclear fission in the reactor core, and the reaction became "poisoned." Instead of waiting for the build-up in the reactor to dissipate, the Deputy Chief Engineer ordered that the power levels be immediately increased thereafter.

By 1:23 AM, all emergency cooling systems had been deliberately turned off for the experimental test, which was undeniably hazardous. Then, "the engineers proceeded with their experiment by shutting down the turbine generator. That... reduced the flow of cooling water through the reactor." When workers noticed this increase in reaction rate and power, they immediately inserted all 205 control rods--a deadly mistake. The control rods--tipped with graphite--increased reaction even further, and displaced the remaining coolant water.

As a result, the reactor exploded, releasing 400 times more radioactive fallout than the Hiroshima bomb.

Though it has been nearly forty years since this fateful disaster, it can be connected to modern humanitarian crises. The Exclusion Zone, the site of the Chernobyl disaster, lies in southern Ukraine and has grown in notoriety because of the recent news of Russia's recent invasion of Ukraine. Russian occupation of Chernobyl has led to multiple disruptions there, and reports from CNN suggest that, "Russian forces have looted and destroyed a laboratory near the abandoned Chernobyl nuclear power plant." Prior to this, however, Chernobyl had become an important location for scientific studies and engineering developments focusing on increasing the safety of nuclear reactors.

While international war and politics may continue to interfere with progress, it is important to realize that scientific data plays a pivotal role in learning from past disasters and preventing future catastrophes.

INTERVIEW WITH RYAN AHMED

What inspired you to found the International Socioeconomics Laboratory?

I started ISL on July 10, 2017 with around four or five people. We started off as a policy group that does research, but we saw the lack of empirical data in decision-making within global leadership.

We wanted to push data-driven decision making (DDDM) because of the current polarization to help leaders make better decisions based on data and empirical research.

Oftentimes, leaders have a gap in data, but they don't have the data itself. When we worked with the Philadelphia City Council, they told us, "We don't have any data on youth homelessness, so we don't know how much money we should put in. We just don't know how many there are, and we want to learn more about that because we cannot make a good decision without knowing it." We can bring people together around data and also socioeconomics.

What role do you think young students play in working towards a more equitable future?

To give them the ability to see the world in a new light is really important for this kind of work. Young people are really good at engaging, bringing themselves together, and advocating for what's right. Without data, we can't really advocate as well. If we have data, and we can get young people to get involved in data, we can make advocacy more effective, and it can also be a lot smoother process for advocates to take data and have substantial pieces of information that can help their way in terms of getting a bill passed or writing legislation, but also to have more leaders in the community who focus on providing data. That engages the field of research and the field of advocates, and we need more of that in society.

This allows young people to be more aware and more empathetic, because every single data point in socio-economic research—every single number, every single statistic—represents a story. These stories describe the experiences that they go through, the circumstances that they're put in, what socioeconomic factors impact them, and so on.

What have you found to be the most effective ways to gather input from the public?

With socioeconomics, you can't really do experiments. Most of ISL's research gets expedited approval from the Institutional Review Board (IRB). We can't really do experiments to make effective socioeconomic research. Experiments wouldn't really go well with socioeconomic research because you would have to affect the control or control variables we have (e.g. socioeconomic status). You can't really test that in the real world. You could do online surveys, you could do random digit dialing (RTD), you could do fieldwork—which many people have done, especially in India and Nepal. We've done tons of fieldwork in-person; in India, we met with migrant workers to study them. Besides that, you could do meta-analysis, where you take existing socioeconomic data sets and apply economic theory or data analysis to compare variables. One example of this is census data, a huge spreadsheet that you could take and analyze. There are already hundreds of research papers for every census data set that comes out. You can take a large data set and come up with your own original research question out of it, because someone may not have asked the same question you have. The answer lies in the data itself—the numbers that are already there!

Have you ever been surprised by the findings of your research?

