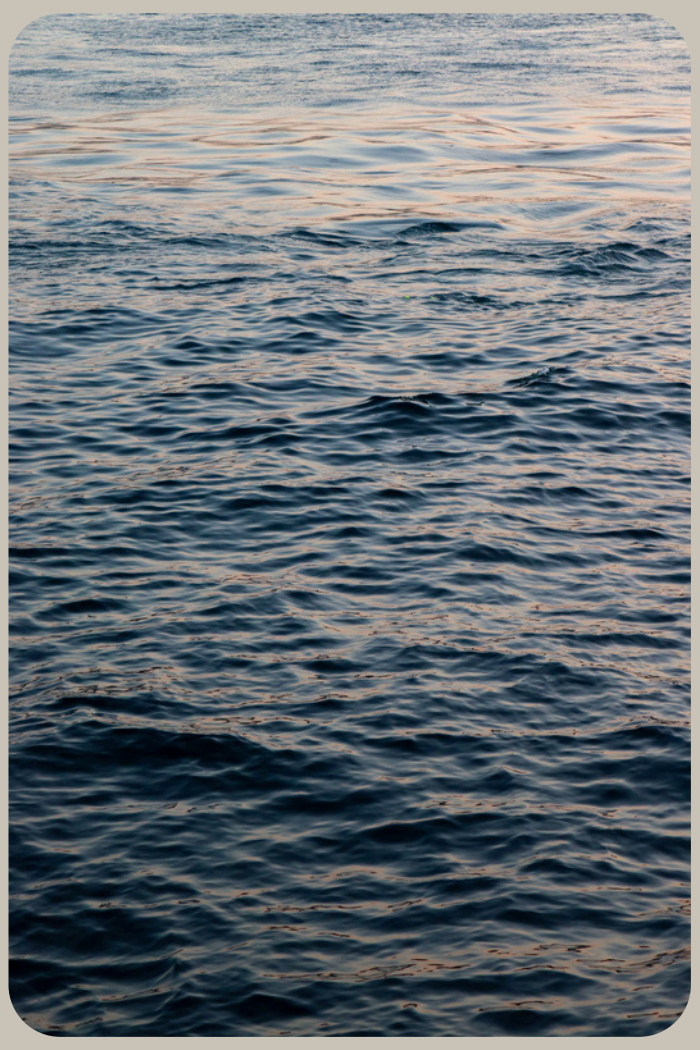
CAFÉ SCIENTIFIQUE

~Above & Beyond~

VOL. 2 (2025-26) - SPRING TERM

CONTENTS

01



Introductions

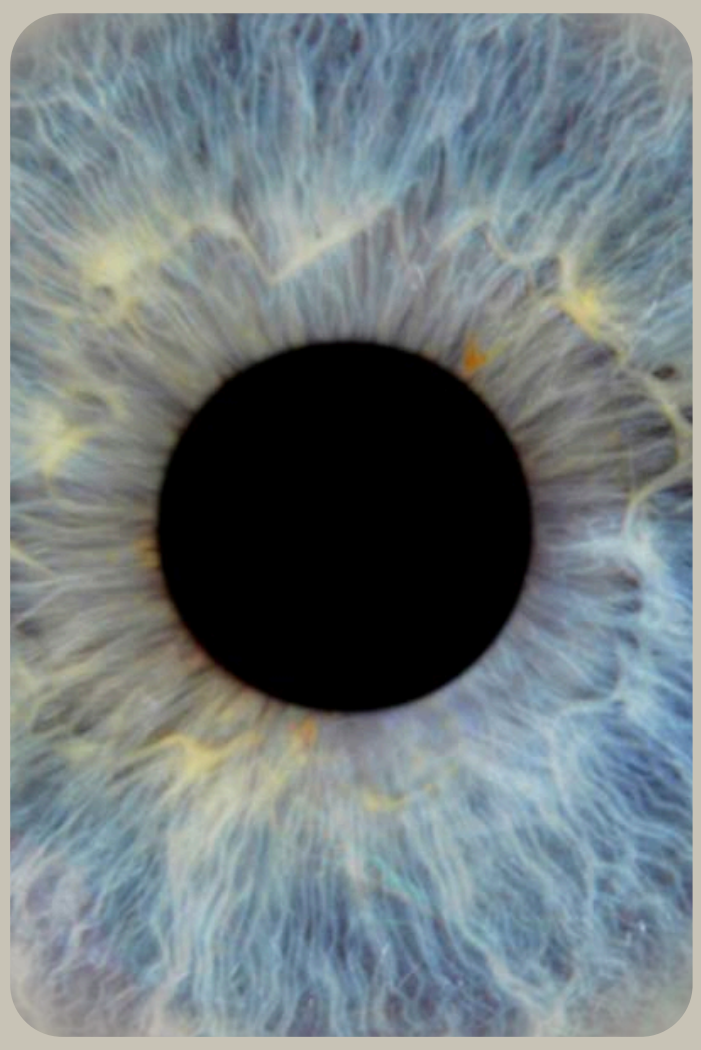
- Adjustments to the team
- About the Theme
- Café Scientifique Events & News

