VOL.2 (2024/25) — AUTUMN 2ND HALF-TERM

CAFÉ SCIENTIFIQUE

~ DEFIANCE IN SCIENCE ~

CONTENTS

MESSAGE FROM THE NEWSLETTER TEAM

VOL.2 - 24/25 - CAFE SCIENTIFIQUE

THIS HALF-TERM'S THEME

This half-term, we have selected the title of the newsletter as, “Defiance in Science”. Besides its glorious rhyme, this theme was chosen as it is becoming increasingly important in the scientific community: considering both past and present discoveries and/or achievements that exceed expectations while giving recognition to the unsung heroes of women in STEM.

We felt that the ethos of "Defiance in Science" is most suitable as we approach the end of the year, reflecting on the past and anticipating what 2025 holds - as we start to focus on resilience, regrowth and raising boundaries.

NOTE OF THANKS

We would like to express our sincere gratitude for all of the support, encouragement, and kind words about our inaugural newsletter issue, "Life and Death".

Thank you!

EVENTS

- Festival of Ideas: Kahoot Science Quiz - Wed 20th Nov 2024
- Charity Doughnut Sale for Bees Abroad & Welsh Marine Life Rescue - Wed 27th Nov 2024
- KS3 Workshop: Light-Up Rudolph DIY - Fri 6th Dec 2024

FRESH FEATURE

We are excited to launch a new facet to the Café Scientifique newsletter, "**Science Spotlight**", in order to better connect with you, our readership.

Defiance in Science – Marie Curie

Written By *Kashvi, 7S* (KHS)

"Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less."

Marie Curie was born on 7th November 1867 in Poland. At the time, Poland was under the Russian Empire and did not exist as a separate country. Women were not allowed to enrol in universities or higher studies, yet Curie is the only woman to date to receive two Nobel Prizes in different fields-Physics and Chemistry!

Curie had to overcome the gender biases of the 19th century that prevented women from accessing higher education and meaningful work in science. Following her ambitions, Marie left for Paris University in 1891. With strong determination and love for science, Curie earned a degree in both physics and mathematics!

Later, she became the first female professor at the University of Paris at the time when women found it hard to be accepted as scientists. Marie Curie's meticulous research on radiation provided a first real understanding of radioactivity- a term she coined. Seeing her progress, her husband Pierre Curie, also a scientist, joined in her research. Through their groundbreaking work, the Curie's discovered two new radioactive elements, Radium and Polonium (named after Marie home country), for which they were recognized with the Nobel Prize in 1903.

Even after achieving her initial successes, Curie struggled for recognition among her male counterparts, but she did not let this discourage her and persisted with her research. Her discoveries laid the groundwork for development of atom theory and nuclear physics. Her work on radioactivity was instrumental in development of radiation therapy - a vital treatment for cancer.

Also, the insights gained from her work was essential in developing nuclear reactors, which, in today's time, provides a significant portion of the world's energy in a relatively low-carbon manner.

Marie's research was suddenly stopped when World War I broke out. During the war, she recognized the potential of X-rays to help surgeons locate bullets and shrapnel in maimed soldiers. She developed mobile X-ray units, known as "petites curies", to be used in the battlefields, saving a countless number of lives. It is estimated that over 1 million injured soldiers were photographed by her X-ray machines. Modern X-rays, CT scans and MRI machines commonly used by doctors and surgeons for diagnosis and treatments owe their existence to Curie's work.

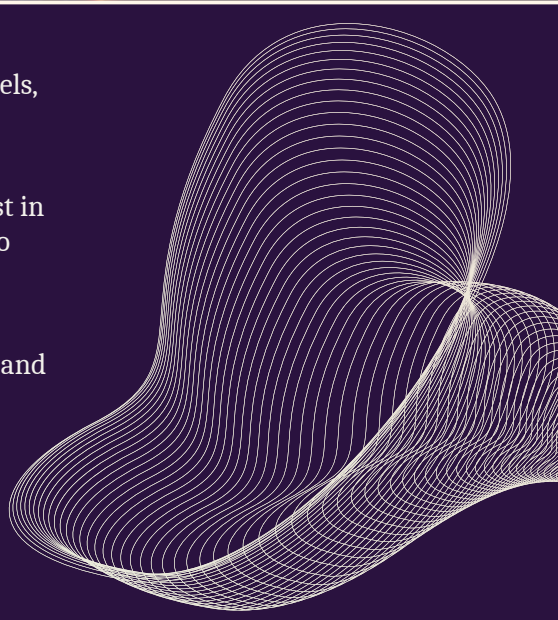
Marie Curie was not only an exceptional scientist, but also a pioneering woman in a field dominated by men. She was the first woman to step into a man's world when Curie was at the Solvay Conference in 1927 sitting amongst the greatest physicists of her time, all men except for her! Her success inspired countless women to pursue careers in STEM, contributing to a more diverse scientific community. Her legacy is a testament to her resilience and dedication in the face of challenges and hardships.

"I was taught that the way of progress was neither swift nor easy."

Quantum Particles are Not Weird. They're a Lot Weirder Than You Thought

Written By *Cherrie, 12K* (KHS)

Quantum physics describes the behaviour of very small objects, which aims to uncover the properties and behaviours of every building block of nature. Solar panels, LED lights, your mobile phone, and MRI scanners in hospitals all rely on quantum behaviours. This is one of the most tested theories in physics and is often used.



However, the quantum realm is mind-blowing. Within it, quantum objects can exist in two places at once; they can move through barriers; they can share a connection no matter how far apart they are. Their behaviours are no doubt very weird and counterintuitive.

This gets less scary and weird when you stop thinking of atoms as minuscule balls and instead imagine any "quantum object" as something like a wave you created by pushing your hand through the water. Basically, you can say everything is fundamentally made of waves.

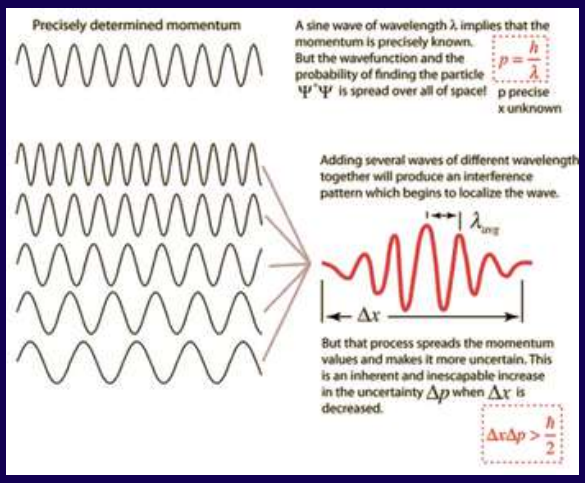
To make quantum behaviours less weird, here are 3 key types of "weird" quantum phenomena that normal water waves can do just as well, and 1 thing that sets the quantum world apart.

1. Not weird, like water waves: Heisenberg's Uncertainty Principle

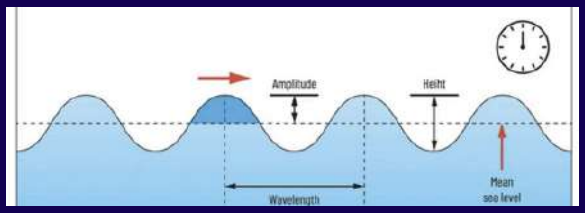
Imagine throwing a tennis ball: you can track the ball's exact position and velocity throughout its flight. But if we shrink the ball into the size of an atom, or something really really small, tracking it becomes impossible. This limitation is known as Heisenberg's uncertainty principle. In quantum physics, it is impossible to know both an object's exact position and momentum. The momentum of a tennis ball is simply mass multiplied by its velocity. But for waves, momentum is determined by measuring its wavelength.

As waves are just flickers, it is impossible to determine their positive and wavelength with 100% precision, meaning no matter whether in water or quantum waves, there will always be a range of positions where a wave can be, and consist of a range of wavelength. In addition, the more you restrict one of those ranges, the less control you will have of the other.

Consider 2 extreme types of water waves. The first wave has an infinitely repeating wave of regularly spaced ripples made by wind. Here, you can measure the wavelength by finding the wave's crests and troughs, but you can't say anything about the wave's "position" as you don't know where the wave starts or ends. Contrastingly, the second wave consists of a single thin crest in a calm pound. Here, you can measure its position, but it does not have a clear wavelength as it never repeats. Hence, all waves lie between a range of positions and wavelengths. Quantum waves are no different.



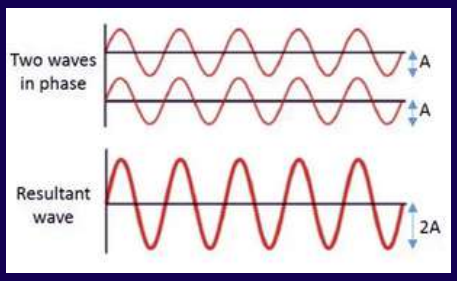
Heisenberg's uncertainty principle



1st Type of Wave: Infinitely Repeating Waves of Regular Period

2nd Type of Wave: 1 Single Crest

Olivie oil with Vinegar dressing



Superpostion: When a quantum object can be at 2 places at once

2. Not weird, like water waves: Superpositions and Entanglement

Superposition of states also means a quantum object can "be at two places at once". Looking at waves, this is no surprise, as a wave can be at two places at once. If a wave is being sent down a forked channel, it can split and flow through both channels at the same time.

A similar quantum concept is entanglement, which merges the superposition in two waves. Explained in terms of salad, in a salad dressing of oil and vinegar, the oil will float on top of the vinegar. If you carefully make a wave in the oil, it will also cause a wave in the vinegar, which looks like ripples where the oil and vinegar merge. Measuring the wavelength of the oil wave also tells us about the wavelength of the vinegar wave. In other words: the two waves are linked, and their properties depend on each other.

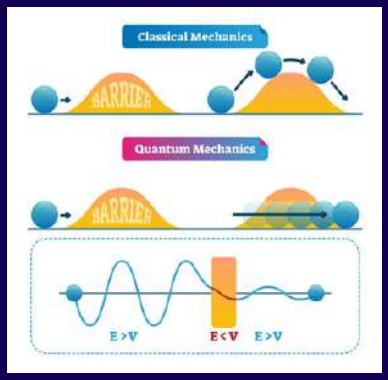
This remains true if salad dressing is separately poured down a forked channel, so the oil-vinegar ripple moves down both channels simultaneously. Measuring the wavelength of just the oil wave in one channel immediately allows us to know all the wavelengths in both channels, even if they are far apart. Hence, if the salad dressing is quantum, you would say the waves in two channels are "entangled" with one another. Quantum technology uses entanglement to create complex encryption or speed up computations. Back to the salad analogy, the best way to break the oil-vinegar entanglement is to thoroughly shake the dressing to from a vinaigrette.

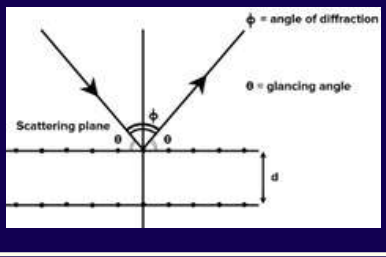
3. Not weird, like water waves: Tunneling

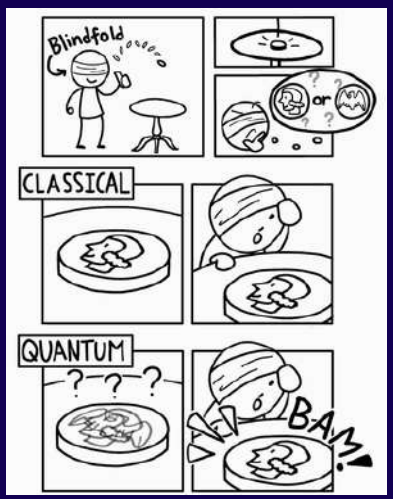
Another weird phenomenon of quantum objects is that some of them can pass through barriers- a potential energy barrier whose height greater than the total energy of particles which according to classical mechanics, should not be possible as an object does not have sufficient energy to pass. This is called tunnelling. Throw a tennis ball at a brick wall it will bounce back. But if you through an atom, you might find it on the other side.

Similar to water waves, they can move through barriers just like quantum particles. This can be demonstrated in your bathtub by building an underwater wall that's tall enough that it almost reaches the water's surface. If you send a wave towards the wall at a glancing angle, it will always reflect back. This is similar to the total internal reflection of light rays.

Although the wave could not pass through the barrier, a small tail can still appear on the other side. If the wall is thin enough, you will see the tail magically reappearing on the other side of the barrier with its original motion, and this is how your water wave tunnelled through the barrier. In other words, the probability of transmission of a wave across a barrier decreases exponentially with increased height and width of the barrier, and increase mass if the tunneling particle's mass. This means tunneling is the most successful in low-mass particles such as electrons tunnelling through microscopically narrow and thin barriers.







Comic describing the weirdness of quantum measurement

4. Very weird, unlike water waves: Quantum Measurement

Thinking of quantum particles as waves instead of tiny balls is weird, but it is not as weird as measuring a quantum object. Whether it's a wave travelling through two channels at once, or tunnelling through a barrier, measuring a quantum wave causes the wave to suddenly appear in a single location: in one channel and not the other, or on one side of the barrier and not the other.

Interestingly, the mathematical equations that describe the quantum waves do not explain what happens when we measure them. Physicists still can't describe nor interpret this phenomenon, in which quantum measurements still set quantum behaviours apart from water waves, making it VERY weird.

To contextualise this, when someone speaks to a crowd, sound waves scrap out across the crowd, and everyone hears the speaker. However in the quantum world, the sound wave will spread out just as expected, but soon as a single person perceives it, the entire sound wave would concentrate itself in that single person's ear, and no one else can hear the speaker.

And this makes quantum particles very weird.

SOURCE

Quantum Physics Isn't as Weird as You Think. It's Weirder | Scientific American

An Optical Illusion – The Thatcher Effect

Written By ***Karine, 12K*** **(KHS)**

"One sometimes finds what one is not looking for." – Alexander Fleming

How was this phenomenon first discovered?

Surely this quote by Alexander Fleming describes the case for the Thatcher Effect, for Thompson, who discovered this effect, came across a 'grotesquely distorted' image of a woman on a magazine cover stuck against a wall near his office at work. The way the glass distorted meant that up close it seemed as if it was a being that could not be described as human, but far away from the carpark, it seemed to be simply a beautiful woman. Intrigued by this phenomena, Thompson, who was working at the Department of Psychology at the University of York at the time, decided to create the famous collage of photos for his students of Margaret Thatcher, commonly known today as the classic sample of the Thatcher Effect.

By rotating the face upside down, but keeping the face's eyes and mouth in the same orientation as it would be normally, it creates a seemingly normal, inverted face of a human if it was kept that way, but by turning the whole face into its normal orientation you can see the sheer uncanniness that this image brings – disrupting our perception of people's faces as a whole. After comparing the photos from the collages, we may perceive the inverted 'Thatcherised' face as welcoming or pleasant. The opposite comes with the normal, un-Thatcherised image though, as the upside down smile may be perceived as a frown, or a sign of aggression. This might suggest that although we may not use that much energy to perceive people's faces as a whole, the perception of other people's eyes and mouths are crucial to facial recognition and cues to perceive other's emotions through their expressions. Moreover, it seems that by Thatcherising a person's face on an image but keeping some features in its original orientation, although it is supposed to make it look less appealing as it is, the Thatcher effect is 'destroyed by inversion which makes these relations difficult to code'.

How is this significant?

Since the collage was placed on the newspaper in the 1980s, this phenomenon became widely known as an optical illusion used to scare fellow friends and family members. However, this may be the crucial start to cracking the code of how the brain recognises faces and cues to facial expressions. This may be beneficial to understanding phenomena such as prosopagnosia (the inability to distinguish between different faces), or even links between facial recognition and visual speech perception, which is a crucial starting point to understanding cognitive aging, which is most prominent in disorders of dementia such as Alzheimer's disease. Additionally, the relationship of it with other visual perceptive phenomena such as the Spotlight Effect and the Hawthorne effect may be explored – opening our eyes to the wider world of human psychology.