The Corona, Queens healthcare project. There is a population of 300,000 and no hospital in the area. The data clearly showed that there is a significant need for a health care facility in Corona. The hospital next door in the next town was at 125% capacity. There are multiple neighborhoods that have a lack of access to health care and a history of hospitals being shut down all throughout New York City throughout the last ten years. There's a lack of access to health care because of the economic downturn going on in New York and the lack of investments going into these communities. But then New York City ran a huge campaign on how they're going to expand health care. Two districts—one being Queens—did not receive any funding on healthcare expansion. That didn't make a lot of sense to us. There's a high desirability rate for a healthcare facility to be built—based on our research—but we saw that $0 in health care investment from the public was going into Queens. What was surprising was that when we reached out to private providers like NYU, private providers didn't see potential in the neighborhood because of their high immigrant and undocumented population. Even though their neighborhood has 300,000 people, they don't see potential in an area that has no hospital. This will lead to an economic downturn in the area, but also a larger economic downturn in Queens.

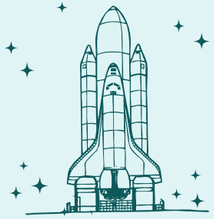
What else do you hope to share with our readers?

Socioeconomics is extremely important! If there are people in Boston who are heavily interested in it, there's currently a bill that we're working on to ban access to muscle-building supplements and diet pills in Massachusetts. That bill has received tons of support from organizations, doctors, and experts in the field, but also a ton of young people. If there's anyone interested in that kind of work and who wants to lead a bill that can help people: these products contain chemicals that are underregulated by the FDA and that can harm a young person. There have been cases where people, even those I know of, have gotten heart attacks from these products. It's really important that young people get involved in this kind of work—not just this project, but so many other projects that they can be involved in. So, try and get involved in any way you can! If you want to take a new approach to that or an approach that's often overlooked, look into data. Look into how you could help other people with research and with data.

ABOUT RYAN AHMED

On May 11, 2022, *Catapulta* Editor-in-Chief Alex Chou (I) conducted a Zoom interview with Ryan Ahmed. Ahmed is the Founder of the International Socioeconomic Laboratory, a Harvard University affiliated non-profit organization that partners young students with graduate researchers and gathers empirical data on social and economic issues to influence local policy change. The transcript has been lightly edited.

ORIGAMI APPLICATIONS



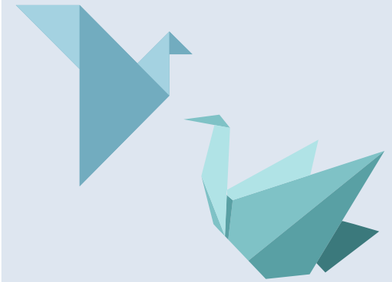
Origami—a simple yet delicate art form—may be considered an act of precision or tranquility to some, but many might consider it to be quite meaningless. After all, the only thing you can do with the finished origami piece is set it on your table, right?

As it turns out, origami has numerous scientific applications. It has been used to help design bridges and stadiums. For example, the pipes of high-speed Japanese bullet train tracks have been designed to absorb pressure in a similar way. Origami techniques have also been used to replicate cell membrane and protein structure or DNA samples.

The most interesting application of origami, though, may be in space technology: origami can be used to mimic organizing luggage to fit into compact spaces. Robert Salazar, an intern at NASA's Jet Propulsion Laboratory, explains, "origami offers the potential to take a vast structure and get it to fit within the rocket... magnifying what we are capable of building in space."

Such fascinating uses of origami prove that the beauty of this ancient art extends beyond entertainment and that it can help pave the steps for groundbreaking progress.

- ANDREW ZHENG



Living Building Materials

(CONT.)

Meanwhile, researchers at the Worcester Polytechnic Institute have designed self-healing concrete that uses an enzyme capable of transforming carbon dioxide into calcium carbonate crystals. This product can seal millimeter-scale cracks with the same material coral is made of, preventing further structural damage. Furthermore, this process is faster than bacteria-based healing and poses no safety issues.