04

KHS Student and CST Articles & Research:

- Chemistry
- Physics
- Biology
- Engineering
- Economics
- Computer science
- Mathematics
- Psychology

23



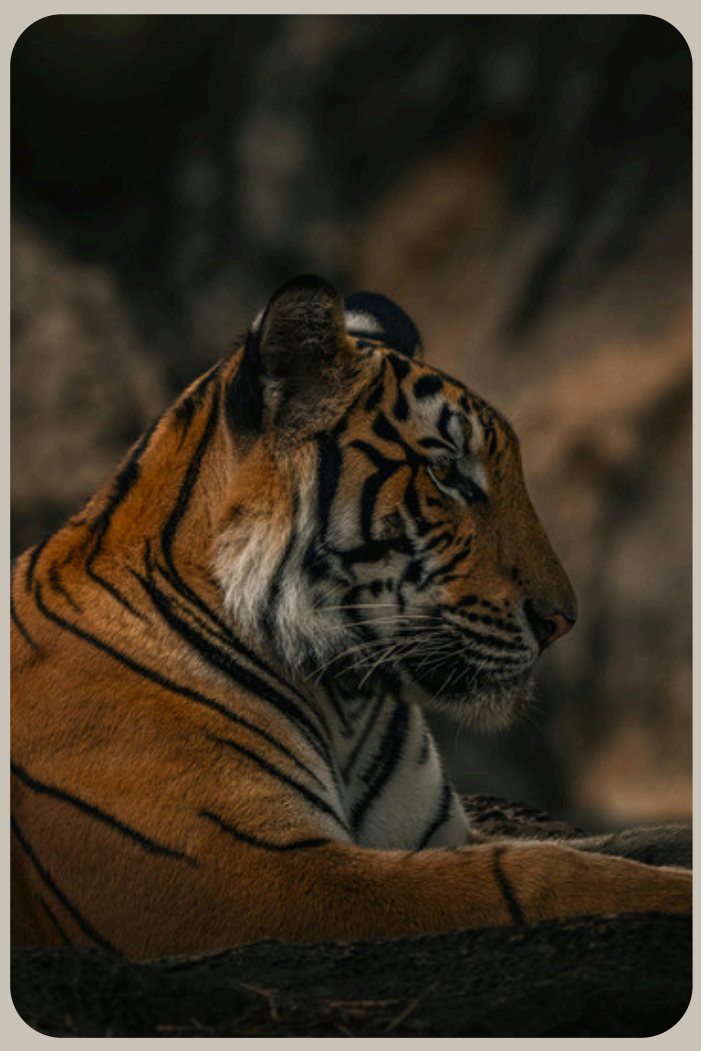
Prep School Articles:

- Chemistry
- Physics
- Biology

29

30

34



Graphical content:

- Memes & Jokes

Media:

- Book recommendations
- Film recommendations

Acknowledgements

A MESSAGE FROM THE CAFÉ SCIENTIFIQUE TEAM

This term, we are excited to introduce a few more members alongside our current Café Scientifique Newsletter editor, Rebecca, who are as follows: Anandiya, Ellen and Jiya. We are all excited to take on these roles as Newsletter members.

We have all put our utmost effort into this newsletter, curating and compiling everyone's articles and research. Without everyone's entries, this Newsletter would not have been possible. We really appreciate and thank everyone who contributed!

Events:

- 20th January - Joint MFL & STEM careers talk
- 4th March - Impact of HIV drugs on hormone therapies
- 9th March - Bridge building challenge
- 13th March - Flame Tests
- 11th March - KS5 Rat dissection

Introducing This Terms Theme:

This term we are adhering to the science week theme, "curiosity" and thus have landed on the title "Above and Beyond" for this newsletter issue. We felt that this particular title lends itself easily to the theme of curiosity as it prompts us to strive beyond the simple and plausible into the fascinating and absurd.

Curiosity is an intrinsic element of Science often fuelling the ideas that precede the discoveries for example space and deep sea exploration.

Within todays social climate where personal interest and satisfaction is often subordinate to necessity and obligation we want to heavily encourage you to exercise curiosity. Hence within this issue we hope to offer an opportunity for you to read about science indulgently.

We hope you enjoy!