SOURCES

Thatcher Effect: Unravelling Facial Recognition's Mysteries

P Thompson (1980) Margaret Thatcher: A New Illusion, Perception 9 p.483-484

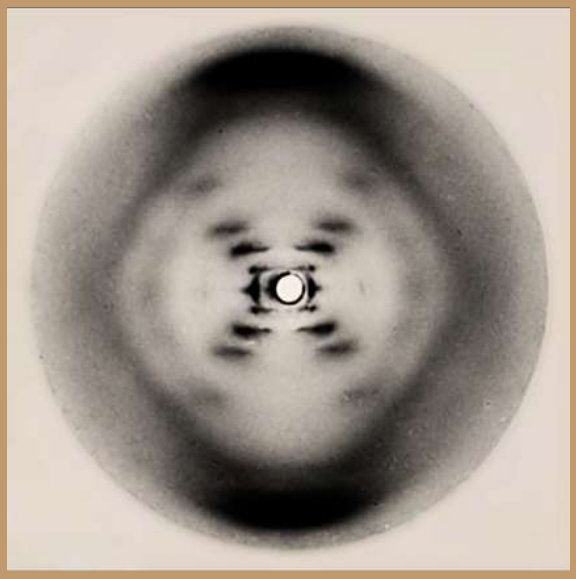
Boxer Crab (*Lybia tesselata*)

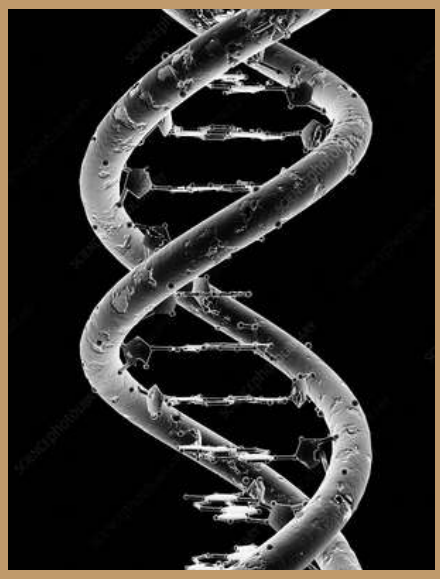
Written By *Abi, nK* (KHS)

The boxer crab was named this due to its unique defence mechanism. It carries around two tiny anemones (Triactis producta) on its front claws. It fights off predators with its anemone boxing gloves and uses the anemones to gather food particles off of using its front legs whilst also leaving enough food for the anemone.

The anemones are only a few millimeters across but poisonous and submit a painful sting to predators, which keeps the crab safe and in return the anemones get to travel around the seabed and get access to more food. Just like a boxer, the crab wants its gloves to be in the best condition, so to stop the anemones from growing too big, it steals their food. If a boxing crab loses its anemones it may try to steal another boxing crab's. These crabs are so intelligent that if they only manage to steal one anemone from another crab, they will tear the anemone in half (this doesn't kill the anemone). This crab has also been named the Pom Pom Crab. Boxer crabs come from the Indo-Pacific where they live under stones and rubble. When the crab malts it has to put the anemones down leaving them vulnerable to predators. Its anemones are very hardy plants, they are white and are non-photosynthetic. The relationship between the boxer crab and its anemone's is called symbiotic mutualism, which is where there is an ongoing interaction between organisms of different species that in this case benefits both.

Rosalind Franklin: The Woman behind the Discovery of the DNA Double Helix





Written By *Claudia*, *12W* (KHS)

> Photograph 51

Rosalind Franklin was a female scientist whose work played a crucial role in understanding the structure of DNA. Although she was not given as much recognition for this as some of the other male scientists she worked with, such as James Watson and Francis Crick, her research was vital to one of the most important discoveries in biology. Franklin was born in London in 1920 and had an early interest in science. She studied chemistry at university, and there she discovered a further intrigue for chemistry. After finishing her education, she worked in France, where she learned about X-ray crystallography—a technique used to capture images of molecules. In the 1950s, Franklin returned to England and started work at King's College London. There, she began studying the structure of DNA, the molecule that carries genetic information in all living organisms. With the use of X-ray crystallography, she was able to produce an image of DNA that would prove to be pivotal in the discovery of DNA'S structure. This image, known as photograph 51, showed that DNA had a helical structure.

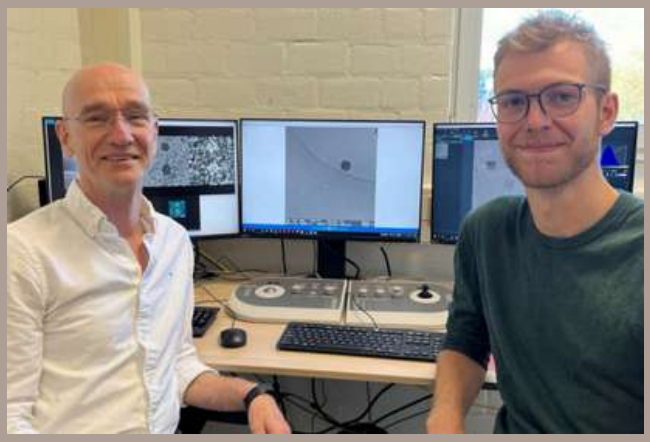
However, Franklin was not working alone. James Watson and Francis Crick, two scientists at the University of Cambridge, were also trying to work out the structure of DNA. Although they did not have permission to use Franklins data, the were still able to access photographs which she had taken of DNA. In 1953, Watson and Crick published their famous model of the DNA double helix, this breakthrough earned them both a Nobel Prize in 1962. However, they based their model on Franklin's X-ray images and research, which they had seen without her knowledge or consent.

Franklin's contribution to the discovery of the DNA structure was significant, but she did not receive the credit she deserved during her life. While Watson and Crick were celebrated for their model, for years Franklins name was unknown. She passed away in 1958 at the age of 37, this was four years before the Nobel Prize was awarded to Watson and Crick for their work on the structure of DNA.

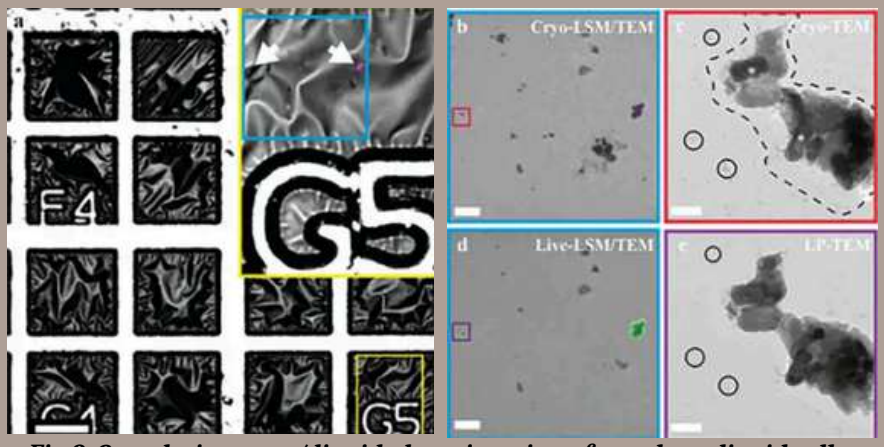
Over time, however, it became clear that Franklin's research had been essential to the discovery of the double helix. Many scientists now recognise that she was extremely important in the understanding of DNA, even though she was not fully acknowledged during her time. Franklin faced challenges that her male colleagues did not, due to gender bias in the 20th century, yet despite these obstacles, she made groundbreaking contributions to science.

Today, Rosalind Franklin is celebrated as a pioneer for women in science. Her work continues to help the future generations of scientists, especially women, to push through the challenges that might stand in their way.

New Breakthrough in microscopy could potentially solve problems of aortic valve calcification by 2025



> Fig 1. Nico Sommerdijk (left) and Luco Rutten (right) developed the world's first microscope that is capable of live imaging of biological processes in such detail that moving protein complexes are visible.



> Fig 2. Correlative cryo-/ liquid phase imaging of graphene liquid cells.

Written By *Cherrie, 12K* (KHS)

The world's first microscope that can show biological processes in such great detail that moving protein complexes are visible was created in Nijmegen earlier this month. This project was led by the researcher Nico Sommerdijk from Radboud University Medical Center. Throughout this new technique, Sommerdijt is now showing how arterial calcification starts, potentially providing solutions to this phenomenon.

Electron microscopes are known for their ability to observe materials in detail down the molecular level, with magnification over 10,000,000x and a resolution of 0.05nm. However with great power comes great responsibility- the specimen must be dead, frozen, motionless. Alternatively, scientists can observe living specimens, but with far fewer details.

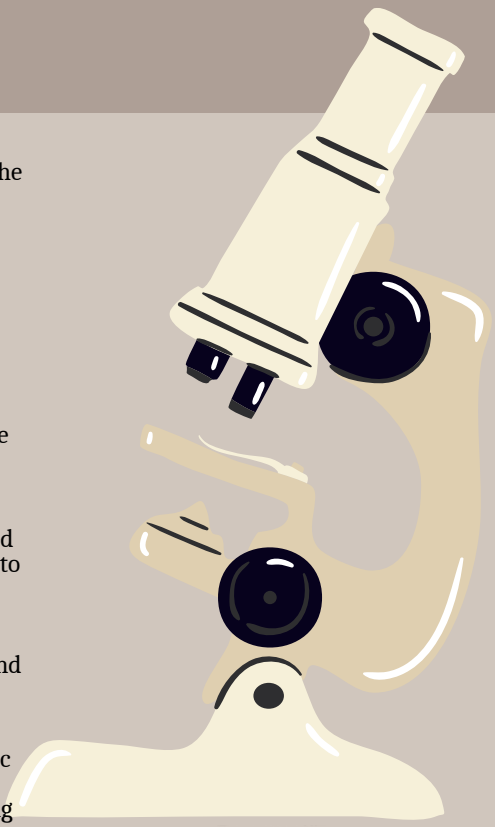
Now, researchers have developed a new technology combining both properties. This opens up new opportunities in microscopy, such as seeing how the COVID-19 vaccine enters a cell or capturing the initial stage of arterial calcification.

How did they achieve it?
Sommerdijk faced the challenge: He wanted to see protein complexes in fine detail, hence he needed an electron microscope. However, electron beams will damage biological materials. The solution is to put a protective layer around the specimen to minimise damage from the electron beam. This is achieved using graphene- an ultra-strong substance made with a single layer of carbon atoms. However, there's another challenge: as soon as the graphene layer is applied, the biological process happens immediately, so you must quickly set up the microscope. This process takes at least half and sometimes the process is finished by then.

To tackle this, Sommerdijk and his team apply a layer of graphene around the tissue and freeze it immediately, stopping the biological process. Then, using a light microscope, they found the specific area in the tissue they wanted to see. After, they place the specimens at the right orientation under the electron microscope to observe. By the time of these setups, the material is warmed, reactivating the biological processes, and allowing the specimen to be seen on a nanoscale.

Discoveries of aortic calcification
This new technique revealed how calcium deposits form, which may lead to calcification of the arteries and aortic valve. When there's an expression of calcium phosphate in the blood, the body manages this by having specific proteins binding to the calcium phosphate, preventing it from forming solid depositions. These protein-bound calcium phosphate is then removed from the kidneys. Under the new microscope, it's observed that these proteins form tiny spheres with calcium phosphate, which still can be broken down. But these spheres can also grow larger, causing calcium phosphate to become calcified deposits, which can no longer be broken down. This contributes to calcification in the body.

Unfortunately, there is currently no treatment for calcified aortic valvules other than complete valve replacement. The causes were still not fully understood. Sommerdijk and his team aim to further study this with the new microscope, which he has recently received a grant to support this work and aims to develop a 'heart valve on a chip' starting in 2025.



GLOSSARY

Calcification: accumulation of calcium slats in a body tissue, causing soft tissues to harden. This can occur in any part of the body, leading to bone pain, lumps, muscle cramps, impaired vision, and potentially death.

SOURCES

Super microscope shows nanoscale biological process for the first time | Science Daily
New microscope shows live imaging of nanoscale biological process for the first time | Phys.org

The Accidental Greatness in Chemistry

Written By *Cherrie, 12K* (KHS)

Science is often associated with accuracy, precision, reasoning, rules, patterns, and anything associated with structure and logic. Contradictorily, serendipity plays a significant role in scientific findings. Around 30-50% of all scientific findings are due to serendipity, and 5.8% of all drugs on the market involve serendipity. Some of the most well-known discoveries include penicillin, microwaves, and Post-it notes. Here, I will present you with some accidental greatness within chemistry, which has positively impacted our lives.

1. Artificial sweeteners- Sweet'N Low

Artificial sweeteners are used to sweeten food without adding extra calories. Throughout history, humans have attempted to recreate the taste of cane sugar, with the ancient Romans being the first to create artificial sweeteners- Lead (II) Acetate, aka Sugar of Lead. Unfortunately, their version was deadly. It was not until the 19th century that scientists invented another artificial sweetener, and this time this sweetener does not poison people.

This happens that this sweetener, saccharin, was an accidental discovery. In 1879, Constantin Fahlberg was analyzing the chemical components of coal tar- a substance used to treat psoriasis. One evening after a long day in the labotary, he forgot to wash his hands before dinner. Fahlberg made some rolls for dinner. He picked up the roll and bit into it. To his surprise, the rolls were incredibly sweet. Fahlberg became extremely excited about his discovery, and ran back to his lab to taste ALL chemicals, tools, and glassware (DO NOT TRY THIS) he used throughout the day to pinpoint the sweet taste. He discovered that the sweet taste came from benzoic sulfimide. Fahlberg then filed a patent for mass production of benzoic sulfimide moved to New York, opened a shop, and started selling his new product he named "saccharin"- drink additive. Eventually, the world began acknowledging and adopting saccharin as an alternative to natural cane sugar. It is now famously known as Sweet'N Low.

2. Vaseline

Petroleum jelly, aka Vaseline, is perceived as the cure-all substance for cuts, bumps, scrapes, bruises, rashes, and other skin disorders. It can also be used (according to the Vaseline official website) to prevent lipstick from sticking to your teeth by applying Vaseline on your teeth before using lipstick, stopping your door from squeaking and preventing uneven tanning. But Vaseline was not discovered by a scientist, a doctor or an engineer; it was founded by oil rig workers.

Petroleum was founded in the mid-19th century in Titusville, Pennsylvania. The rig workers discovered an issue: the oily wax accumulated on their petroleum rigs caused their machinery to malfunction. At the same time, Robert Augustus Chesebrough- a scientist from New York who spent years working with sperm whale oil- was interested in alternative ways to use petroleum. Upon visiting Titusville, Chesebrough heard about the oily wax accumulation the workers had to deal with, but he also learnt some workers apply the wax to their wounds, finding it helped them heal faster. Intrigued, Chesebrough brought some wax back to his lab, refined it into a gel, patented the process for making it, and started selling the way under the name of Vaseline. To market his product, Chesebrough would travel around New York, and demonstrate the usefulness of his product by burning himself with acid or open flame and applying Vaseline to show its healing effects. (**DO NOT TRY THIS AT HOME**)

3. Teflon

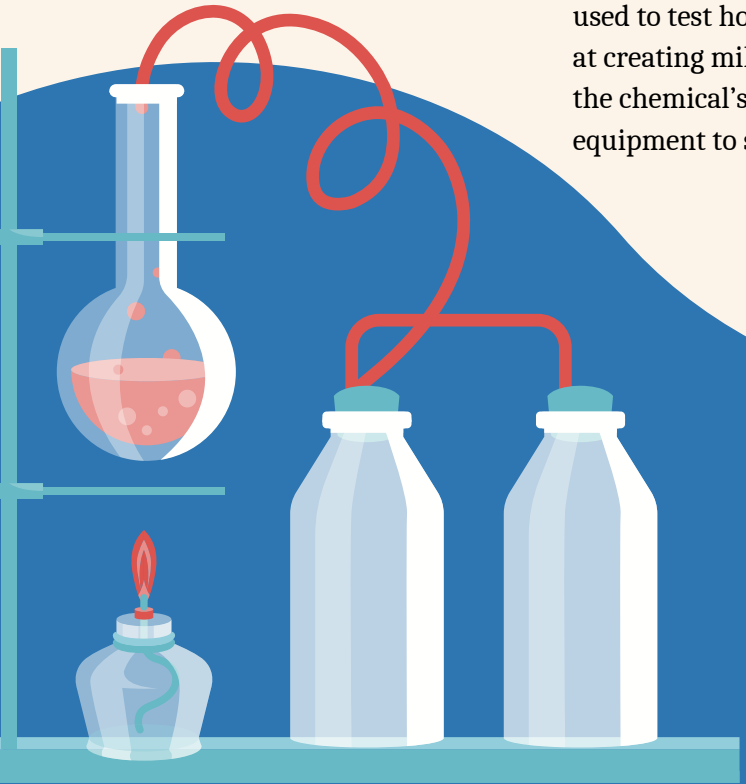
We all know penicillin was one of the most well-known, most impactful, most celebrated serendipity in history, that was discovered by Fleming accidentally, and extracted by Howard Florey. Coincidentally, the same year Florey's research on penicillin began, Roy Plunkett of DuPont (an American chemical company) made another accidental chemical discovery. Plunkett was tasked to find a non-toxic refrigerant to replace toxic ones, such as ammonia and sulfur dioxide. At some point, Plunkett was experimenting with a gaseous refrigerant called tetrafluoroethylene (TFE), which he created 100 pounds of TFE and stored in small cylinders.