Mycelium—which functions as roots for fungi—is another contender in the field of living construction materials. Materials based on this technology have good insulation properties, are fire retardant (fireproof), and do not produce toxic gasses. In 2014, The Living created Hy-Fi, the first large-scale structure made of mycelium bricks grown in just 5 days. Mycelium-based materials are being considered by NASA, since they can be grown on-site and thus would greatly reduce the mass of materials transported.

Of course, these ideas need to be tested before they become fully realized. The Hub for Biotechnology in the Built Environment is a research project bringing together bio-scientists from Northumbria University along with architects, designers, and engineers from Newcastle University to develop living building materials in a replica house for this purpose. There is still much work to be done before these products become commonplace, but they pose promises of a future cleaner, greener world.

- WILLIAM KIRCHMAN

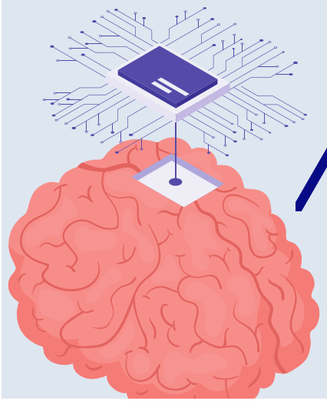
Brain Chips

No, not those types of chips! Neural chips, or brain chips, are a form of technology that involves devices which can be connected to a brain, allowing for the control of its neurons. These implants enable communication between the brain and other devices that monitor its activity. Neural chips send electrical signals to the brain to stimulate the neurons in a particular region, which in turn causes the brain to elicit a certain action from the body, such as moving a limb or opening an eye. This technology is already proving to be extremely useful for individuals affected by disorders such as Parkinson's disease, a condition characterized by symptoms like involuntary tremors. Deep brain stimulation is a type of treatment that has been designed to utilize brain implants to help Parkinsons' patients, where these devices are surgically implanted into the afflicted areas of the brain, helping to reduce the tremors.

Recently, a study was conducted by a research team at the University of Tubingen in Germany which claimed that a 36 year old man with amyotrophic lateral sclerosis, or ALS, was able to communicate with the scientists by modifying his brain signals using a neural implant. This implant produced an audible tone that indicated the speed of the electrical firing of the neurons. The man could produce sentences by holding the tone to choose letters or respond "yes" or "no" to certain questions. This promising study demonstrates how brain implants could be used to help people affected by progressive nervous system disorders.

However, there are some drawbacks to this technology: one problem is that the neural implants have a high risk of infection. Since the brain is an extremely delicate and important organ, infection would be detrimental to the patient's motor function and could cause further complications. Brain technology is certainly not perfect yet, and its features require improvement, but hopefully in the future we will be able to utilize the potential of these systems and improve the lives of people affected by nervous system disorders.

- KIEN BUI



Thalidomide: How a Destructive Drug Shaped the FDA

How can we be certain that the medicine we take is safe? Are we more assured if it has been tested on humans? That it went through the FDA approval process? That its side effects are transparently labeled?

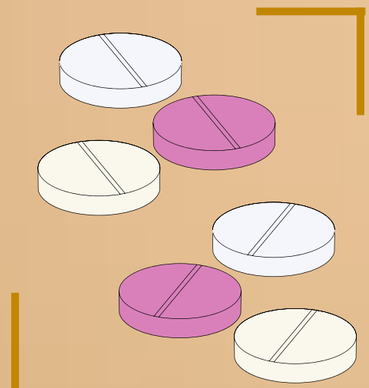
In contemporary times, these may be the typical standards for regulating medicine. Before the mid-1960s, however, regulations were much more lax. So what caused this shift in protocol?

Unfortunately, it took what is now considered the "biggest man-made medical crisis" in history for the FDA and its equivalents to become stricter with their approval processes. This crisis, known as the Thalidomide Scandal, took place in the 1950s and 60s. Although it occurred primarily in Europe, its repercussions could be felt worldwide.