Written By: Anandiya & Rebecca

This Term's Events

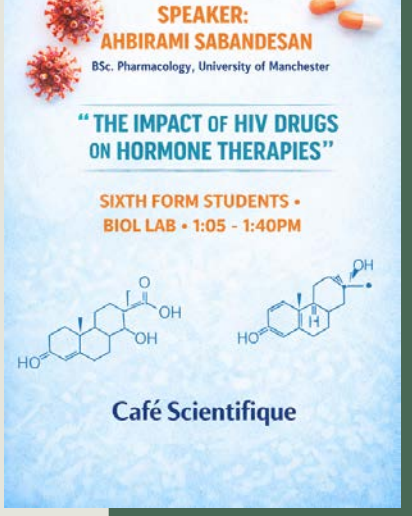
MFL & STEM Talk:

This term in Café Scientifique, we have arranged a wide range of science events for the student body including two wonderful talks that have opened up another sector of science for us. Starting with the empowering talk by Dr Martina Zimmerman on the topic of molecules to multilingualism. Zimmerman took us along into her journey from where she began as a pharmacist to researching and writing books on her discoveries on Alzheimer's disease and cancer. The enticing portion of the talk was how she intertwined her knowledge of 8 languages to her knowledge of science when doing her research. She expressed how her expertise in languages allowed her to make references from French, Spanish, German and Italian articles for her science research, enrichening her knowledge. She was truly an empowering talker who portrayed her passion for the powerful combination of languages and science to all who attended inspiring many of us.

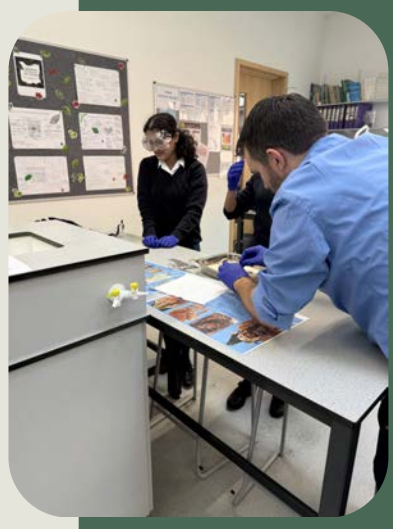
British Science Week:

To celebrate British Science week, 7 members of Café Scientifique spoke in our Tuesday whole school assembly with topics that fascinate them. Topics including the chemistry behind how drugs alter your brain, wormholes, coral reef symbiosis and the placebo effect were featured. In addition, we had a talk on the effect of HIV drugs on Hormone therapies and many workshops during Science week: these included 'Build a Bridge challenge' and 'flame test activities' for KS3, 'Rat dissection' for KS4 and a KS5 'Particle Physics Workshop' for Year 12 physics students.

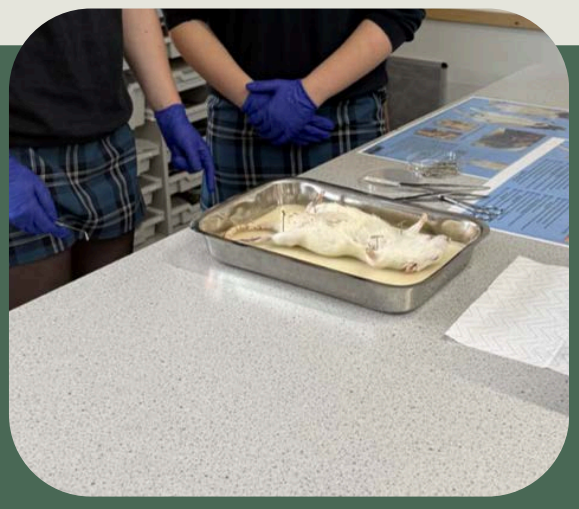
Impact of HIV Drugs on Hormone Therapies Talk:



An old student, Ahbirami was kind enough to come in to do a captivating talk on the impact of HIV drugs on hormone therapies. This was a topic that she chose for her final project in university and was eager to share to us. The talk consisted of how HIV viruses work, how they replicate, drug metabolism and the interactions between HIV drugs and hormone therapies showing how this affected transgender people. It was a fascinating talk which provoked those who attended to consider possible solutions for this problem that effects transgender people. This strive toward understanding and aiding transgender individuals within medicine is extremely important and we are thankful to Ahbirami for sharing her research into this area with us.



Written By: Anandiya



The Geckos

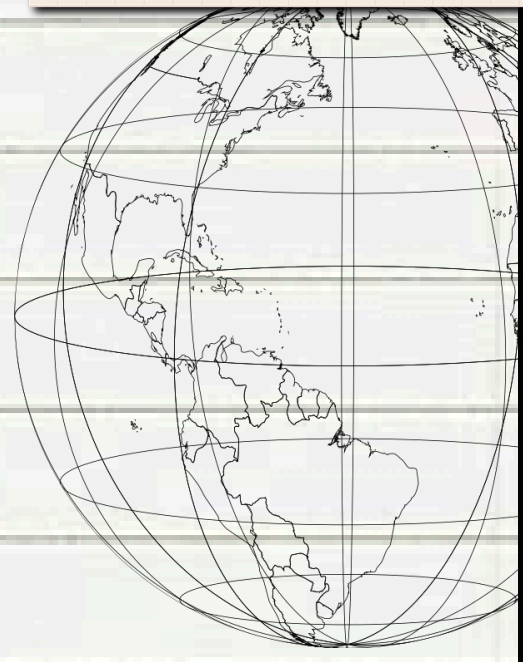
At King's, we're very passionate about all the animals that we nurture and care for and It is a pleasure to announce that we have two new additions, our new geckos, Freckle and Speckle.