One day, when Plunkett opened one of the cylinders, no gas came out. But the cylinder weighed the same, meaning the gas didn't leak, and the TFE seemed to have vanished. Plunkett was confused, so he cut the cylinders open. To his surprise, the TFE gas had polymerised into a waxy powder, aka polytetrafluoroethylene (PTFE), and got stuck in the cylinders. Plunket found the PTFE to be very slippery- in fact, the slipperiest substance known to humankind. Soon, DuPont obtained the trademark name "Teflon", and partnered with well-known brands to incorporate PTFE into a range of products, including plumber tape, stain repellant, and non-stick pans.

4. Superglue

As penicillin was saving lives during WWII, scientists were assiduously working to develop new materials for military equipment, Harry Coover- a scientist- did his part by searching for new materials to make plastic gun sights. During his search in 1942, he came across cyanoacrylate- a chemical that would be perfect, but it sticks to everything it touched. Obviously, it is undesired to have the plastic gun sight sticking to your eyes, so Coover abandoned the chemical and looked for something else.

In 1951, Coover, who worked for Eastman Kodak (an American company that produces various products relating to its historic basis in film photography), joined Fred Joyner, who was working to discover temperature-resistant coating for jet cockpits. One of the compounds he tested was Coover's cyanoacrylate. Once again, the compound failed for its intended purpose. Instead, it made it impossible to separate the 2 refractory lenses that were used to test how light passes through it. Finally in 1959, after 2 failed attempts at creating military products using cyanoacrylate, Coover and Joyner realised the chemical's commercial potential, and went from selling military equipment to selling glue- which is known as superglue nowadays.



SOURCES

Accidental Greatness - How Some of the World's Most Famous Discoveries Started with Mistakes

Discover 101 Uses of Petroleum Jelly | Vaseline

Five Life-Changing Chemicals Discovered by Accident | Chemistry & Engineering Media Group

‘Who wants to live forever?’ The Immortal Jellyfish – *Turritopsis dohrnii*

Written By *Mae, 12K* (KHS)

Imagine being able to restart your life, all over again. Cheat death, time and time again. Impossible right? Not for the Turritopsis dohrnii (T.dohrnii), also known as the immortal jellyfish who is one of only a few animals to escape mortality and stay in the cycle of life, well, forever. It can actually reverse its life cycle, dubbing it the immortal jellyfish.

The Medusa (adult jellyfish) is typically bell shaped, with a maximum diameter of 4.5 millimetres (0.18 inches or the size of your fingernail). Around its edge, it has up to 90 thin tentacles that help it swim and grab food. So how can something so small be so powerful?

When the Medusa becomes physically damaged or experiences stress, instead of dying it shrinks on itself, reabsorbs its tentacles and loses the ability to swim, it then settles on the seafloor as a blob-like cyst. Over the next day, the blob develops into a new polyp and after maturing the medusae bud off. The process behind the jellyfish’s remarkable transformation is called transdifferentiation and it is extremely rare. The life cycle reversal can be continuously repeated, and in perfect conditions, it may be that these jellyfish would never ever die.

T.dohrnii may be able to bend the rules to rejuvenate itself, but it isn’t always possible for it to escape death. For example, T.dohrnii, just like other jellyfish, are prey to other animals (such as fish and turtles) and are practically defenceless to predation or any other external factors.

Turritopsis dohrnii has ignited a lot of interest in fields such as ageing and regenerative medicine. If scientists can successfully discover how it pulls off this cellular reprogramming trick, it could open up many new possibilities. Such as treating diseases, healing injuries or even slowing down ageing in humans. In the end, Turritopsis dohrnii reminds us of the beauty, mystery and harmony of nature’s design. A tiny thing defying the rules of life and death while massive mammals are confined and restricted by death. If something so small holds the secret to continual regeneration, what might we learn from it about our own momentary existence?

The Guilt of Holding Different Beliefs

Written By *Karine, 12K*

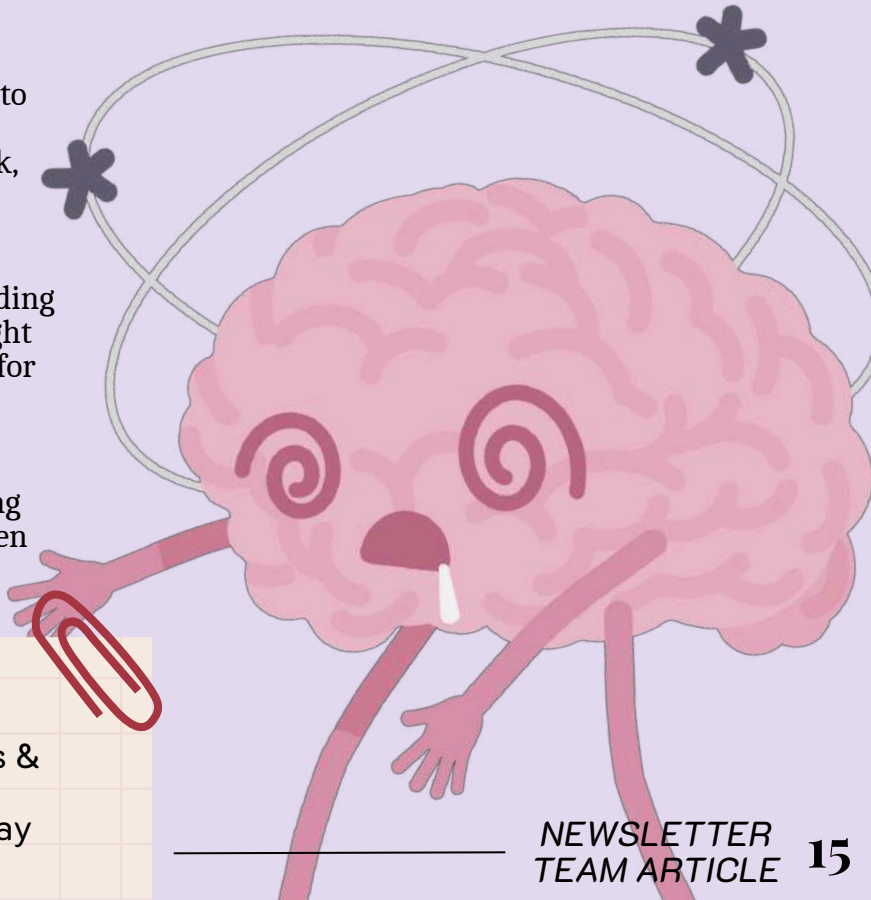
As it is simply human nature for us to feel strong emotions and cling to our own beliefs towards everything in life, it is also natural for us to hold contradicting beliefs with one another. But what if that is the case within yourself? Perhaps question yourself you've ever had a weird lightbulb moment when you realise that your actions do not match what you truly think deep inside.

This theory is called the Cognitive Dissonance Theory — one of the most well-known theories in psychology that offers an explanation as to why we hold contradicting beliefs, proposed by Leon Festinger in 1957. This theory states that we may feel discomfort or guilt when realising that we are not acting the way our beliefs tell us to, and the stronger this guilt is, the greater our motivation is to reduce the discomfort surrounding it. This can lead to multiple strategies that allow us to reduce this discomfort. Let's use the example of skin cancer and sunbathing to apply these strategies. Say that you were a person who liked to sunbathe, and upon knowing that sunbathing may cause the risk of you developing skin cancer to increase, you have second thoughts. Now, could you imagine yourself doing either of these 4 things?

1. Changing your behaviour – stopping sunbathing upon knowing that it might cause cancer
2. Changing your own thoughts – deciding to ignore this evidence showing the link between sunbathing and skin cancer risk, continuing to sunbathe
3. Adding other consonant thoughts – deciding to give emphasis into the fact that sunlight provides Vitamin D, which is important for bone health and has other benefits
4. Trivialising the inconsistencies – deciding that this is a myth and has been disproven multiple times before

Now, although all 4 of these strategies seem like a desperate attempt to escape from the reality we live in, it is not uncommon to find ourselves in these situations. Sometimes, cognitive dissonance can be harmful, especially if it is realised when a relationship has been developed for a while and a bond has been created between two people. Perhaps if your partner's beliefs don't align with their actions or your own beliefs, it could lead to conflict, ultimately risking the relationship falling apart if it is not dealt with in a mindful manner from both parties. If you are in a toxic relationship, cognitive dissonance may also come into place and allow you to justify your partner's actions, causing further psychological harm to yourself.

On the other hand, cognitive dissonance is not necessarily a bad thing. It sometimes allows us to reflect on ourselves and change our behaviour, enforcing our values and providing a new outlook into the world we live in. It is an opportunity to grow and nurture our beliefs. It is, however, important that we learn to challenge our own beliefs, sometimes even doubt them, so that we learn to react to the world in a mindful way. This can include mindfulness practices, or speaking about your core values to somebody you trust to not accidentally get into an argument with. Please bear in mind that it is also important to respect others' values and beliefs, even if you may not agree with them.



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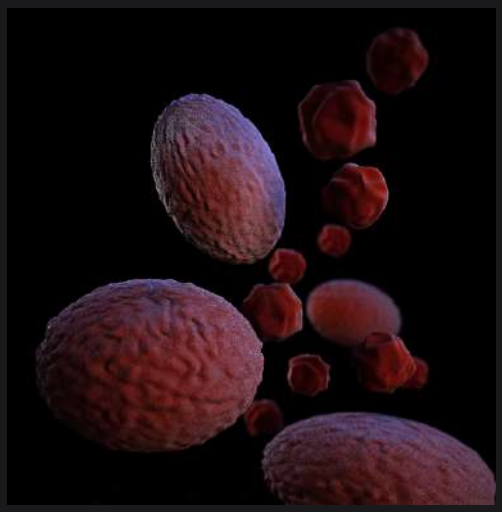
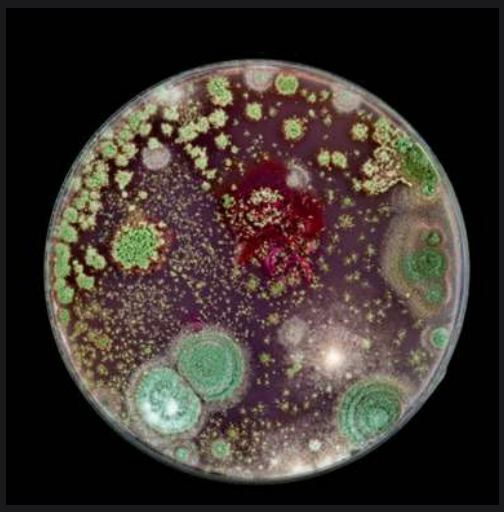
The Race Against Antibiotic Resistance





Written By *Sahana, 12L* (KHS)

Bacteria, one of the smallest organisms that we consider as life, are everywhere. While several beneficial bacteria help us thrive – such as Lactobacillus – others invade the human body, sometimes resulting in irreversible damage. In fact, infections caused by bacteria account for over 7 million deaths per annum. Bacteria are also responsible for some of history's deadliest epidemics/pandemics, such as the bubonic plague (caused by Yersinia Pestis) which killed approximately one third of 14th Century Europe's population. Today, antibiotics have become necessary for combating bacterial threats. However, as antibiotic resistance rises, it is becoming tougher for humanity to counteract these dangerous diseases.

Antibiotics generally cause disruption to internal functions within bacteria. For example, they can interfere with metabolism (therefore slowing down the growth of the bacterium) and can also attack DNA (hence reducing the reproductive rate of bacteria). This ultimately decreases the risk of infection. Since their discovery, antibiotics have revolutionised modern medicine.

On the other hand, the phenomenon 'antibiotic resistance' occurs when bacteria develop defences against medications designed to eradicate them (i.e. antibiotics). This can be done in several ways, including investing energy in pumps to remove the antibiotics out of the bacterium or intercepting the antibiotics and converting them into harmless molecules. Overall, this is an increasingly significant problem impacting treatment and management of several diseases, including tuberculosis.

The two main ways that resistance spreads among bacteria is through the exchange of plasmids – which allows the transfer of beneficial survival qualities; and "harvesting" – where bacteria collect DNA remains from other dead bacteria. Harvesting can also work between different bacterial species which can lead to the formation of superbugs (bacteria which are resistant to several antibiotics).

There are currently a variety of superbugs, which can be attributed to two major factors:

1. The overuse of antibiotics due to people treating the strong medication as a commodity. *While millions of people still lack access to them; in other regions of the world, prescriptions for antibiotics are given easily and used carelessly.*

2. The extensive use of antibiotics in the meat production sector. *To optimise profits, livestock are often confined in inadequate space and unhygienic conditions, creating a hotspot for disease. Therefore, antibiotics are frequently provided to animals to prevent them from becoming ill. Bacterial resistance to the last-resort antibiotic, Colistin, has been a consequence of this.*

The race against antibiotic resistance demands both a change in public sentiment and new scientific innovations: consumers must be aware that using antibiotics to treat viral illnesses is inefficient and may result in resistance. In the spirit of "defiance in science," we must unite in our commitment to responsible antibiotic use: the spread of resistant bacteria can also be mitigated by supporting regulations that limit the prescription of antibiotics. There is also a growing scope for alternative treatments such as the use of bacteriophages and immunotherapies.

Antibiotic resistance is more than just a challenge for healthcare professionals; it stands as humanity's next health crisis that threatens to reverse decades of medical progress. If left unrestricted, the superbugs of today could become the pandemics of tomorrow.

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SOURCES

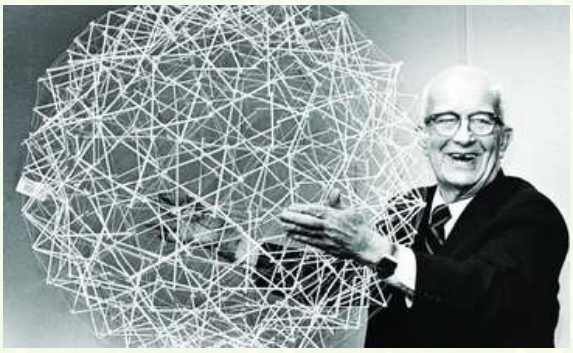
7.7 Million People Die from Bacterial Infections Every Year | ReactGroup.org

Anti-microbial resistance fact sheet | World Health Organisation

In Strings & Solids

Written by *Tiffany, 12L* (KHS)

Key Words:
Tension, Compression, Structure, Integrity, Balance, Equilibrium, Distribution, Geometry, Stabilisation, Efficiency, Responsive



>Fig 1. Buckminster Fuller holding a geodesic tensegrity sphere

What is tensegrity?