During the 1900s, thalidomide was marketed toward pregnant women as a drug to cure anxiety, morning sickness, and colds, promising the safety of the fetus even though no testing for such claim had ever been conducted in a clinical trial. Created in Germany, it was produced around the world, which made it difficult to later link it to the disaster it created. It is important to note that many medicines at the time only needed to be tested on rodents, rather than humans, for approval for wide-scale use.

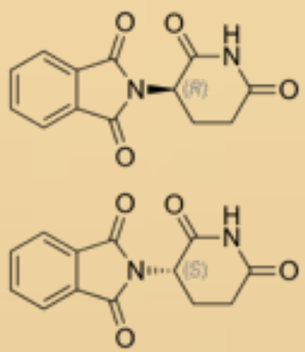
Despite any false claims about the drug's safety from the company Grünenthal, which was responsible for creating Thalidomide, the drug was extremely harmful to fetuses, causing high rates of birth defects, miscarriages, and stillbirths. If thalidomide was taken between the 20th to 49th day of pregnancy, the fetus would be harmed. Unfortunately, a common symptom during this stage of pregnancy was morning sickness, the main symptom. Birth defects ranged from malformations of the limbs, toes, and fingers to total or partial hearing or vision loss, paralysis, and organ injury.

It was estimated that over 10,000 children were born with birth defects and thousands of women had miscarriages because of Thalidomide.