They arrived early in February, and the names were specially voted for by the whole school. Freckle lives in the Ansell lab and Speckle lives in the Biology (Constantine) lab, so do go and visit them. We are incredibly grateful for them and hope they enjoy their time at King's High!

The Fine-Tuning Argument

Written By: Zoë

Sources: Fine-Tuning (Stanford Encyclopedia of Philosophy)



Through explaining the Fine-Tuning argument, I hope to demonstrate how the ideas of physics and philosophy are hugely intertwined.

The idea of "fine tuning" refers to instances where the fundamental and physical constants of our universe fall within extraordinarily slim or "fine" ranges that allow for the existence of stars galaxies, planets, and thriving life. We know that even tiny adjustments or changes in these constants would drastically change the balance of our universe and would be capable of making the universe unable to support complex structures and beings.

Some examples of these fundamental constants include:

The strength of gravity. When this is measured against the strength of electromagnetism gravity seems hugely fine-tuned for life. If gravity was absent or considerably weaker our universe would not have been able to form to begin with. Moreover, if gravity was even slightly weaker (or electromagnetism was stronger) main sequence stars such as the sun would be hugely cooler and unable to form elements such as hydrogen. However, if gravity was stronger stars would remain stable but more short-lived.

The strong nuclear force (the fundamental force which binds quarks together to form protons and neutrons and holds these formed nucleons together within atomic nuclei). Similarly to gravity, the strong nuclear force also seems fine-tuned for life. Interestingly if this force had been about 50% stronger almost all hydrogen (a massively important element) would have been burned n the very early universe. Contrastingly, if it had been weaker by the same amount, very few elements beyond hydrogen would have ever formed. Even if the nuclear force was just marginally different, carbon and oxygen in stars would have been fatal.

These are just some instances of how our universe is so meticulously specialised for life, or "finely tuned". Similar examples are numerous not just in our understanding of physics but all science – this makes the existence of our universe and ourselves as individuals extraordinarily unlikely.

These lead some to believe that the fine tuning of the universe for life points towards the existence of a divine creator (a God). They would argue that the extraordinary existence of the universe and the huge probability for its failure and collapse may mean that someone/something has designed it to be able to perfectly sustain life. A universe that is not designed and was formed due to purely chance just seems improbable!

However, briefly, there are plenty of counter arguments to this idea. A fascinating one is the possible existence of the multiverse. This rests on the idea that rather than there being a divine creator of the universe there may have been infinite other universes separate to our own which failed, meaning that rather than our universe being completely miraculous, it was simply inevitable, given that there were so many other chances for life.

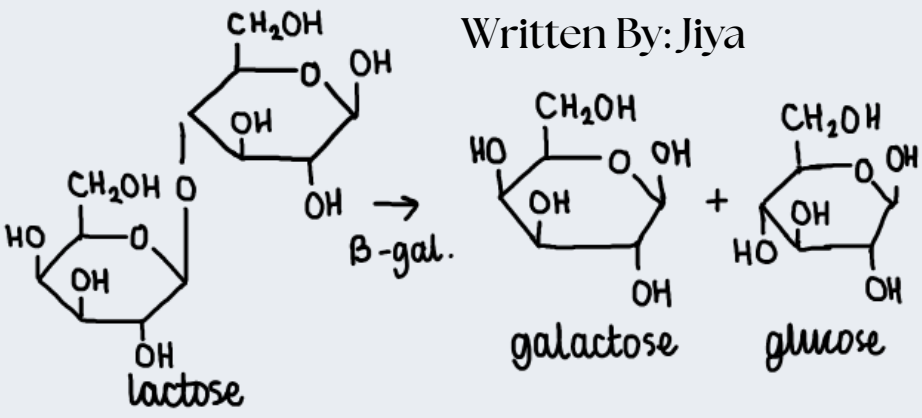
Effect of pH on E.coli and β-Galactosidase Activity