Tensegrity is a system of balanced forces of compression and tension of its elements which allows structures of this concept to hold itself in stability without reliance to external forces. At the forefront of its timeline, 1960, Buckminster Fuller* devised the concept of Tensegrity in hopes of building material efficient constructions, giving rise to light yet.
Note: You may have come across this name in organic chemistry, this is the same man who discovered Buckyballs C60

Principles and their resulting Properties

Tensegrity Structures (TS) are composed of two key elements: Strings and Solids. Strings in tensegrity experience a relative portion of the solids' weight. The force they resist without elastic deformation or breaking is called Tension. On the other hand, solids undergo Compression, the inwards force they can endure without breaking. Solid Components usually show designs of curvature or slant to reduce bending strain from compression. A balanced force of tension and compression interact between all elements to maintain its shape. Strings, bounding the solid in place while solids, weighing the structure down. So, we can see a form of interdependence.

>Fig 2. Kurilpa Bridge Brisbane, Australia- World largest tensegrity bridge

Yet this is not the only theory TS follows for stability. For a 3-Dimensional TS and in fact for any 3D object to remain supported upright, the solids must have their centre of mass balanced equally by their supporting points, in this case strings. It is for this principle, TS firstly have at least 3 evenly spaced strings to fix its plane.

To demonstrate the significance of plane fixation and geometric arrangement, visualise a spinning plate on a uniform stick, the plate being a flat-lying plane. It would be very prone to tipping. By adding 3 evenly spaced sticks, the arrangement enables even distribution of weight. However, in consideration of this, the plate is still highly volatile under external forces like loads. This is where Dynamic Stability comes in play.

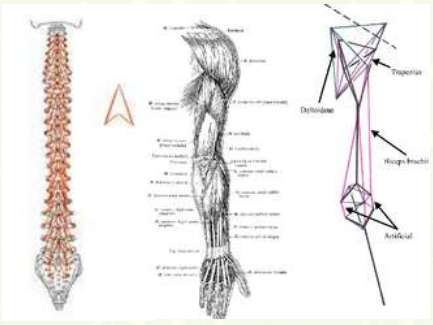
In TS, strings are pre-stressed from tension, its elasticity allows the structure to react accordingly to external forces in neutralisation. As highlighted by the model, each tension adapts in relativity to the magnitude of force, this results in calibration of the centre of mass. This implies that the geometry is vital in controlling the balance of forces acting internally between elements. When TS experience additional force, it unironically undergoes a state of contraction then reverts to its original shape after removing the forces. Therefore, TS are not only self-supporting, but they also could accommodate loads and be versatile under uncontrolled environments.

Applications of Tensegrity

Below are some prompts to find out how Tensegrity can be utilised:

Construction: Iconic Needle Tower in Washington D.C, USA by Kenneth Snelson

Space Exploration/Mobility: NASA's Super Ball Bot



Anatomical/Physiological Studies with Fascia, fibrous tissues that connect bones, muscles, joints, organs, etc.

Dorothy Crowfoot Hodgkin

Written By ***Bani, 6SW*** **(WPS)**

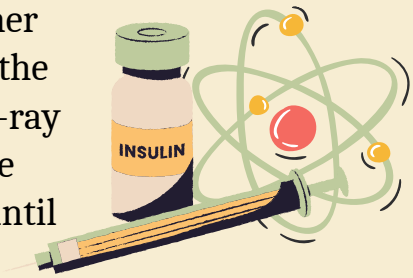
There are many great female scientists in the world who have achieved great things and won many awards. I am going to write about Dorothy Crowfoot Hodgkin. Dorothy was an English chemist and in 1964 is the only British woman to be awarded the Nobel Prize in Science.

Hodgkin helped advance the x-ray crystallography technique which was the key to understanding the dimensional structures of biochemical compounds, including Vitamin B12, penicillin and insulin.

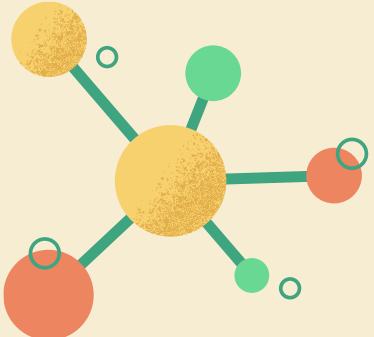
Illustration of Dorothy Hodgkin by Bani

Born in Cairo on 12 May 1910, she came to England as a child and studied at the Sir John Leman school and then at Somerville College, Oxford. At Oxford she studied x-rays of complicated macro molecules. She made the first x-any diffraction photograph of the protein Pepsin in 1934.

In the same year she came back to Somerville Collage, as its first fellow and tutor in chemistry. One of her students at Oxford College was Margaret Roberts (Margaret Thatcher) who later became prime minister. Thatcher hung a portrait of Hodgkin in her office out of respect for her tutor.
Dorothy married Thomas Hodgkin in 1937. From 1942 to 1949 she worked on the structured analysis and confirmation of the structure of penicillin.



In 1948 she and her colleagues made the first detraction x-ray photograph of the vitamin B12-up until then normal chemical methods had revealed little of the structure of the central part of the molecule, at the heart of which it is a cobalt atom.
Hodgkin was a professor of the Royal Society at Oxford University from 1960 to 1970 and a member of the Order of the Merit in 1965. She was the Chancellor of Bristol University in 1970 and was also a fellow of Wolfson College, Oxford from 1977 to 1983.



Hodgkin's work has enabled researchers to better understand and manufacture life-saving substances and also made crystallography an indispensable scientific tool. Mapping the structure of penicillin has made the drug easier to manufacture and vitamin B12, is an essential weapon against anaemia. Dorothy Hodgkin died on 29 July 1994 in Shipston-on-Stour in Warwickshire.

Women in STEM: The Success of Dorothy Hodgkin

Written By ***Karine, 12K*** **(KHS)**

SOURCES

Dorothy Crowfoot Hodgkin Biographical | The Nobel Prize

Dorothy Crowfoot Hodgkin: The exceptional professor who solved the structure of insulin | BBC Science Focus

Growing up, Hodgkin had always been exposed to the wider archaeological field. With both her parents and many family friends both being active in scientific research, Hodgkin had witnessed many excavations since childhood – cultivating her love for everything archaeology and the wacky minerals found at these sites. One particular day when she was 14, she found a mysterious, shiny, black mineral in her yard and asked a family friend if she could analyse it. Two years later, she received a book by William Henry Bragg about using X-rays to analyse crystals, also receiving formal education in chemistry, being one of two of the only girls allowed in her chemistry class. Kickstarting her scientific career with her interests, this would surely lead to great things happening in the future.

With the encouragement of her parents, she went on to study chemistry at Somerville College, Oxford University to do a chemistry degree. Given that just 8 years prior to her entry in Oxford, A very few number of women (130 people) had just started taking their degrees, the bias on women when it comes to education must be incredibly tough for Hodgkin to get into the scientific degree courses at Oxford. Her perseverance is further highlighted with the completion of her PhD at Cambridge later on.

X-ray crystallography was still very new when Hodgkin started her PhD. Previously, scientists had used salt and copper sulphate, placing the crystal in front of a beam of X-rays, capturing the X-ray beams as spots on photographic film. This was not only an arduous process, it was also one of the many untouched pieces of research at the time. However, defying all odds, working together with her PhD supervisor, they had developed a way to diffract patterns from the digestive enzyme pepsin. Since pepsin is a protein and incredibly important to the human digestive system, being able to decipher the structure of proteins was very valuable at the time.

At the incredibly young age of 24, Hodgkin had already been known for her work in protein crystallography. Not only was her remarkable skill and technique recognised, but the gradual support for women in scientific fields had also been a push in her back to make more scientific discoveries. Further along her career, she had also been able to diffract images of the hormone insulin, another protein, decades after she had first been known as the pioneer of protein crystallography. She had also solved the much bigger structure of Vitamin B12, incredibly valuable for the treatment of pernicious anaemia – disrupting the stomach from absorbing vitamin B12, which may lead to many health complications. And finally, after much blood, sweat and tears had been shed, he and her team had finally cracked the solution to insulin – which she described as ‘one of the most exciting moments in my life’.

Although there are many instances of women not being recognised for their pioneering research in biomedical fields, thankfully, Hodgkin was not one of them. Perhaps this is the indicator to the start of a new era – where men and women can equally excel in the wider field of science, contributing to many great causes and give pointers to all the young, aspiring scientists in the world. Hodgkin is the 3rd ever female in history to receive a Nobel Prize in Chemistry, perhaps the next one will be somewhere out there as well.

DNA evidence of people buried in the Pompeii eruption wrote a new story of the inhabitants of Pompeii

> Fig 1. The Destruction of Pompeii and Herculaneum painted in 1822 by the English artist John Martin of the eruption of Mount Vesuvius in 79 AD

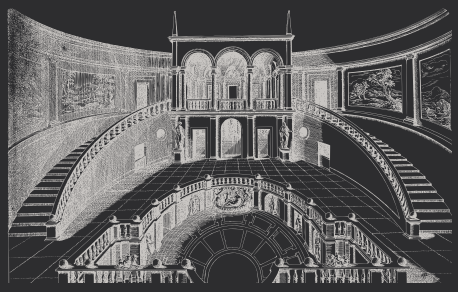
> Fig 2. DNA analysis was carried out on plaster casts of people who died in the deadliest volcanic eruption in history in Pompeii, showing the adult on the right is unrelated to the child on his lap.

Written By ***Cherrie, 12K*** **(KHS)**

Researchers from the University of Florence, Harvard University and the Max Planck Institute of Evolutionary Anthropology in Leipzig used ancient DNA to oppose the long-held assumptions of the people in Pompeii. Contrasting the physical appearances, DNA analysis revealed an unexpected difference in gender and kinship, doubting the stories written since 1748. The genetic data also showed the multiracial nature of the Roman Empire, revealing Pompeiians were mainly descended from immigrants from the eastern Mediterranean.

In 79 AD, Mount Vesuvius erupted in southern Italy, burring the prosperous Roman cities of Pompeii and the inhabitants under a thick layer of shones and ash. This lead to thousands of death as home collapsed and volcanic ash rained down from the sky. Those who survived the initial phase of the eruption eventually choked and died from the fast-moving streams of hot gas and volcanic matter (aka pyroclastic flows). This however coated their bodies in a solid layer of ash, effectively preserving their features, and allowing scientists in the future to stud them.

Since the 1800s, casts have been made form these bodies. The research team extracted DNA from the fragmented skeletal remains of 14 casts, allowing them to accurately establish their genetic relationship, sex and ancestry of them. Interestingly, the genetic evidence juxtaposed with the previous assumptions based on appearances and positioning of the casts.



Through this research, it showed that genetic analysis can significantly add to stories constructed from archaeological data. These findings challenged the pervasive beliefs, such as the association of jewelries with femininity, and the physical proximity with familial relationships.

Further, DNA evidence added complexity to kinship presumptions based on body positions, where 4 people traditionally through to be 2 patterns and their children actually have no genetic relation to each other. Other examples include an adult wearing a golden bracelet and holding a child was traditionally thought as a mother and child, but they are an unrelated adult male and child. Then, a pair who were thought to be sisters or mother and daughter were actually found to include at least one genetic male. These evidences challenges traditional gender and familial assumptions in Pompeii.

Not only about relationships and gender, DNA analysis also revealed the ancestry of the Pompeiians. These findings showed they were mainly descended from immigrants from the eastern Mediterranean, highlighting the diverse nature of the Roman Empire. These findings provide significant insight into the integration of archaeological data and the understanding of ancient societies.

Further, this highlights the importance of integrating genetic data with archaeological and historical information to prevent misinterpretation based on modern assumptions. The genetic findings reflects the diverse nature of the Pompeii population, showing broader patterns of trade and cultural exchanges in the Roman Empire.

SOURCE

DNA evidence rewrites story of people buried in Pompeii eruption | ScienceDaily

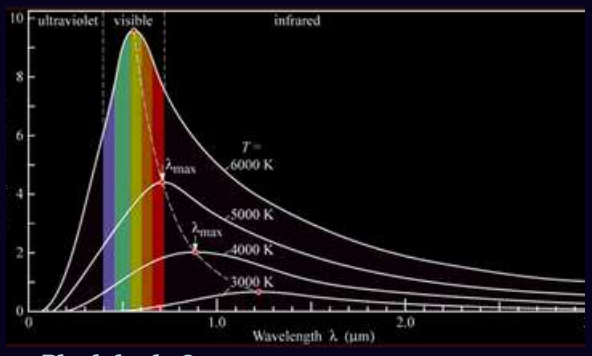
Max Planck and the Quantum Leap

Written By *Sahana, 12L* (KHS)

The lightbulb is often recognised as a symbol of innovation and new ideas, but do you know about Max Planck's true "lightbulb moment" that changed the course of physics forever?

Planck was commissioned by electrical companies in 1894 to deduce how to generate the greatest luminosity from light bulbs with the minimum energy. To address this, he concentrated on the problem of black-body radiation: the ultraviolet catastrophe. The variance between the expected behaviour of electromagnetic radiation (established by classical physics) and the observed behaviour of electromagnetic radiation (as proven by experiments) is known as the 'ultraviolet catastrophe'. The 'Rayleigh-Jeans Law' formulated by English physicists Lord Rayleigh and Sir James Jeans is based on the classical physics model and suggests that the amount of radiation released at all frequencies will increase in proportion to the temperature of a black body. Experiments, however, demonstrated that the amount of radiation released did not rise as expected at high frequencies (in particular, in the ultraviolet portion of the spectrum). Hence, the 'ultraviolet catastrophe' was the name given to this disparity of theory and findings.

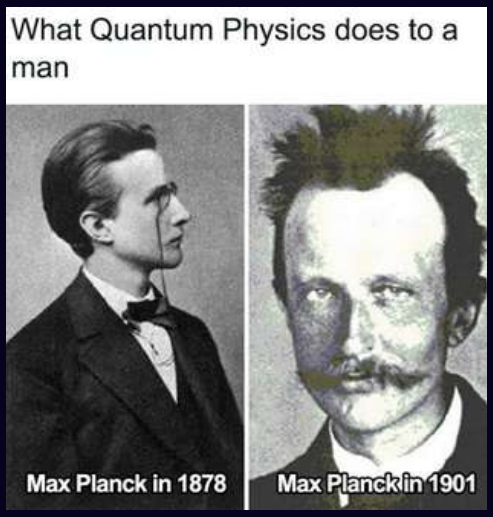
Max Planck had to ensure that as much light as possible was given off by visible waves. He tried to work out how much light of each colour a hot object emits based on electromagnetic theory, although this disagreed with findings from his experiments. Instead, in what he referred to as "an act of despair", he worked backwards from his experimental results – abandoning electromagnetic theory.



> Black-body Curve

The data guided him to a new rule of physics: that light waves carry energy in packets 'quanta' (which photons are a type of) – where high frequency light consists of large packets of energy. Planck proposed that light is not emitted continuously but rather in discrete packets. This profound break from conventional physics marks the birth of quantum theory.

From his experimental data relating to black-body radiation, Planck derived Planck's constant (6.626×10^{-34} Joule-seconds) which was proportional to frequency and inversely proportional to temperature. Commonly denoted as '*h*', it appears in almost all equations that describe quantum phenomena – from Heisenberg's Uncertainty Principle to the de Broglie Wavelength equation – and most importantly, the Planck relation to evaluate photon energy: $E=hf$.



The scientific community was initially hesitant to accept Planck's results when he presented them in 1900. In fact, Planck himself was sceptic of his own theory, characterising it as an instrument for calculation as opposed to a fundamental physical reality. The true breakthrough occurred in 1905 when Einstein used Planck's quantum theory to explain the photoelectric effect – the phenomenon whereby electrons are liberated from metals in the presence of UV light – articulating the idea of wave-particle duality, which was exceptionally difficult for the scientists of the time to accept.

GLOSSARY

Black-body: object that absorbs all electromagnetic radiation that falls onto it - no radiation passes through it, and none is reflected.