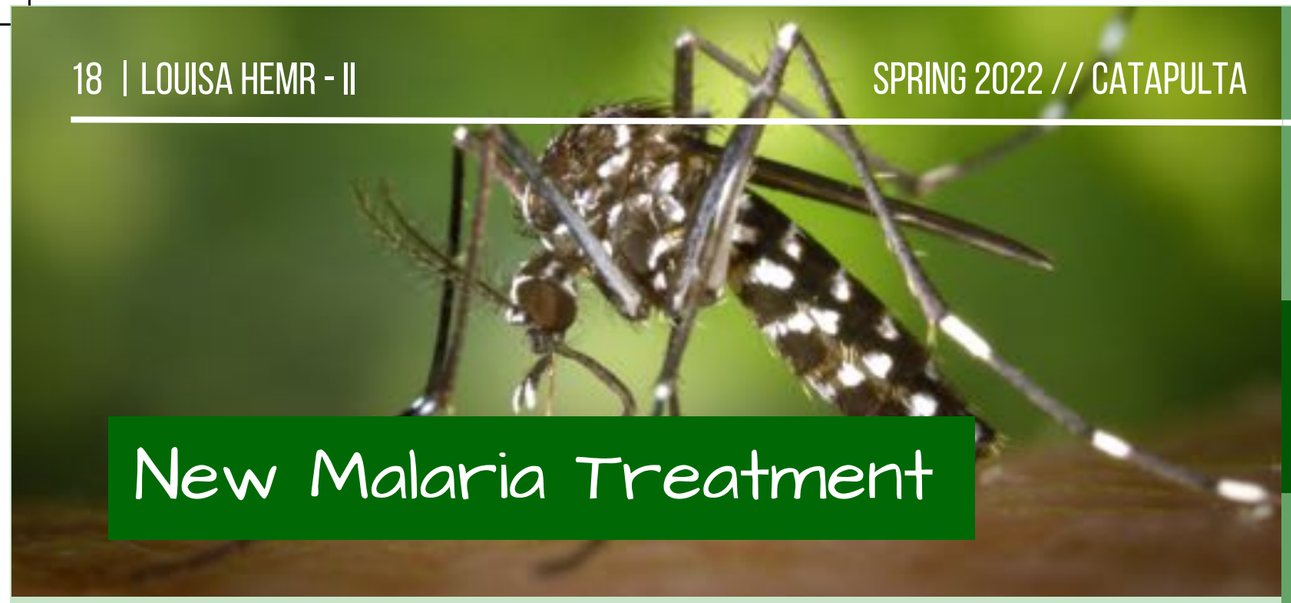


Before the link of these effects to thalidomide was realized, drug dealers had attempted to bring it to American markets. For this to occur, they would need approval from the FDA. Despite pressure from Grünenthal, one doctor—Dr. Frances Oldham Kelsey, a doctor in her first month of work at the FDA—adamantly refused to approve the drug. Before joining the FDA, Dr. Kelsey worked in a lab focused on finding treatments for malaria. This experience provided her with an in-depth explanation of the connections between enzymes and embryos in animals, which sensitized her to drug effects on fetuses.

Dr. Kelsey saw in a report from the British Medical Journal that peripheral neuritis, inflammation of the peripheral nerves, was a present side effect from thalidomide and decided to further investigate the drug. She suspected that the company did not disclose all of the potential side effects and began to wonder about its effect on fetuses. The company continued to pressure the FDA to get thalidomide approved, even changing its name, but Dr. Kelsey would not allow it without further scrutiny. Dr. Helen Taussig, the founder of the field of pediatric cardiology, heard about the thalidomide crisis in Europe and immediately went to work, examining many of the infants that suffered from the effects of thalidomide. She proved that thalidomide was the cause of the birth defects and wrote many articles on the dangers of thalidomide in pregnant women and the potential dangers of taking medication when pregnant. With her help, Dr. Kelsey was able to inform the US Senate and FDA about the dangers of thalidomide. Thalidomide was banned shortly after in the United States in 1961.

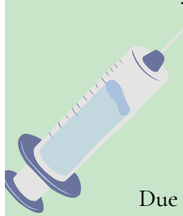


Due to the worldwide ramifications of this scandal, Congress passed the 1962 Kefauver-Harris Amendments, which changed the FDA approval process so that medicines and drugs required proof of efficacy and safety, informed consent for those enrolled in clinical trials, and reports listing the adverse side effects. Today, we consider these standards conventional, but it may surprise us to know that they have only been around for 60 years.



New Malaria Treatment

The World Health Organization (WHO) recently approved the first vaccine to combat malaria in children. Named Mosquirix, the vaccine was developed by GlaxoSmithKline, a United Kingdom-based pharmaceutical company. Malaria, a mosquito-borne disease, is one of the most common illnesses in the world, claiming over half a million lives every year. The majority of malaria-related deaths occur in sub-Saharan Africa, and the disease is particularly dangerous for young children and pregnant women. Thanks to improved mosquito prevention measures and drugs such as chemoprophylaxis, malaria has been successfully eradicated from many first world countries such as the United States and Russia. However, it remains a major concern in many less developed regions of the world.



> Experts are hopeful that the production of this vaccine may save thousands of lives in the upcoming years.

Due to its high fatality rate, malaria has greatly impacted the development of modern human genealogy. One of the reasons why the malaria parasite is so deadly is its direct effect on human blood cells, which are essential in transporting oxygen and vital nutrients around the human body. Malaria spreads within the body by draining nutrients from the red blood cells and using them as hosts for creating more malaria parasites. However, during the 1950s, Anthony C. Allison discovered that humans had, in fact, evolved a partial solution. In areas where malaria was especially prevalent, there was also a higher prevalence of sickle cell disease, which impacts the shape of the red blood cell. Sickle cell disease is quite dangerous in itself, as it hinders the blood's ability to transport oxygen. However, this mutation provided a benefit: these abnormally shaped cells are much harder for malaria parasites to attach to. A carrier for sickle cell disease is someone who receives the mutation from only one parent and thus gains this benefit of malaria resistance without being hampered by the effects of sickle cell disease. However, even in those regions where malaria is most common, less than thirty percent of individuals were found to carry this beneficial genotype, underlining the necessity for this vaccine.

While this vaccine is relatively new-- just recently approved for adults by the WHO in October of 2021-- the history of medical research on malaria is very extensive.