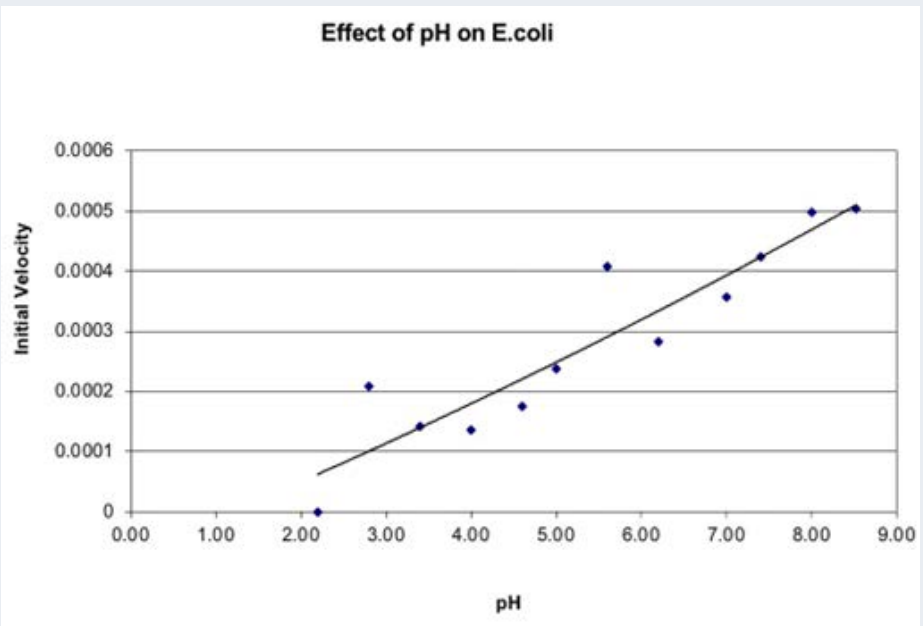
Written By: Jiya

Aim: To investigate how pH affects β-galactosidase activity in E.Coli by measuring hydrolysis of ONPG to ONP through absorbance (430nm)

- Enzyme catalysed reactions are affected by pH
- Changes in pH can alter the shape and structure of protein molecules
- Ionic bonds, hydrogen bonds, dipole interactions and disulphide bridges can be broken or formed, altering the tertiary structure and active site of the protein
- E.coli maintains a stable environment at approximately pH 7.2-7.8

- β-galactosidase is an enzyme produced by E.Coli which hydrolyses lactose -> galactose and glucose
- In laboratory assays (measures amount of a substance) ONPG synthetic substrate is used
- When hydrolysed it produces ONP (yellow compound)
- β-galactosidase converts ONPG —> ONP

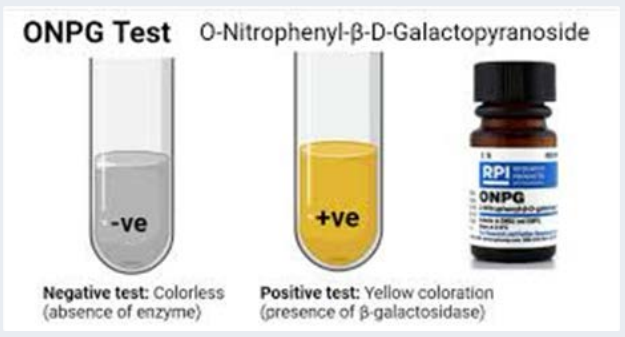




Results obtained when using a range of buffers from pH 2.2-8.5:

Tube no.	0.5cm³ Buffer of pH	OD (Abs)
1	2.20	0.00
2	2.80	0.05
3	3.40	0.11
4	4.00	0.28
5	4.60	0.11
6	5.00	0.13
7	5.60	0.35
8	6.20	0.36
9	7.00	0.44
10	7.40	0.67
11	8.00	0.95
12	8.50	0.64

- ONP concentration is proportional to enzyme activity
- Absorbance value (430nm) allows measurement of reaction rate in mM/L/min



Method:
- Make 12 test tubes pH 2.2-8.5 using 0.2M Na_2HPO_4 and 0.1M citric acid to create buffer
- Add equal volumes (0.5ml) of buffer & E.coli cell suspension to each tube
- At t=0 min, add 1.0cm³ ONPG
- After 2 mins add 2.0cm³ 2.0M Na_2CO_3 to stop reaction and develop any yellow ONP
- Use colorimeter & standard curve to calculate OD
- Plot graph of pH vs initial velocity of enzyme activity

- When investigating effect of pH on enzyme activity, temperature, enzyme concentration and substrate concentration are controlled
- Low enzyme activity at low/acidic pH as enzymes do not have sufficient kinetic energy and E.coli utilises stress mechanisms to handle protons (H^+)
- Increasing enzyme activity at alkaline pHs as E.coli is a gut bacteria
- Above optimum pH, OD value decreases as slower enzyme activity
- Anomalous results above pH 8 suggests there was an error in measuring the concentrations of buffer solution using the graduated pipettes
- Errors with the calorimeter readings as the E.coli suspension appeared cloudy

References:
- SIA Investigation of the Effect of pH on E.Coli & β-galactosidase Activity sheet
- https://pmc.ncbi.nlm.nih.gov/articles/PMC303440/

Who pays to clean up the Sky and how is it done?

Written By: Harishana

What is space debris?