Wave-Particle Duality: concept that light acts as both a particle and a wave depending on the circumstance

Although Planck and Einstein were both awarded Nobel Prizes for their findings, the development of quantum mechanics by other prominent researchers such as Paul Dirac and Erwin Schrödinger, who showed that wave-particle duality was crucial to understanding quantum phenomena, was the catalyst for the complete acknowledgement of quantum physics in the 1920s.

Even though the quantum field eventually gained support, many physicists found the theory's probabilistic nature disconcerting as it introduced substantial ambiguity into their predictions. Therefore, quantum theory, both regarding its history and conceptual nature truly epitomises 'Defiance in Science'.

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Ignaz Semmelweis

Written By *Grace, 7G* (KHS)

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Have you ever wondered if there was an action so small that people argued against that could save people's lives, as simple as handwashing? Well, there is!

Ignaz Semmelweis was a pioneering figure in medical history, whose groundbreaking work revolutionized the field of obstetrics. In the 19th century, at a time when maternal death rates were staggering, he dared to challenge conventional wisdom. Armed with relentless determination and an acute scientific mind, Semmelweis discovered the life-saving practice of handwashing in medical settings, long before germ theory was widely accepted. His bold ideas not only saved countless lives but laid the foundation for modern infection control practices, securing his place as one of medicine's unsung heroes.

Childbed disease, also known as puerperal fever, was currently spreading worldwide- this is a disease which led to the death of many new mothers, leading to their unfortunate death days or weeks after labor. This could enter the body because of unsanitary medical instruments or hands used during surgery. The horrible symptoms included: Fever, abdominal pain and in severe cases, sepsis- which could sadly easily lead to death.

Ignaz proposed the simple concept of washing your hands with antibacterial soap before performing surgery to reduce the risk of this infection occurring. However, when Ignaz Semmelweis presented his handwashing theory to the medical community, it was met with skepticism and hostility. Despite his evidence showing a dramatic reduction in maternal deaths, colleagues rejected his ideas, dismissing them as unscientific. Semmelweis faced ridicule and isolation, and his discoveries were largely ignored during his lifetime.

It wasn't until after his death that he was listened to when a scientist presented the idea of their antibacterial theory that people from the medical community read and looked over his research, saving people's lives and having a drastic effect on the sanity and health of the labor surgery.

This is how Ignaz defied science and always tried hard with what he knew, and it saved people's lives, even though it may seem like a basic, everyday action!

Breaking barriers: Edith Clarke and the world of electrical engineering.

Written By *Emma, 12H* (KHS)

Electricity, what is it?

Could you imagine life without lights, phones, or the internet? Hard to picture, right? Our world would fall apart without them, but what do they all run on? ELECTRICITY!
Electricity is the invisible energy that powers nearly everything around us, from tiny gadgets to whole cities. At its core, electricity is the flow of energy through charged particles called electrons. It is essential to our daily lives, so we need systems and people to manage it; this is where electrical engineers play their roles.

What are electrical engineers?

Electrical engineers are problem-solvers. They design and develop systems that produce, transmit, and use electricity. Here are some of the exciting areas they work in:
· **Power Systems**: Designing power plants, transmission lines, and renewable energy systems like solar and wind farms.
· **Electronics**: Creating devices like smartphones, computers, and medical equipment.
· **Robotics and Automation**: Building robots and systems that can perform tasks efficiently.

> Edith Clarke

Who was Edith Clarke?

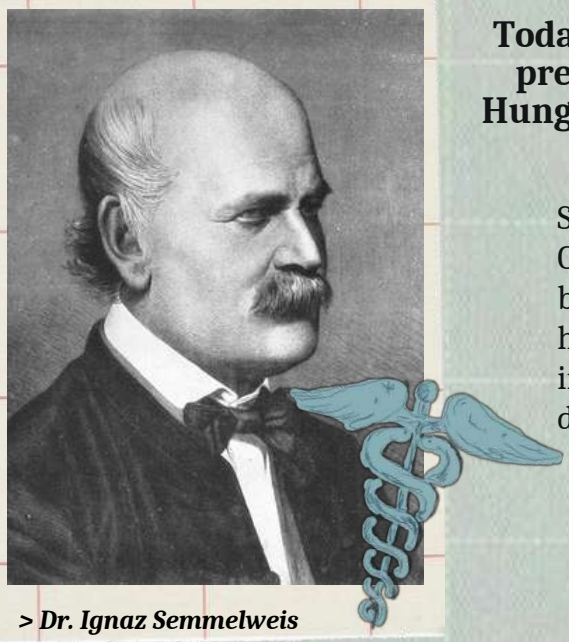
Edith Clarke was the first woman to become a professionally recognised electrical engineer in the United States. Born in Maryland, USA, in 1883, she grew up when very few women had careers in science or engineering.
After studying maths and engineering, she became the first woman to earn a master's in electrical engineering from the Massachusetts Institute of Technology (MIT) in 1919. But even with her qualifications, finding a job as an engineer was not easy because of her gender. Despite this, Edith found work at General Electric (GE), where she made groundbreaking contributions.

What did Edith Clarke do?

Think about the calculator you use every day; isn't it a lifesaver? At GE, she invented the 'Clarke Calculator,' an early graphing calculator that simplified complex equations - used to design power lines. This invention made it easier and faster for engineers to plan how electricity would travel long distances.
In 1947, Clarke became the first woman to be a full-time professor of electrical engineering at the University of Texas. She was also the first woman to deliver a technical paper at the American Institute of Electrical Engineers (AIEE). Her work on power transmission systems helped shape how electricity is delivered today.
Alongside her fascinating work as a pioneer, Clarke defied gender stereotypes and proved women could excel in science, leading the way for future generations of female engineers and scientists.

Semmelweis versus Society: The Handwashing Revolution

Written By *Sahana, 12L* (KHS)



> *Dr. Ignaz Semmelweis*

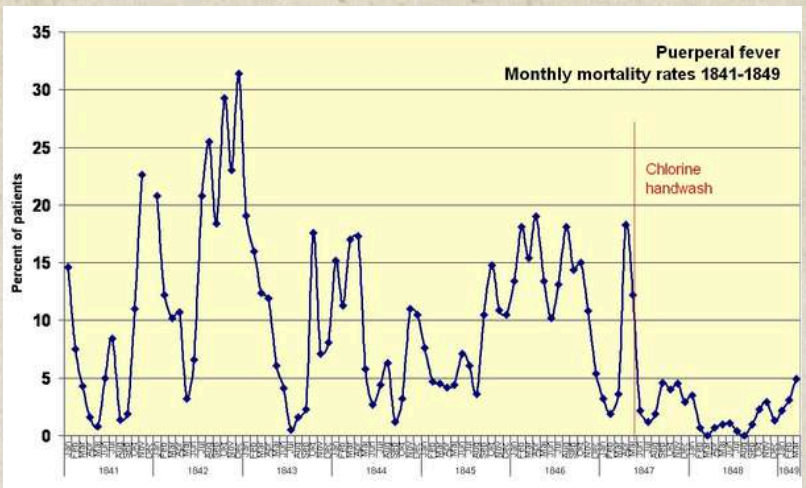
Today, we know that handwashing is a crucial practice to prevent the spread of disease. However, as the story of Hungarian physician Dr. Ignaz Semmelweis demonstrates, this was not always a well-acknowledged fact.

Semmelweis started off by working as an assistant in the First Obsterical Clinic at Vienna General Hospital in 1846, soon to become widely attributed as the first person to discover handwashing as an effective way to prevent the spread of infection. He made an observation based on the number of deaths from two maternity wards in the hospital:

- One ward was staffed **exclusively by doctors and medical students** (hereafter 'Ward A')
- One ward was staffed **exclusively by midwives** (hereafter 'Ward B')

He made the shocking discovery that the mortality rate of women in Ward A was five times higher than the mortality rate of women in Ward B. Semmelweis then set out to deduce the reason why so many women in Ward A were dying from puerperal fever (an infection which occurs after childbirth, commonly known as "childbed fever"). Ignaz Semmelweis made several modifications in the medical practice of Ward A, in the hopes of drastically reducing the rate of puerperal fever and hence mortality. He tried changing position of women during labour – in Ward B, women gave birth laying on their side as opposed to their back – but this attempt was to no avail. Whenever a woman died on Ward A, a priest would walk slowly through the clinic ringing a bell (which, due to the high mortality rate, was quite often) which led Semmelweis to theorise that the ringing of the bell terrified the women after birth so much that they developed a fever. So, he asked the priest to stop using a bell and change his route – although this was similarly to no avail. He also tried modifying other factors like room temperature which unfortunately did not affect the mortality rate on the ward.

Semmelweis then realised that the doctors and medical students on Ward A were using the same unclean hands to facilitate childbirth of women, whereas midwives in Ward B never performed autopsies – so their hands never encountered decaying flesh. He concluded that the doctors were transferring lethal particles from the dead to the living. To solve this, Semmelweis advised the medical students to cleanse their hands in chlorinated lime (as it masked the smell of corpses – he did not know that chlorine is one of the strongest disinfectants) before facilitating childbirths in order to test his theory. Mortality in Ward A **dropped from 18% to less than 2%** – proving the idea that handwashing saves lives.



SOURCE

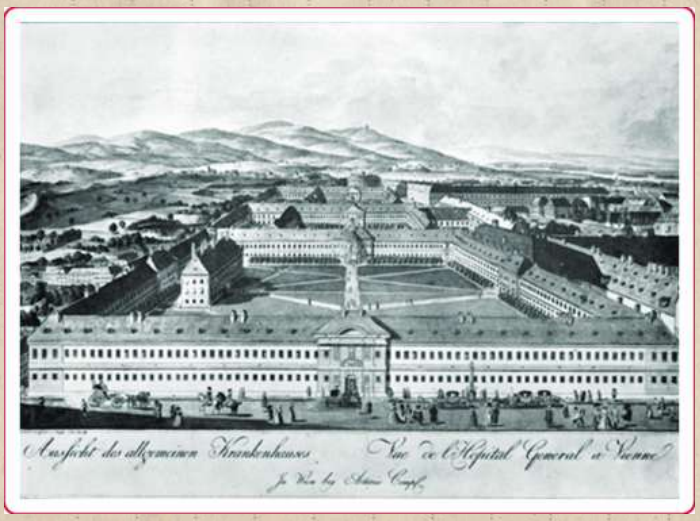
The Doctor Who Championed Hand-Washing And Briefly Saved Lives | NPR

Though congratulated by the medical students in substantially reducing deaths on Ward A, neither Semmelweis' superiors nor the wider medical community shared this sentiment. He had accumulated significant dislike through his fixation on reducing the mortality rate (since he was not focusing on his actual work) and berating those who disagreed with his newfound practice. The maternal mortality rate decreased to 0.85% in his private clinic in Hungary when he relocated there, as opposed to 10-15% in Vienna, where handwashing was not practiced. Also, in 1861, Semmelweis wrote a book titled *„Die Ätiologie, der Begriff und die Prophylaxis des Kindbettfiebers"* (German for "The Aetiology, Concept and Prophylaxis of Childbed Fever"), which he sent to heads of medical departments around the world. However, his writings were viewed with scepticism.

Over time, Semmelweis became depressed, angry and frustrated and it has been theorised that he was suffering from a late stage of syphilis (common in doctors who spent their lives delivering children without PPE – and of course handwashing...). In 1865, he tragically died at the age of 47 from sepsis after suffering injuries from beatings in an Austrian mental asylum – ironically one of the diseases he had spent his lifetime trying to prevent.

As this was all prior to Pasteur's publication of 'Germ Theory', Semmelweis could not offer a scientific explanation behind the importance of handwashing. Sadly, Semmelweis was not acknowledged during his time for this discovery. But a few decades later, Joseph Lister – the 'father of modern medicine' – proved the successes of hygienic measures in medical practice to the world.

Despite rejection and being met with hostility during his efforts, Semmelweis' defiance made him a crucial pioneer for handwashing in healthcare. He is credited with the term "Semmelweis Reflex," which refers to the reflexive propensity to reject new knowledge or findings because they conflict with established paradigms or concepts. Therefore, his work emphasises that in order to strive for truth and the improvement of humanity, it is necessary at times to challenge convention.



> Vienna General Hospital (1784)

GLOSSARY

Autopsy: examination of a body after death to determine the cause of death or extent of the disease

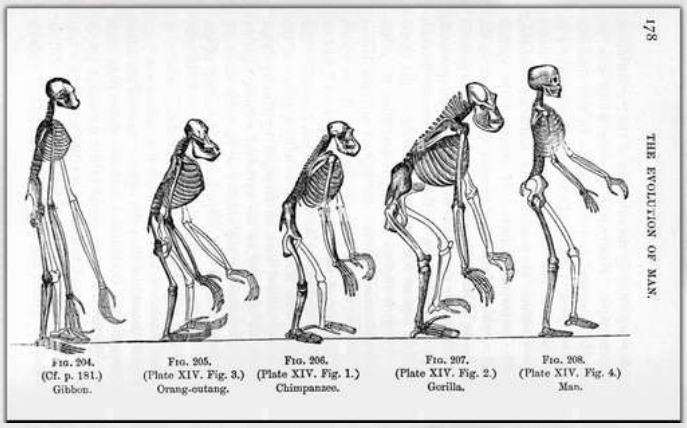
Cadaver: a dead body

Propensity: a natural tendency/inclination

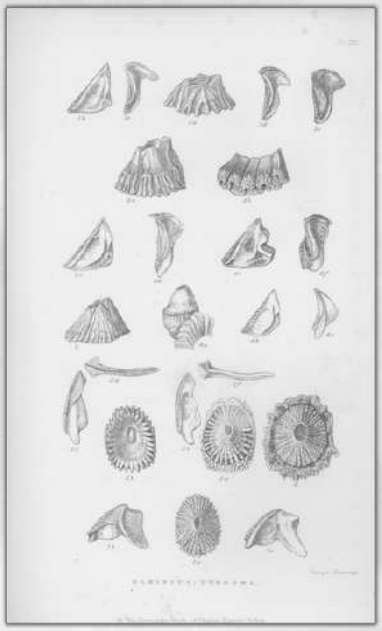
The Clash Between Religion and Biology

Written By ***Cherrie, 12K*** (KHS)

Evolution is the genetic change in a species or population over many generations. It occurs when evolutionary processes such as natural selection and genetic flow affect genetic variations, causing certain characteristics to appear more or less within a population over many generations. This process gives rise to biodiversity and new species.

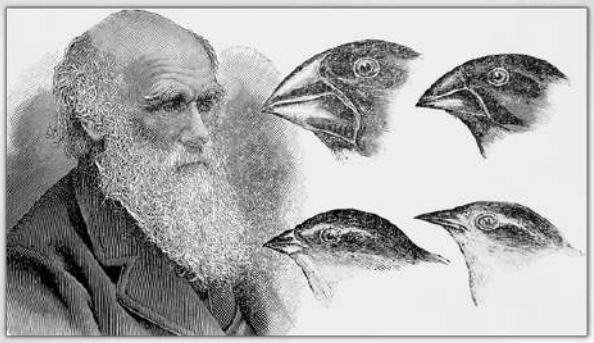


The Theory of Evolution through natural selection was first formulated in Charles Darwin's (a British naturalist) work - 'On the Origin of Species' - published in 1859. Darwin states that organisms change over time through the 'survival of the fittest'; Individuals with advantageous genes allow them to adapt to their environment better, so they can have offspring and pass on advantageous characteristics. Individuals with less adaptive traits die earlier (before mating age), so traits can't be passed onto offspring. This leads to evolution and speciation. This is how dinosaurs turned into birds, amphibious mammals into whales, and apes into humans.



However, Darwin knew nothing about genetics throughout his discovery, as he only observed the pattern of evolution but didn't understand the mechanisms. In 1865, Gregor Mendel discovered the basic principle of genetic inheritance by observing the different inherited characteristics in pea plants. This led to the incorporation of genetics into Darwin's theory, known as the 'modern evolutionary synthesis'. This states that genes encode different biological or behavioural traits, and how genes are passed down from parent to offspring.