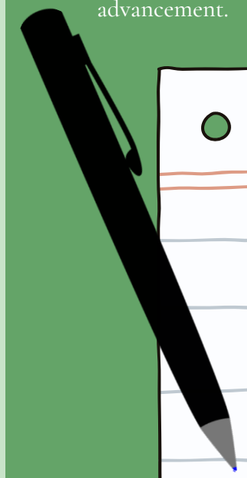
> A malaria cure, in the form of the bark of the cinchona tree of western South America, was used for thousands of years before the arrival of Europeans in the Americas.

The chemical derived from this bark is known as quinine and it was the first chemical compound that was used to treat infectious diseases in humans. While it has since then been replaced with compounds called artemisinins-- which are easier to extract from plant material and have exhibited fewer side effects--quinine continued to be recognized by WHO as the primary treatment for malaria up until the early 2000s.

As we all are aware, vaccines themselves are not new and have been used for over two hundred years.

> The centuries-long search for a malaria vaccine has been complicated by the fact that malaria is not caused by a specific virus or strain of bacteria but instead by several species of parasites.

According to Dr. Pedro Alonso, the director of the WHO's malaria program, the Mosquirix vaccine is the first vaccine that has been proven to combat a parasitic infection, which undoubtedly makes it a significant scientific advancement.



There is hope that the Mosquirix vaccine will be able to lead to future breakthroughs in the treatment and prevention of other parasitic diseases.

Data In DNA

(cont.) However, even with this information coded as DNA, how would you actually retrieve that microscopic data? Where on the DNA strand would you find information you are searching for?

Recent developments have the solution. Mark Bathe, a professor of biological engineering, has worked alongside colleagues at the Massachusetts Institute of Technology to find a novel method to retrieve this data. The team encapsulated each piece of information into files of DNA that was then placed onto a small silica particle. These silica particles are labeled with DNA barcodes, which allows quicker access for certain information—similar to using a file cabinet. To better picture this, imagine you have a secret word, "human," of which you want a search engine to find pictures. By entering the word "mammal," you eliminate all other images of nonmammals since the contents of an image are given specific tags, thus decreasing the number of your search outcomes. The exact process happens when you use DNA as a medium for data storage. Fluorescent or magnetic primers serve as barcodes for DNA that each have a label for what they are describing. The researchers demonstrated this method by pulling out images stored as DNA that was 3,000 nucleotides long or about 100 bytes. In addition to soliciting the desired images, researchers also found that the DNA remained unharmed through this process, unlike previous methods. researchers were able to remove the desired image.

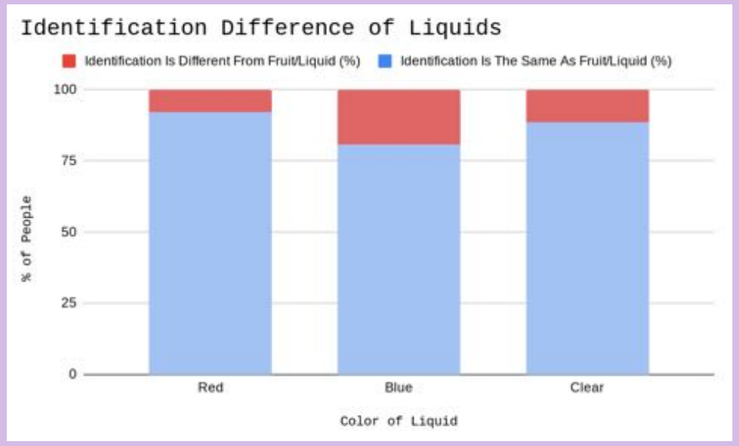
This creation is groundbreaking for future data storage, though there is still a significant amount of work that needs to be done. Though they have begun to decrease in costliness, DNA synthesis may be a huge barrier to this method, as it may cost upwards of one trillion dollars to write one petabyte (one million gigabytes) of data using DNA. Consequently, as current data technologies improve, DNA storage may become unnecessary or altogether obsolete. However, Bathe argues that DNA encapsulation can hypothetically keep cold data stored forever because polymer storage does not require any energy. store cold data, kept for long periods and not checked often.