Space debris, otherwise known as space junk, is any piece of machinery or debris left by humans in space. In numbers, space junk consists of up to 5000 satellites in Earth's orbit (with around 2000 being active, and 3000 dead), and millions of other smaller pieces of debris.

References:
https://www.nhm.ac.uk/discover/what-is-space-junk-and-why-is-it-a-problem.html
https://www.nasdaq.com/articles/cleaning-up-space-trash:-a-billion-dollar-opportunity
https://www.privatebanking.hsbc.com/individual-investors/frontiers-series/space-junk-is-a-huge-problem/
https://www.kavout.com/market-lens/the-rise-of-space-junk-cleanup-technologies-and-investment-opportunities

The process behind cleaning Space Debris:

The UN has asked that all companies remove their satellites from the Earth's orbit within the next 25 years. This includes removing dead satellites from orbit and dragging them back into the atmosphere where they burn up. This is done by methods such as using harpoons, catching it in a huge net, using magnets, as well as laser-based solutions, in which high powered lasers could be used to alter the orbit of debris larger than 10cm, by vaporising part of its surface. This method, known as "laser nudging ", is considered to be cost-effective, with a total cost of around $360 million–1.1 billion for all intact debris pieces and an annual operating cost of $15-50 million. In contrast, the cost of carrying out a single debris removal can range from $100-500 million, therefore showing how these investments can save satellite operators from incurring damages, lost operating time and replacement costs. This is only possible for larger satellites, however for smaller pieces of debris, we will just have to wait for it to re-enter the Earth's atmosphere naturally. Astroscale (a space sustainability company founded in Japan) is working on other debris capture methods, involving a spacecraft with a robotic arm grabbing one satellite, and moving it into a disposal orbit, which is then released to burn up in the Earth's atmosphere.

What is the main risk of space debris?

Collisions: in July 1996, for the first time a French Cerise satellite was sent tumbling towards the Earth after being struck by another piece of space debris. This was the first recorded incident of space debris colliding, and this certainly was not the last. From August 2018 to August 2023, there have been 18 separate incidents of space debris colliding and striking other satellites and rockets.

How does space debris offer investment opportunities for organisations?

Tackling space debris is becoming a bigger priority for governments; Japan, the UK and Europe are all funding missions to demonstrate "active debris removal" capability. Astroscale has also raised more than $380 million in funding for the space debris removal. According to a recent report, the "active debris removal" market will be worth more than $600 million–1.5 billion by 2030. This shows the increasing demand for space debris mitigation. Companies like Astroscale Holdings Inc., ClearSpace AS, D-Orbit SRL, and RemoveDebris Ltd are focusing on partnerships to strengthen their market position. The space debris removal market can allow investors to capitalise on advancements made in laser-based solutions, robotic systems, and de-orbit motors. These investments can save satellite operators from incurring damages, lost operating time and replacement costs.

Above our Carbon Footprint with Sodium Ion Batteries

References: https://www.thebatteryshow.asia/sodium-ion-battery-how-does-it-work-pros-cons-explained/
https://www.technologyreview.com/2026/01/12/1129991/sodium-ion-batteries-2026-breakthrough-technology/

In 2026, we're seeing the introduction of sodium ion batteries: a cheaper, safer, and more abundant alternative to lithium which is finally making its way into cars and the greater grid. Alternative more resilient batteries have been considered due to lithium's limited supply and volatile pricing. Luckily, we've found that sodium-ion battery work similarly to the lithium ones we have everywhere. The difference we've been searching for is it's frequency and general price, since lithium is a somewhat rare element that is currently mined in only a handful of countries. Sodium is cheap and found everywhere. While today's sodium-ion cells are not significantly cheaper, costs are predicted to drop as production scales upwards. The only downside is that a sodium ion cells' density is still too low than that of high-end lithium-ion ones, but it'll continue to improve each year since as you'll read it's already been approved and determined sufficient for small passenger cars and other simple motor-vehicles.

Sodium batteries work by releasing energy from transferring sodium ions between two electrodes during charging and discharging. These electrodes are the cathode being the positive terminal of the battery, and the anode being the negative terminal that receives sodium ions during charging and releases them back to the cathode during discharging. In this process, we also have electrolytes which is a liquid or gel that allows sodium ions to move between electrodes while blocking electrons, and a separator which is the barrier preventing the anode and cathode from touching while still allowing ions to pass through. To charge a sodium battery, the battery pushes sodium ions from the cathode to the anode using external energy. While you use this battery, the ions flow back to the cathode, producing an electric current.

The most powerful EV industry has been leading most of the early development, which is in China. Those invested heavily in the technology are specifically CATL and BYD. CATL, which had it's first sodium-ion battery prototype in 2021 have since launched Naxtra in 2025, being a proper production line. They claim to have already started manufacturing sodium ion batteries at scale. BYD also is building mass-production facility for the batteries soon in China. In 2024, JMEV began selling its EV3 vehicle with a sodium-ion battery pack also, being the first introduction into motor-vehicles. HiNa Battery is testing sodium-ion batteries in low-speed EVs too. In smaller electric vehicles, we're seeing in China the scooter maker Yadea launching four models of two-wheelers powered by the sodium ions. Cities including Shenzhen started considering swapping power stations for sodium ion batteries in order to support commuters and delivery drivers.