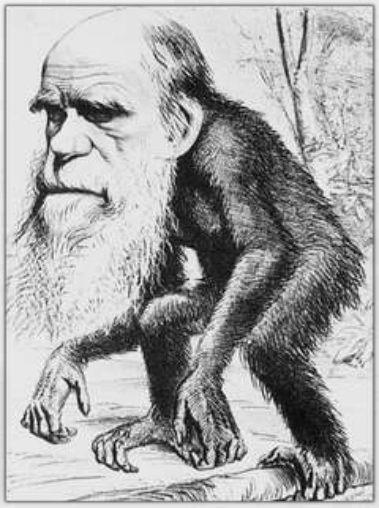
Natural selection is not the only mechanism of evolution. The process of gene flow- which is when genes are transferred from one population to another when organisms migrate or immigrate - can also lead to speciation. Further, epigenetics - when genes are switched on and off due to environmental factors- can also lead to different expressions of genes in the phenotype, which can be passed down to offspring.



> Charles' Darwin's sketches from the Galápagos Islands

Despite the strong evidence and vast research on genetics and evolution, there are still recurring cultural, political, and theological rejections over evolution by religious groups regarding the origins of the Earth and humanity. Creationism is the belief that all products are created by a divine power, such as God. Since the establishment of natural selection in the mid-19th century, this has led to heated debates between religion and biology. In majority-Christain countries, the debate could be viewed as a culture war due to how natural selection defies the fact that God created mankind. This controversy also appears in other religious communities, such as Judaism and Islam.

One of the greatest debates was sparked when Darwin made his publication in 1959. Many liberal Christian authors and Nonconformists expressed support for Darwin, but other Christians opposed the idea, and even some of Darwin's close friends and supporters- e.g. Charles Lyell and Asa Fray (who later supported Darwin and produced an influential book- Darwiniana). During the late 19th century, evolutionary ideas were most strongly disrupted by the premillennialists, who claimed Christ would return. Some science professors at liberal northeastern universities immediately accepted the theory of evolution and implemented it within their teachers. But others in parts of the south and west of the US- who were influenced by Christian faith, rejected the theory as immoral. All in all, Darwin received lots of support, but also many criticisms and abuse especially from Christians and the Catholic churches.



> An image of Darwin as an ape from 1871, reflecting the social controversy over the common lineage of human apes.

> An Anti-Evolution League book sale at the beginning of the 1925 Scope Monkey Trail, where an American legal case was filed against a high school teacher, John T.Scopes, for violating Tennessee's Butler Act, which made it illegal for teachers to teach the human evolution theory in any state-funded schools.

A US legal challenge towards the evolutionary theory occurred in 1925 when Tennessee passed the Butler Act, which banned the teachings of the theory of evolution in all schools in the state. Later that year and in 1927, both Mississippi and Arkansas passed a similar law. In 1968, the Supreme Court of the United States banished these 'anti-monkey' laws. In recent years, religious fundamentalist who believes in creationism struggled to get their rejection of implementing the teachings of the evolution theory in school, which resulted in a series of major court cases.

Fortunately, the idea of evolution was quickly accepted as a fact since Darwin's publishment in 1959. Darwin also received lots of support and positive feedback upon his revolutionary finding, which allow future discovery of genetic inheritance and inclined the way we think about evolution. Evolutionary sceptics, creationists, and the Catholic Church had also gradually adopted the evolutionary theory.

✳ Glossary ✳

Natural Selection: Process by which a population adapt and change
Genetic Flow: when genes are transferred from one population to another when organisms migrate
Phenotype: An individual's observable physical trait
Creationism: The belief that the universe and living organisms originate from specific acts of divine creation, as in the biblical account, rather than by natural processes such as evolution
Liberal Christianity: A movement that interprets Christian teachings by taking into consideration modern science and ethics.
Premillennialism: (in Christian eschatology): belief that Jesus will physically return to the Earth before the Millennium

✳ Sources ✳

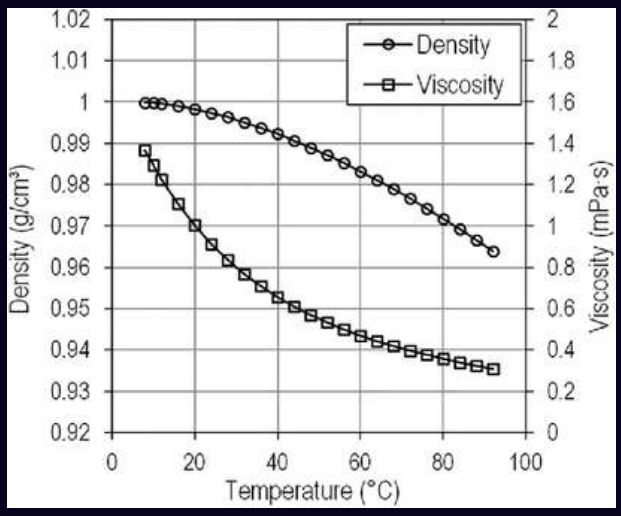
Rejection of evolution by religious groups | Wikipedia
What is Darwin's Theory of Evolution? | Live Science
Overview: The Conflict Between Religion and Evolution | Pew Research Center

Anomalous Expansion of Dihydrogen Monoxide

Written By *Dheepthi, 12G* (KHS)

Water is the most essential substance on our planet, from the smallest single-celled organisms to the largest mammals, we all depend on water to survive. Although there are many interesting things to say about dihydrogen monoxide (H_2O), this article is going to focus on one of its lesser known properties: The anomalous expansion of water.

Effect of temperature on substances

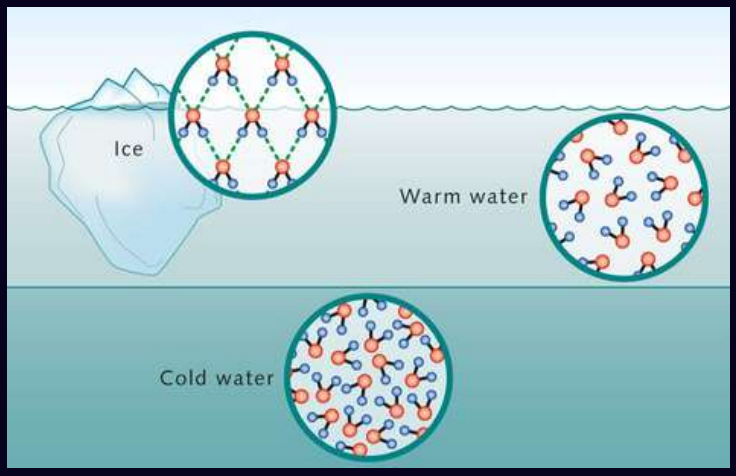


> Fig 1 Graph showing the relationship between temperature, density and viscosity- where increase temperature causes decrease in density and viscosity.

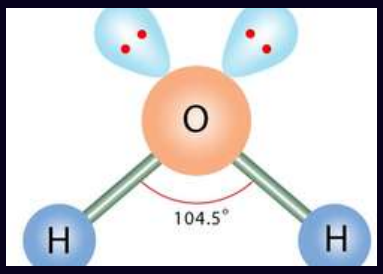
Most of us know that to change the state of a substance you freeze or boil it, in other words, you change the temperature of it. Changing the temperature of a substance can also cause it to expand(when heated) or contract(when cooled) without changing state, but why does this happen? Temperature is a measure of heat energy so when you increase the temperature of a substance you are providing each of the molecules with more kinetic energy causing them to move around faster. With enough energy the intermolecular forces of attraction are overcome and the molecules move further apart from each other, therefore the substance's density decreases so the total volume increases which we perceive as the object expanding. When you cool a substance, the opposite happens, the molecules lose kinetic energy so they move slower and closer together, the density increases and the total volume is reduced. In the summer you might have noticed that it is harder to close the doors in your house, this is because the warm temperatures causes the wood to expand making the door bigger than it was originally and unable to fit into the door frame. This property is also taken into account in lava lamps, building construction, railways, power lines, etc...

Effect of temperature on water

Considering the effect of temperature on a substance is based on the fundamental nature of molecules, you would expect every substance to expand when heated and contract when cooled. However, when liquid water is cooled below a certain temperature (above its freezing point though) it expands instead of contracting. This anomalous property of water was first observed by Thomas Charles Hope in 1805, he then devised a method to study this property which is now referred to as Hope's experiment wherein he noticed that when cooled from 4°C and 0°C, the density of water increases (it expands). This is known as the anomalous expansion of water.



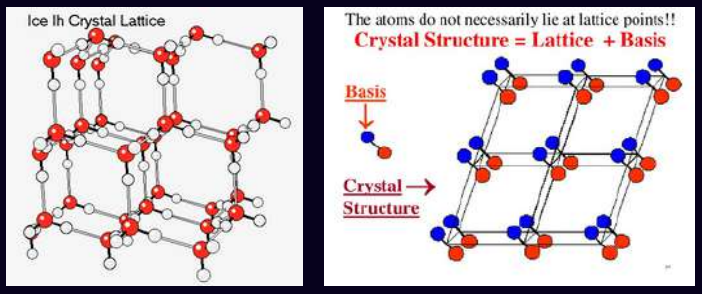
> Fig 2. Bonding and structure of water molecules in ice, warm water, and cold water



> Fig 3. Water is a simple covalent molecule with a bent structure, having 2 lone pairs and 2 bonding pair, giving water a slightly positive and slightly negative end.

This is due to the fact that water molecules are made of 2 positive hydrogen atoms and 1 negative oxygen atom, the atoms are arranged so that the 2 hydrogen atoms are on one side and the oxygen is on the other. This then means that the positive side of one molecule is attracted to the negative side of another molecule, however in water vapour and warm water, the bonding between the molecules is very weak because the heat energy overcomes these bonds, but when the substance is cooled, the bonds between the molecules get stronger (causing them to move closer together).

As water is cooled below 4°C, the hydrogen bonds form a fixed hexagonal lattice. Even though the hydrogen bonds are extremely strong, they stay at a fixed distance from each other and create gaps between the molecules. This forces the crystalline structure of water to be very open so the molecules are further apart and the density decreases so the overall substance expands.



> Fig 4. Hydrogen bonds form between the highly electronegative oxygen atom with the slightly positive hydrogen atom on another water molecule, forming a tetrahedral-like structure in water.

Benefits of anomalous expansion of water

Have you ever left a can of soda in the freezer and come back to the scene of an explosion? This is due to the anomalous expansion of water, as the liquid water in your beverage is being cooled below 4°C in your freezer, the drink expands and no longer fits in the volume of the container causing your can to explode. This property also explains why ice floats in your drink instead of sinking (the density of ice is lower than the density of water). The main benefit of the anomalous expansion of water is the very fact that ice floats on water. In the winter when temperatures drop to single digits and sub-zero, water in lakes and rivers start to freeze, but not all of it! Only a small layer on the surface of the water freezes. This is because the density of water decreases from 4°C to

> Fig 5. Low densitty of ice allows ice to float, giving polar bears a breeding ground.

0°C causing the ice to float to the top, this also acts as an insulating layer for the water below the surface which prevents the rest of the water from freezing as well maintaining a stable and habitable environment for aquatic life to survive even during the coldest temperatures. Without this property of water, fishies and marine life would freeze during the winter which is not only bad for them but it would also have larger negative implications for the environment around the body of water. Apart from sustaining aquatic life, the anomalous expansion of water also plays a role in weather and climate, soil formation, the water cycle, etc...

EVERYONE APPRECIATE WATER!!!!

SOURCE

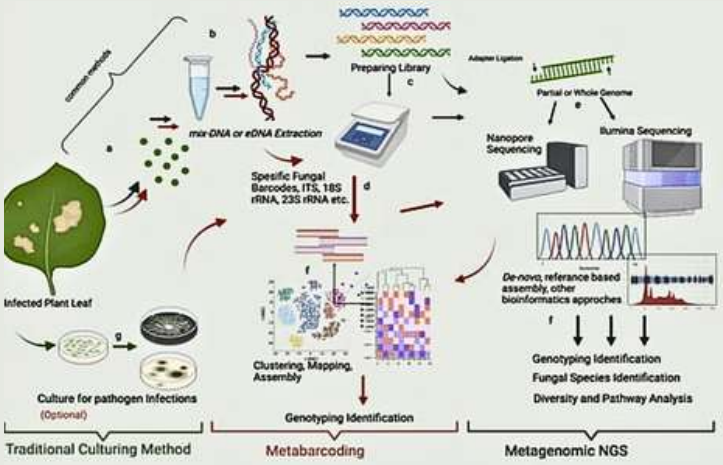
Hope's Experiment: Anomaly of Water | physicsexperiments.eu

One tool to detect all viral, bacterial, fungal, parasitic, and even neurological diseases? How is that possible?

Written By *Cherrie, 12K* (KHS)

Researchers at UC of San Francisco recently developed a genomic test to quickly detect almost any kind of pathogen- virus, bacteria, fungal and even parasite- and has proved successful after a decade of use. This test has the potential to vastly improve care for neurological infections, such as meningitis and encephalitis, along with speeding up the detection of new viral pandemics.

This technology uses a genomic sequencing technique called metagenomic next-generation sequencing (mNGS). Rather than looking for 1 type of pathogen at the time, mNGS analyses all genetic materials within the sample. Replacing multiple tests with a single test, can shorten the lengthy guesswork of identifying and testing infections.



> Fig 1. mNGS and metabarcoding workflow chart for sample of infected leaf. Metabarcoding (red workflow chart) allows genotyping identification. mNGS (black workflow chart) allow fungal species identification, microbial diversity, pathway detection, and genotyping identification. Both have the same steps, but algorithms are different. Traditional culturing method (green workflow chart) allows culturing of possible microorganisms causing infection prior to metabarcoding.

mNGS tests were originally developed to analyse cerebrospinal fluid (CSF)- the liquid found in tissues surrounding the brain and spinal cord. Since then, the test has been performed on thousands of patients in hospitals across the country. In a paper published on 12th November 2024, the team showed the mNGS test correctly identified 86% of neurological infections. The team also showed that by using mNGS, processes of identifying pathogens in respiratory fluids that cause pneumonia can be automated to get results faster. They deduced that the automated test has the potential to detect viral pathogens which can cause respiratory pandemics like COVID-19.

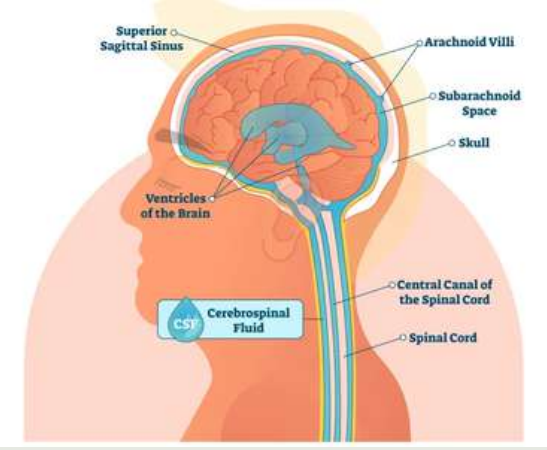


Fig 2. Where cerebrospinal fluid (CSF) is found within the body- marked by the light blue regions

A breakthrough in diagnosing infectious neurological diseases

Rare, infectious neurological diseases, such as encephalitis, are difficult to diagnose, especially when it is caused by a rare or unknown pathogen. In addition, these diseases get progressively worse.

In the early 2010s, a group of researchers developed a metagenomic sequencing method to test CSF for possible pathogens that cause neurological infections. This test works by sequencing all genetic materials in CSF and then running a computer analysis to separate human sequences from those originating from bacteria, viruses, fungi or parasites.

In 2014, the team used the technology to help doctors to diagnose a young boy in Wisconsin who was in the intensive care unit with an undiagnosed infection. Previously, an extensive series of tests had failed to diagnose him, but the mNGS test took just 48 hours to develop the boy had leptospirosis, which can be treated with penicillin. He was then prescribed it, and he fully recovered.

Fig 3. Joshua Osborn, 15 (in 2014), who was diagnosed with leptospirosis in 2014 through mNGS testing, received penicillin treatment and has now fully recovered.