As the world steams ahead into the digital age, demand for low-cost data storage will only continue to grow. When the time is right, you could perhaps hold your life in your hands, with memories made up of DNA.

THE EFFECTS OF COLOR ON VISUAL IDENTIFICATION OF A LIQUID?

BACKGROUND INFORMATION

Together, psychology and biology study how the mind behaves. The human brain has different parts that influence our physical motions, emotions, and decisions. At times, however, these parts may come in conflict. This occurs in addicts, for example: one part of the brain--the nucleus accumbens--provides motivation to achieve feelings of satisfaction through a certain addictive source or behavior, while another part of the brain--the prefrontal cortex--may use logic to contemplate the consequences of receiving this reward and consciously wish to stop it. In my project, I explore a similar question: does changing the color of a liquid affect a subject's ability to visually identify the liquid?



CONCLUSION

The results of my experiment demonstrate that there is a strong relationship between liquid color and people's visual identification, supporting my hypothesis. Most people chose the fruit or liquid that was the same color as the mystery liquid. For the red liquid, more people identified the liquid as the same color as its corresponding fruits, raspberry or cherry. In fact, more than ninety-two percent chose raspberry or cherry. Similarly, for the blue and clear liquid, more people identified the liquid as the same color as its corresponding fruits or liquids. Most people chose the fruit or liquid that was the same color as the mystery liquid because of bias.

If I were to conduct this experiment again, I would add more different colored liquids, such as liquids dyed purple, orange, and green and increase the number of participants. This will make my results more accurate, the more tests and participants, the higher the accuracy. To build on my research, I would like to further investigate how different colors of liquids affect people's visual identification. I would like to investigate this, because this experiment showed that color does have an impact on people's visual identification, so I am interested to see if people would choose the same color of fruit or liquid for one, but not the others.

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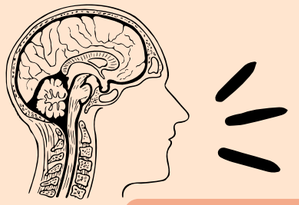


THE HISTORY OF ANATOMY

THROUGHOUT HISTORY, THE STUDY OF HUMAN ANATOMY HAS OVERCOME THICK AND THIN. FROM THE BEGINNING OF TIME, OUR ANCESTORS HAVE POSSESSED A PERFUNCTORY UNDERSTANDING OF THEIR ORGANS.

Anatomical studies in antiquity were conducted for religious reasons, out of genuine curiosity, and vitally, for medical purposes. Culminating in the work of Galen, traditional anatomy remained in place through the Middle Ages, until further research by scientists, such as Andreas Vesalius, during the Renaissance. These works laid the foundation for the modern field of anatomy and physiology. Understanding the human body is key to any medical career. It provides the basic knowledge of how our bodies function, which healthcare workers use to tackle the assortment of ailments they may encounter.