We're also anticipating seeing sodium-ion batteries in our power grids. Storing clean energy such as that from solar or wind has always had it's challenges with weather limitations. Sodium-ion batteries, with their expected low cost, enhanced thermal stability, and long life cycles, are the alternative. A startup in the US called Peak Energy has started to deploying grid-scale sodium-ion energy storage.

The new batteries are also being tested in smaller electric vehicles. In China, the scooter maker Yadea launched four models of two-wheelers powered by the technology in 2025, as cities including Shenzhen started piloting swapping stations for sodium-ion batteries to support commuters and delivery drivers.

Written By: Ellen

Acute Radiation Syndrome (ARS)

Written By: Aimée

Have you ever wondered what would happen to you if you were to be exposed to a massive amount of radiation?

A Brief History of Radiation Poisoning:

Radiation was only discovered in the late 19th century. Pioneers like Joeseph Meller, and Marie and Pierre Curie did extensive research on radiation and earned Nobel Prizes for their contributions. Marie Curie unfortunately died from radium poisoning that she amassed while doing her research.
When radiation was first discovered, its adverse effects were not known. They weren't really known until the end of the Second World War, after the Hiroshima bombing and the consequences it had on the residents of Hiroshima. In 1946, Radiation Poisoning was known as Atomic Bomb Disease.
Because of this lack of knowledge on the harmful effects of radiation, radioactive substances were prescribed like common prescription drugs are now. An example is the water tonic "energy drink" Radithor: a highly radioactive substance that was advertised as a miracle elixir with healing properties and prescribed for everyday use.

The Case of Ebenezer Byers:

Ebenezer Byers was an American golfer in the late 1920s. He suffered an injury to his arm and was prescribed Radithor as a treatment. He took at least three times the recommended dose incessantly for three years. As a result, his teeth fell out, he developed holes in his skull and brain, and his jaw had to be removed. He later died of radium poisoning.

What Can Cause ARS?

Acute Radiation Syndrome (ARS) is the proper name for radiation sickness, or radiation poisoning. ARS can be caused by high direct exposure or contamination to radioactive materials. High doses of ionising radiation (alpha and beta particles, gamma rays) turn atoms into ions (charged particles), which can damage DNA within cells, leading to mutations that can cause cancers and cell death (apoptosis). If exposed to a high enough dose, it can result in organ failure. Ionising radiation can also directly cause damage to membranes by ionising lipids in the phospholipid bilayer, meaning the membrane no longer functions correctly, increasing the permeability, or indirectly leading to free radicals, made by ionised water molecules.

The bone marrow is also extremely vulnerable to radiation. Since stem cells are made here, the resulting limitation of red and white blood cell production is very dangerous.
Symptoms of ARS
Main symptoms include vomiting (blood or vomit), weakness, fatigue, rectal bleeding, confusion, hair loss, erythema – redness of the skin that looks like sunburn, caused by capillary dilation and damaged skin cells.
Many of these symptoms include vomiting and diarrhoea. This is because the gastrointestinal tract is constantly regenerating itself with new cells. This means the cells are very vulnerable to DNA changes during mitosis, resulting in apoptosis, or "cell suicide", and damaging the tissue.

Illustrated by our Newsletter Team

Many firefighters present at the 1986 Chernobyl Nuclear Powerplant disaster reported a metallic taste and pins and needles like sensations. They were treated with skin grafts for burns, and bone marrow transplants, but most of these measures did not work because the firefighters were already too internally damaged for bone marrow transplants to help. They were isolated in the hospital because of their weakened immune systems, not because of risk of radiation exposure to others.

The three stages of Acute Radiation Syndrome are:

The Prodromal Stage. This can start immediately to two days after exposure. Symptoms include nausea, vomiting, diarrhoea, and fatigue.
Next is the Latent Asymptomatic Stage. As implied, there is a deceptive lack of symptoms, a phase during which the patient may feel better and even see some recovery to skin, though fatigue and nausea may persist. During this phase, the blood cell counts still drop, particularly lymphocytes, weakening the immune system, and there is severe bone marrow or gastrointestinal damage.
Finally, the Systemic, or Manifest Illness Phase. This could appear from a few days to weeks after initial exposure. Different syndromes can occur during this phase: Hematopoietic Syndrome, which affects the bone marrow – low white blood cell counts that lead to infections and haemorrhaging (rapid, uncontrolled blood loss from damaged blood vessels); Gastrointestinal Syndrome, which includes severe bloody diarrhoea, fever and abdominal pain, electrolyte imbalance and even sepsis; Cerebrovascular Syndrome, which manifests as convulsions and confusion. Any one of these syndromes can be fatal.