The mNGS test soon became a routine at UCSF, with hospitals and clinics across the country sending samples to be processed. Between 2016 to 2023, the UCSF team analysed nearly 5,000 CSF samples with my test. With 14.4% tuned out to have an infection, and of which the test had accurately identified the pathogen 86% of the time.

The mNGS test performs better than any other category of test for neurological infections and proves that mNGS testing is a critical tool for physicians working with patients with infectious diseases. Its ability to quickly diagnose an infection not only means improving the quality of life for patients with neurological infectious diseases but also reducing healthcare costs.

To prepare for the next pandemic, the UCSF team adapted the mNGS test to work with respiratory fluids and future out how to automate it. The CSG test takes more than 100 different steps and can take up to 2 to 7 days to process, whereas the respiratory test takes only 30 minutes for all steps before handing the job to computers.

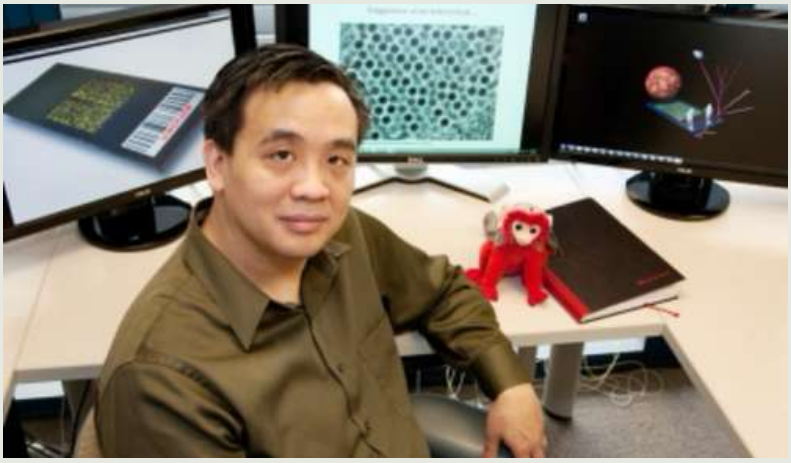


Fig 4. Charles Chiu, director of UCSF-Abbott Viral Diagnostics and Discovery Center and associate director of the UCSF Clinical Microbiology Laboratory, has developed superfast steps for reading out DNA sequences and analyzing them for matches with disease-causing pathogens of all kinds. His technology of mGNS diagnosed Joshua within 48 hours, which Joshua was diagnosed with Leptospira santarosai, a bacterial species native to Puerto Rico – where he and his family had visited a church camp a year before he was hospitalized.

Research has demonstrated that the test can detect respiratory issues with pandemic potential, such as SARS-CoV-2, influenza A and B, and RSV in less than a day, even if only a small amount of virus is present. The test is also modelled to detect rare or newly evolved strains of viruses.

Their goal is to have the entire process completed within 12 to 24 hours, providing a same-day or next-day result. This promising breakthrough can hypothetically detect all pathogens, providing patients with a better quality of life.

SOURCES

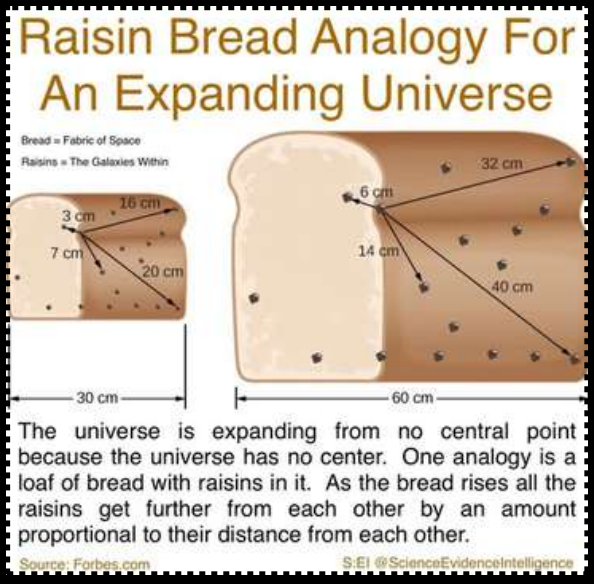
One genomic test can diagnose nearly any infection | Science Daily
A Diagnosis Just in Time | Jeffery Norris | UCSF

"WHY IS THE UNIVERSE EXPANDING?"

Question By *Katherine, 8G* (KHS)
Answered By *Karine, 12K* (KHS)

Ever since the Big Bang happened approximately 13.8 billion years ago, the universe has been expanding outward. This theory is due to the fact that galaxies have been observed to move away from us in all different directions.

To be honest, scientists at this stage can only theorise why the universe expands, however there are many theories as to why the universe does this. However most of these theories can be traced back to a form of energy called dark energy. It exerts a repulsive force and permeates through all space, countering any form of gravitational pull. It is also said to make up 68% of the total energy of the observable universe. Well, Albert Einstein introduced a 'cosmological constant' that represents energy that continuously expands throughout the universe. It was initially introduced to allow for a static universe (a universe that is not ever-changing), but after the discovery of the universe's expansion , it was reinterpreted as a driver of this expansion. So how does dark energy drive the universe's expansion? Imagine the universe is like a balloon that cannot pop no matter how much you blow into it, and this cosmological constant is an undying breath that can breath out as much air as it lives. This air breathed into the balloon ensures that the balloon (the universe) does not stop growing.



Aside from the cosmological constant, a concept called quintessence is also a hypothetical form of dark energy. It is different from the cosmological constant in that it can change over time and space. Quintessence is modelled as a scalar field that evolves over time. This means that its properties such as energy density, can vary throughout the universe. It is a more flexible explanation to the universe's expansion from the cosmological constant as it allows for potential to evolve over time. How quintessence expands the universe is similar to other forms of dark energy – by exerting a repulsive force that counteracts gravitational pull. However during certain periods, it might accelerate expansion more strongly or weakly. There have been observations of distant supernovae and the distribution of galaxies and galaxy clusters that serve as evidence for this explanation.

Another of these theories is that our universe is just one of many universes in a larger multiverse – called the Multiverse Theory. In this theory, there are a few ways the universe could not necessarily expand, but that there is potential for the universe to be even larger than we can perceive it to be. One way is to think of the multiverse as a giant foam bath. Each bubble in the foam is like a separate universe (including ours!) and that these bubbles can have different rules for their own universe. Another way is to think that every time a decision has been made by something or someone, the universe splits into different versions, so there are countless parallel universes where things happen, much like the butterfly effect if all the potential aftermaths of these effects come into play, one universe at a time. However, this theory is highly theoretical and controversial even amongst physicists.

FEATURED BOOK TITLES

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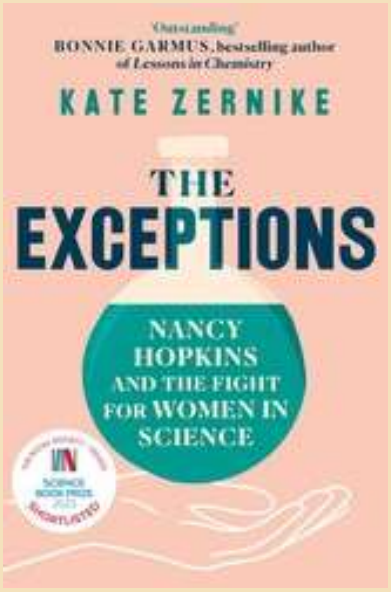
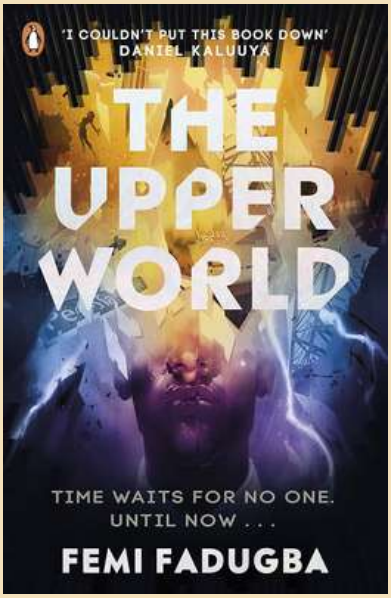
Suggested by **WS/KHS *Students*** and ***Newsletter Team***
Collated by ***Sahana, 12L*** **(KHS)**



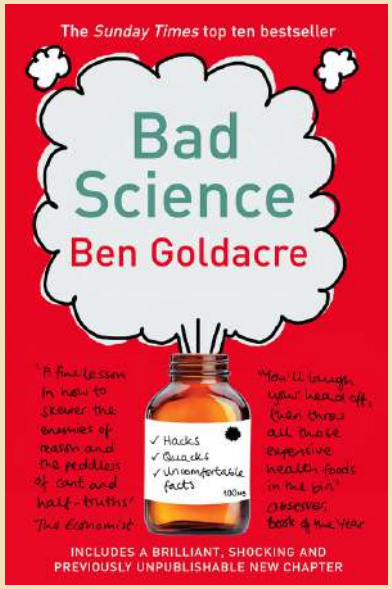
BIOLOGY MEDICINE

The Exceptions
By *Kate Zernike*



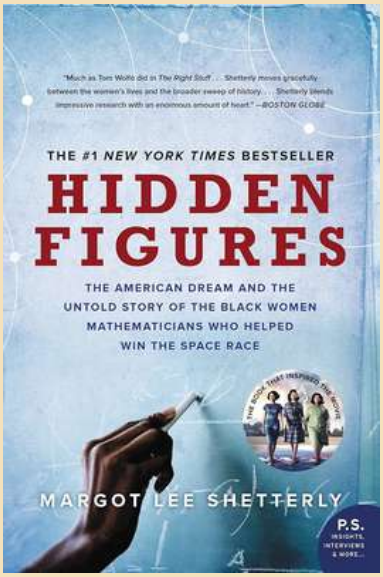
PHYSICS

The Upper World
By *Femi Fadugba*



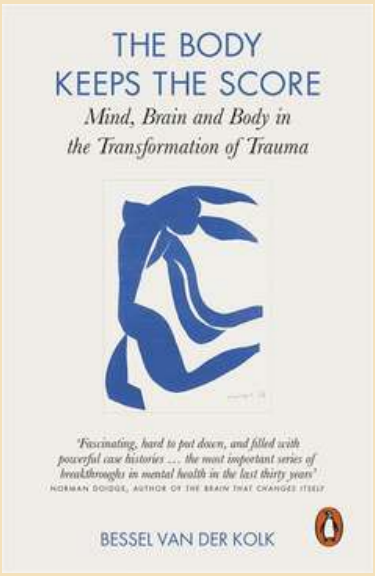
MEDICINE PSYCHOLOGY

Bad Science
By *Ben Goldacre*



ENGINEERING

Hidden Figures
By *Margot Lee Shetterly*



PSYCHOLOGY MEDICINE

The Body Keeps the Score
By *Bessel Van der Kolk*

PODCAST RECOMMENDATION

VOL. 2 • 2024/2025 • CAFÉ SCIENTIFIQUE

Written By *Cherrie, 12K* (KHS)

SCIENCE WEEKLY- THE GUARDIAN

Evolution is a biological process, where organisms change and evolve in order to adapt with their surroundings, leading to speciation. Human evolution had been a hot topic in the past years, with some scientist stating there had been no biological change in human in the last 40,000 or 50,000 years, and which human evolution might have stopped; some scientist also argue that human evolution has accelerated in the past 10,000 years, with now happening 100 faster than the long-term average over the 6 million years of our existence. Either one, a US tech startup- now introduces a new way for human evolution. Is this controversial to interfere with biology, or is it a revolution for inherited diseases?

The biggest concerns for parents are no doubt the health of their kids. In an ever-advancing society, technology can answer and solve this using genetic analysis technology.

GLOSSARY

IVF: In vitro fertilisation - a technique to help people with fertility problems to have baby

MZ twins: Monozygotic twins - Twins which develop from a single fertilised ovum that splits, hence they have the same genetic materials and are identical.

DZ twins: Dizygotic twins - Twins which develop from separate fertilised ovum and do not have the same genetic metals, hence they are unidentified.

A REVOLUTIONARY STEP FOR THE HUMAN RACE OR COMPLETE DISASTER?

A US tech startup proposes a function for you to customise your baby.

Genetic screening of embryos has been around for a while, and it is crucial for identifying embryos from individuals with family history of sickle cell disease or Huntington's, to prevent mutations from passing on to their offspring. This is not controversial. However, a US tech startup - Heliospect- might be taking this further- allowing parents to pick characteristics for their offspring, like how you customise your character in The Sims. The company proposed that it could be possible to select traits like, IQ, height, risk of physical and mental illness, and even personality. To give some context, Heliospect is a US startup that was not publicly launched yet, but they offer couples who want to have offspring the opportunity to screen their embryos for IQ, height, and a range of other mental and physical health conditions. Heliospect is not involved in IVF process nor the genetic analysis, however they run a prediction algorithm to predict the traits of the embryo.

This is a very controversial technology and raises ethical concerns, hence the Guardian had sent an undercover researcher to investigate Heliospect in 2023. The researcher scheduled several meetings with Heliospect, in which they were offered to screen up to 100 embryos over a 5-year period for the cost of $50,000. At the time this investigation was done, Heliospect already had 13 clients, with 5 embryos analysed under IVF. In addition, there are babies on the way, hence by now there are babies born where the embryo was analysed and selected based on this technology.

Heliospect's prediction algorithm allows parents to pick the most desirable offspring, and coud he highly beneficial for the future of humanities. As intelligence is partly inherited, in which MZ twins display a far similar IQ score compared to DZ twins, this can produce a smarter future generation. Environmental factors, like schooling, could also affect your intelligence. Your immune system or something that stops you having time off school might also mean you perform better in school. Positive parent personalities could also be inherited, such as being more compassionate, dedicated, and a stable person, which helps the child develop better. However this explanation is oversimplified, as your traits depend on thousands of genes.

Heliospect scaling that selecting the smartest of the 10 embryos would lead to an average IQ gain by more than 6 points. But this claim is impossible to prove using science. Some scientists looked into how to use genetics to predict IQ, however using embryo screening to predict IQ will be a strength. -Firstly, taking 10 embryos from a person would be quite a lot. 10 embryos doesn't mean 10 viable pregnancies. So for some couples, the IVF process might take a very long time. -Secondly, medical ethics must be considered, as there are risks on the mother in IVF. Social and ethical questions about this technology must also be considered. -Thirdly, despite having a gain in IQ points, we are unsure whether this results in a more desirable trait, or that it might be risky -Fourthly, genetic selection could cause health problems, like intensively bred dogs. This might also negatively impact the society, in which a famous example is the super chicken. These super chickens were selectively bred to lay the most eggs. However when I produced a farm herd, these super chickens were extremely aggressive, bullying other chickens, and pecking each other to death. -Lastly, what is proposed here sounds like eugenics, where actions are done to improve the human gene pool. In the past, this resulted in discrimination as seen from the Nazi Germany. This phenomenon is known as techno-eugenics, which would result in children being genetically superior or inferior to each other, leading to discrimination.

In conclusion, Heliospect is proposing a huge step towards improving the quality of life in humanities, and a potential breakthrough in human evolution, making humans smarter and more efficient. However, it comes with a cost of social, medical, and ethical concerns. It is crucial that future legislation and further considerations are taken into account before carrying out this technology, otherwise this is definitely undesirable to be released into the public.

PODCAST RECOMMENDATION

VOL. 2 • 2024/2025 • CAFÉ SCIENTIFIQUE

Written By *Cherrie, 12K* (KHS)

DISCOVERY - BBC WORLD SERVICE

As the men gather to talk about top secret military weapons, a woman sat quietly at the back of the room, listening contently upon the conversation of how to improve the arsenal weapons in Austria. This woman was the trophy wife of a powerful arms dealer, who uses her beauty as his own secret weapon for trade. Little did everyone know, she was listening to every word they say.

This is Hedy Lamarr. (see picture below!) An inventor and an actress, also known as 'the mother of Wi-Fi' and other wireless communications like Bluetooth and GPS.