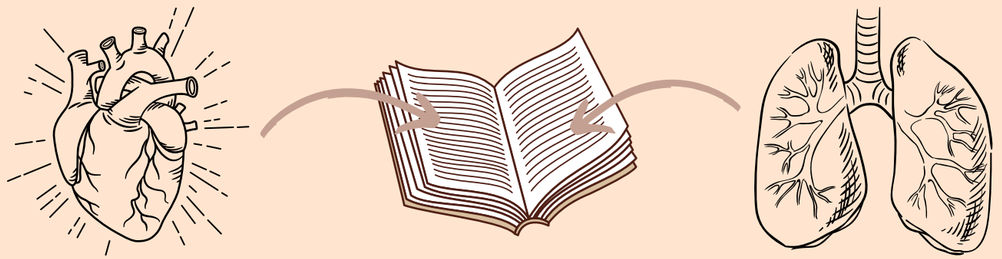
Evidence of anatomical awareness can be found as early as 30,000 years ago, among Stone Age societies. Among their cave paintings are drawings depicting basic animal anatomy. As civilization developed, more practical reasons to grasp the subject arose; complex Egyptian embalming procedures meant morticians would need a degree of knowledge of the body. The Egyptians attached little significance to the brain in their interpretation of anatomy, instead focusing on the heart as the center of consciousness. This "cardiocentric hypothesis" stemmed from religious beliefs of the soul. The idea of the heart as the "control center" of the body would both be accepted and challenged in Classical Greece. Their advancements in anatomy represented the next step in the arduous journey to enlightenment undertaken by many generations of physicians and scientists.

The term "anatomy" itself derives from the Greek word meaning "to cut open." Indeed, the first dissection of animals and corpses was performed by a Greek philosopher, Alcmaeon. He suggested that the brain was in fact the most important part of the body, a "cephalocentric" view. During the Classical and Hellenistic periods, medical texts explored bodily systems, differentiated between arteries and veins, and theorized the importance of body fluids. The dominant theory of the time was the four humors: a hypothesized system of the body with a balance of four fluids—black bile, yellow bile, phlegm, and blood. Diseases were ruled to result from an imbalance among the humors. This system persisted in Europe until the 1800s.

Following up the Greek works was the physician Galen. Born in Pergamon during the height of the Roman Empire, his career ranged from caring for gladiators to serving as a personal doctor for emperors. Galen, prohibited from performing dissections on cadavers, vivisected monkeys and pigs, which formed the basis of his assumptions on human anatomy. Although he discredited many old Greek ideas, his observations were not perfect.

After the fall of the Roman Empire, Europe fell into a dark age. Little learning was done. In contrast, the Islamic Golden Age brought about advancements in anatomy, conducting forensics studies and autopsies, while also preserving Greek medical records. Throughout the centuries, Galen's research was deemed infallible. However, revolutionary changes would take place during the Renaissance, more than 1300 years after the death of Galen.

Starting in the 12th century, universities in Europe incorporated courses about anatomy and surgery, featuring the opening of corpses. The field flourished during the Renaissance. From this era are the commonly known anatomical drawings by Leonardo Da Vinci. Andreas Vesalius, born in the 16th century, first challenged Galen's views in his book "De Humani Corporis Fabrica," Latin for "On the Structure of the Human Body." He pointed out that previous research on the human body was based on dissections of other animals, and therefore not necessarily accurate. He is credited with the establishment of anatomy as a modern field of science. The spread of knowledge regarding the human body meant that cadavers, or corpses, were in high demand. Those who were unable to get hold of a corpse resorted to practices such as body-snatching. In London, medical schools regularly paid groups of men to steal recently deceased bodies from cemeteries. The risingneed for corpses drove governments to increase the use of capital punishment to provide the required cadavers. "Anatomical theaters" brought dissection to the general public, going to see presentations on the wonders of the body. Through these rather distasteful practices, modern anatomy was born.



Though sometimes unscrupulous, the research of these 17th and 18th century scientists firmly brought the world onto the track of accurate, modern anatomy. It developed alongside disciplines such as histology, radiology, and genetics. Contemporary research gained access to advanced technology like X-rays and MRIs. Today, medical workers have a strong understanding of the human body, thanks to the generations of scholars prior. Although imperfect at times, their work is a testament to human's persevering curiosity.

PUZZLE

Submit your answer to
catapultasciencebls@gmail.com
for the chance to win a $25 gift card!

You are given a box with 9 squares, each one can be filled with only one number. Each number can only be used once and must be from 1 to 9.

	3	
		1
2		

3 numbers are already placed for you, win by filling out the rest of the box!

the sum of every diagonal and straight line should be 15

GOOD LUCK!