"I was like a doll, some object of art which had to be guarded and imprisoned, having no mind, no life of its own." - Hedy Lamarr

Born in 1915, Lamarr grew up in a modest household in the suburbs of Vienna. Both her parents were Jewish, and her father became a successful banker. She rose to fame as one of the greatest femme fatale of Hollywood in the 1940s, after her controversial role in "Ecstasy" in 1933 (in which she appeared in full nude). She was one of the prettiest women within the film industry at the time. Hot from her fame at 18, she managed to wow a new fan- Mr Fritz Mandl, an arms dealer- in her theatrical performance. They quickly got married. Mandl became a monarch of the marriage, which he only valued Lamarr for her beauty, and demanded her to act naive and sweet. Fritz often held grand parties due to his involvement with politics, and he used Lamarr to his advantage to convince others to trade.

Fritz was an avid supporter of Austrofascism- an extreme right-wing party that dictated Austria in 1943. Fritz's arms company also supplied weapons to this party, hence many meetings were held in secret with other dealers. He often put Lamarr at the corner of the room- like a doll- hoping her beauty will dazzle other dealers so they would make a deal with him. Unfortunately, this was not the case. Lamarr was actively listening. An issue arises in one of the conferences. Despite the vast variety of weapons Fritz produces, they were hard to control, and were often wasted. Hence, Fritz and his comrades had thought upon the issue, and one of the solutions was using radio signalling. To elaborate, they thought that if they had a torpedo and they stick an antenna on it, and then they take their ship and stick another antenna on that, then tune them both to the same frequency, they can then communicate with the torpedo and guide it to where it will go. However, if the enemy figured out the frequency signal, they can play their own signal to block the communication between the ship and the torpedo. Another wasted weapon. However, not a wasted conversation. Silently, Hedy Lamarr's inner inventor was taking notes of the conversation.

Fast forward to 1937, Hedy managed to escape from the marriage. Alongside with her Jewish roots and instability in Europe, she fled to the US, where she joined Hollywood and changed her name (her previous name was Hedwig Kleiser). Hedy founded fame in La La Land, but also within the artistic industry. In 1940, at the height of WWII, she met her next key to her invention- a composer and pianist called George Antile. George was no ordinary composer. He produced very experimental pieces called Ballet Mécanique, where he used 16 self-playing pianos. Instead of having a musical score, there are rolls of music that have tiny holes in them, which direct air to each key, and play a note. This was the last key behind how Lamar solved the torpedo control problem. As Hedy saw this, she arranged a discussion with George, which she mentioned the torpedo control problem. They both thought, "what if we look at the torpedo and the ship as 2 self playing pianos? To get those pianos to play together, they both need identical musical rolls, so they hit the same note at the same time.". Hedy further proposed, "what if the rolls contained a set of instructions with lots of different radio frequencies?".

Rewind to Fritz and his comrades' obstacle, they only have the torpedo and the ship talking on just one frequency, which makes it easy for enemies to block their communication. NOW what Hedy is proposing was known as frequency hopping, in high the frequency of the communication between the ship and the torpedo kept changing at the same time. This makes it a lot more difficult for enemies to interfere with the signals. This idea was donated by Hedy and George to the US Navy, which they could use it against the Nazis. Unfortunately, this idea was not used as the Navy said the mechanism to sync up the ship and the torpedo was too bulky. Later on, a more developed version of this technology- frequency hopping- was used in the 1960s, during the Cuban Missile Crisis, where the ships and torpedo made lots of hops between frequencies to communicate, so enemies could not predict. Sadly, Hedy was not involved as the government told her to leave the sciences to the men, and go back to her movies and selling war bonds. Hedy did her job, and sold more war bonds for the US during WWII than any other person. This is highly patriarchal, especially with how Hedy proposed a war-winning idea, but the government manipulates her beauty to make money for the country. Hedy's idea was not only war-winning, but also world-changing, as this idea led to the creation of Wi-Fi, Bluetooth, and GPS. But from the 1970s onwards, Hedy's life took a downturn. She became more secluded, and had rejected roles in several projects. She moved to Florida in the 1980s and kept to herself. At the end of her life, nobody remembered her movies and nobody knew about her invention. It was only her death which led us to know about her invention. Hedy passed in 2000 without knowing her idea sparked the invention of Wi-Fi. At a point in her life, she was also publicly stealing the idea of frequency hopping.

Hedy was a woman who was ahead of her time, when women were expected to be submissive and be little housewives. To empower and educate her children upon the injustice of society, Hedy used to read a few lines from a poem called The Paradoxical Commandments by Kent and Keith to her them before bed:

"So, if you do good, people will accuse you of selfish ulterior motives. Do good anyway. The good you do today will be forgotten tomorrow. Do good anyway. The biggest men and women with the biggest ideas can be shot down by the smallest men and women with the smallest minds. Think big anyway."

HALF-TERM AI NEWS

CAFÉ SCIENTIFIQUE

Less is More: Iridium-based catalyst

New iridium-based catalyst called P2X that is highly efficient and stable, requiring only a quarter of the iridium compared to the best commercial catalysts for hydrogen production.

miRNA Solves Evolutionary Mystery

Researchers discovered that a microRNA (miRNA), rather than the previously believed protein-coding gene 'cortex,' is responsible for controlling the melanic wing coloration in butterflies and moths.

AI Weather Forecaster Outperforms World-Class Systems

AI model developed by DeepMind provides more accurate weather forecasts 15 days out, faster than the best operational models.

New Shape-Changing Polymer

RScientists have developed a new liquid crystalline elastomer polymer that can change shape in multiple directions, which could revolutionize the construction of future soft materials.

Innovative Immunotherapy

Phase one clinical trial has shown promise for a novel cell-based immunotherapy for breast cancer, significantly reducing tumor volume in patients and minimizing side effects compared to traditional chemotherapy.

The Secret to our Big Brains Might Be in Our Gut

A new study suggests that gut microbes could play a key role in supporting the energy needs of larger brains, potentially influencing human evolution

Children in England Excel in Science

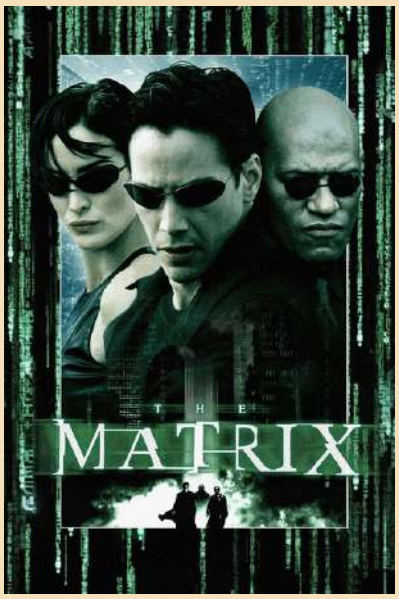
Despite the pandemic, children in England have moved into the top five globally for science performance, thanks to curriculum reforms and strong school commitment

NEW

FEATURED FILM/TV TITLES

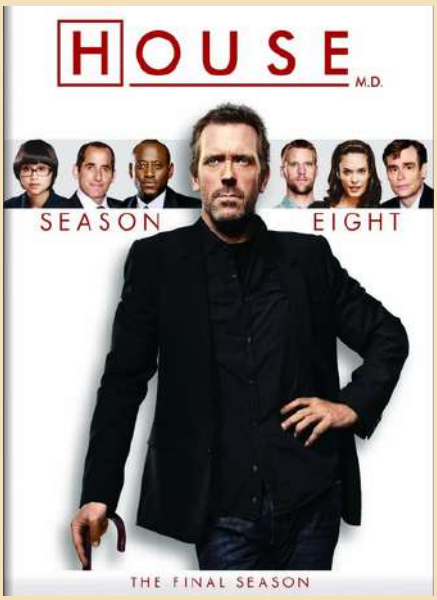
VOL. 2 • 2024/2025 • CAFÉ SCIENTIFIQUE

Suggested by *Newsletter Team*



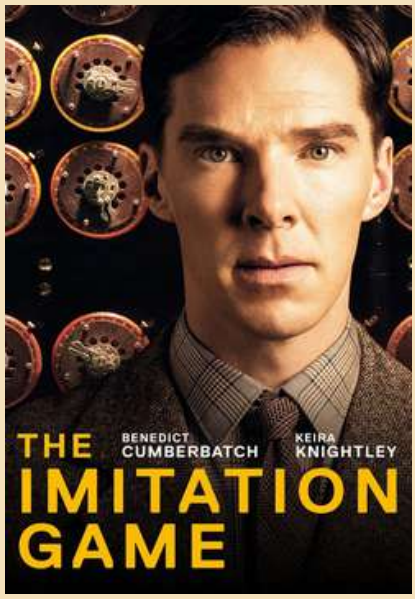
PHYSICS PSYCHOLOGY

The Matrix (1999)



BIOLOGY MEDICINE

House M.D. (2004-2012)

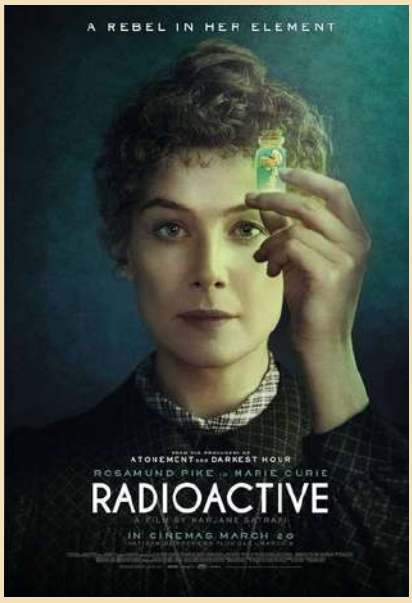


ENGINEERING

The Imitation Game (2014)

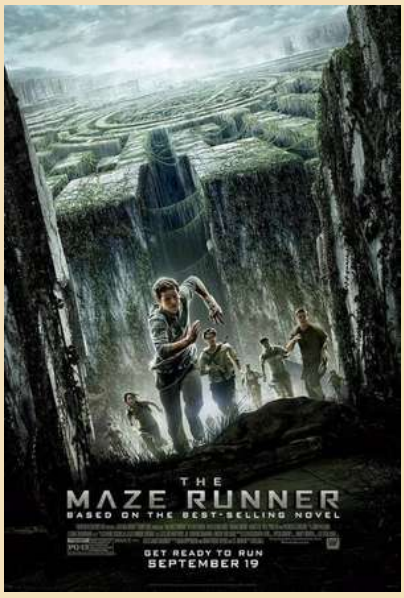
PSYCHOLOGY

Karthik Calling Karthik (2010)



CHEMISTRY

Radioactive (2019)



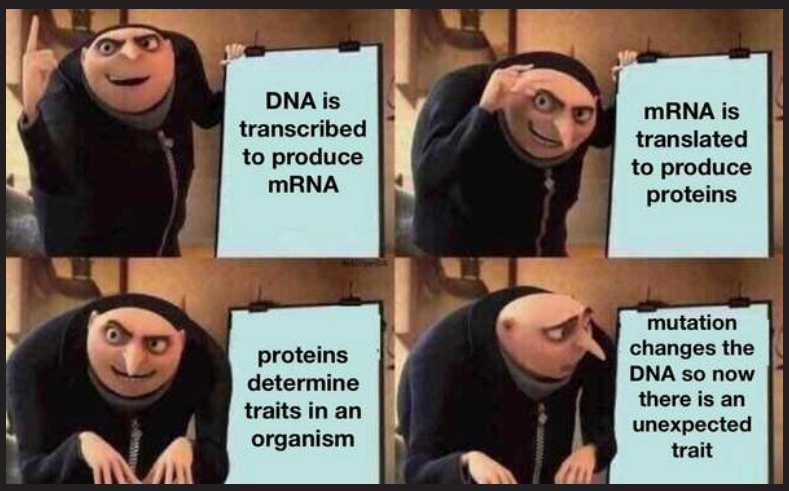
PSYCHOLOGY

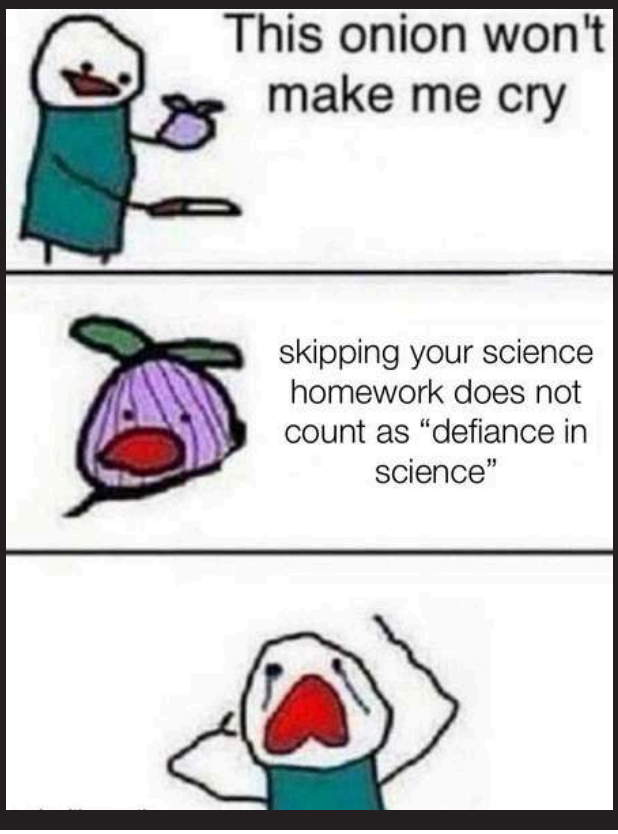
The Maze Runner (2014)

MEMES

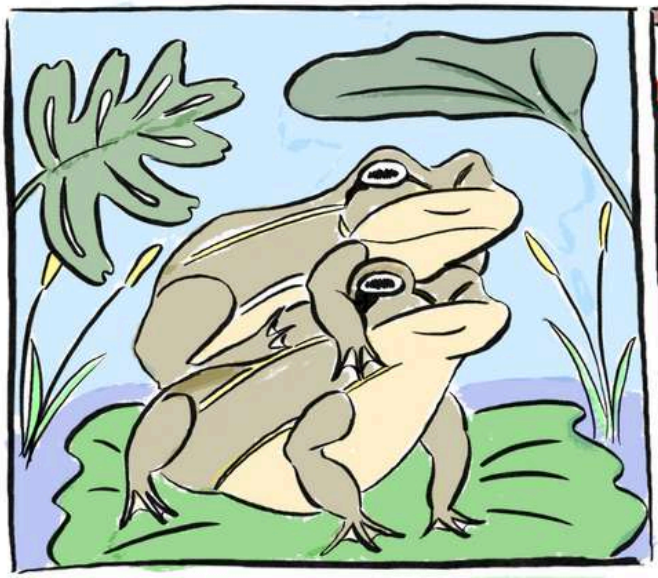
By Sahana, 12L (KHS)

The memes for this half-term portray the excitement (and chaos) of breaking limits in our science studies





WOOD FROGS PREPARING FOR THE WINTER



WOOD FROGS ARE FOUND IN FORESTS OF ALASKA & NORTHWEST. THEY'RE THE ONLY FROG THAT LIVES NORTH OF THE ARCTIC CIRCLE.

AS WINTER ARRIVES, THEY MUST PREPARE FOR THE FREEZING COLD, AS IT CAN GET DOWN TO -35°C AT THE ARCTIC.

SO THEY RAISE THEIR BLOOD GLUCOSE LEVEL BY 450 TIMES!!!

THEY STOP BREATHING & THEIR HEART STOP BEATING. THEY MAKE AN ANTIFREEZE AND THEY FREEZE.

WOOD FROG'S BLOOD GLUCOSE & ORGANS RISE OVER 300 mM IN A FEW HOURS. FURTHUR, ALTHOUGH 2/3 OF TOTAL BODY WATER FREEZES AS EXTRACELLULAR ICE, THE GLUCOSE CONCENTRATION REMAINS IN LIQUID SPACES.

DRAWN BY CHERRIE

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Sahana
Cherrie
Karine
& Members of Café Scientifique

Please look forward to our next issue. Thank you for reading, and Happy Holidays!

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~ DEFIANCE IN SCIENCE ~

CAFÉ SCIENTIFIQUE