How Can We Treat ARS?

External decontamination of radiation involves cleaning the body, and changing out of contaminated clothes prevents other people being exposed.
Internal exposure can happen from inhaling alpha or beta particles, since they can’t penetrate the skin, or exposure to gamma rays in general. Internal exposure can be treated by special drugs, such as Prussian blue dye, which acts as an antidote for radioactive elements in the bowel, preventing the absorption of them and encouraging the ejection of radioactive elements in stable compounds. Prussian blue is quite effective at reducing the half-lives of radioactive elements at any stage during Acute Radiation Syndrome.
Diethylenetriaminepentaacetic acid can also be used to treat internal exposure, working similarly to Prussian blue by forming stable compounds with the radioactive metals, allowing them to be excreted safely. It is most effective when administered shortly after exposure.
Antibiotics are also given to help with treatment for burns, and possible infections since the immune system will be weakened because of a low lymphocyte count.

How Much is a Lethal Dose of Radiation?

We are often exposed to radiation, though very, very small amounts of it. Some everyday things are slightly radioactive, including travelling by plane, X-rays, and even some foods like bananas, shellfish and Brazil nuts.
At 5sv (sieverts: a unit used to measure the biological effect of ionising radiation on human tissue) and above, radiation is lethal and can leave severe enough skin damage to never recover. 5sv is equivalent to the radiation you receive from 156,250 flights to New York from London. 5sv is equivalent to 50,000 chest X-rays. So don’t worry; you won’t be getting a lethal dose of radiation any time soon.
The case of physicist Louis Slotin
In 1946, Slotin was exposed to a 21Sv dose (remember 5Sv is lethal) from a plutonium core (equivalent to the radiation of 210,000,000 bananas!). He vomited immediately and died after 9 days of awful symptoms. The incident was so intense that the lab itself became ionised, with a clear blue glow and a visible heat wave, which is the visible sign of the lab being ionised.

Venus is Backwards? Beyond our Understanding (for now)

In our solar system, everything orbits the sun in the same direction, as well as separately spinning the same direction too. So why is Venus the only planet spinning the other way? Our planets in the Solar System came about from a collapsing cloud of gas called the Solar Nebula, at least we think. Eventually the nebula flattened into a protoplanetary disc of cosmic material which spins, forming our planets. But that makes it extra confusing why Venus has decided to spin the other way. We should be finding that the angular momentum causes the planets to spin in the same direction with this understanding. So what if Venus was struck by a giant asteroid?

Venus, the second planet from the Sun and Earth's closest planetary neighbour, is the third brightest object in the sky (under the Sun and Moon). It is of a similar structure and size to Earth, and some people like to call it Earth's "evil twin". It has a heavy and thick atmosphere that traps heat, similar to the greenhouse effect but of a greater scale, making it hotter than Mercury, which sits next to the Sun. Definitely not somewhere to visit: Venus' surface temperature could melt lead in an instant, along with the dense clouds and abundance of deformed mountains/volcanoes.

Our Solar System is extremely cluttered with high-speed objects and material, including that of comets and asteroids which are known for crossing, and occasionally colliding with planets. Large asteroids have hit Earth before, such as with the dinosaurs, and we think asteroids is how our Moon formed too. Therefore plausibly Venus could have collided with another celestial object similar in size so the consequence is spinning backward. If this collision also altered orbit, the presence of the Sun, Mercury and Earth would have pulled its orbit back to its original position, and the only remaining effect would be on the direction it spins about its own axis. Collisions like these also could explain why Uranus spins on its side.

The only problem is that Venus has no rings or moons. These would've helped to prove Venus was struck by something as big as it, especially since we'd expect the mass it collided with to be obliterated, not just randomly floating around somewhere else. We do have a quasi-satellite named Zoozve, which was discovered back in 2002 by Brian Skiff at Lowell Observatory Near-Earth-Object Search (LONEOS) in Flagstaff, Arizona. This project was funded by NASA until early 2008. Quasi-satellites or also called quasi-moons, are asteroids that orbit the Sun but stay close to a specific planet. Their orbit is usually oblong and very unstable than a planet's orbit. What's more over time their shapes adapt and change, as well as their orbit, sometimes moving away from their assigned planet. Could this be the clue we need?

Unfortunately, there's no way of saying just yet, but whatever caused Venus to spin backwards was very important in creating the Venus we know today: its rotation is ridiculously slow, with a Venusian day lasting close to 243 Earth days, which is somehow longer than a Venusian year of 225 Earth days - how fun!

Drawn by our Newslettter Team

https://science.nasa.gov/venus/venus-facts/
https://www.skyatnightmagazine.com/space-science/venus-spins-backwards

Written By: Ellen

How could quantum computers solve problems that classical computers cannot?

Some problems in science and technology are so complex that even our most powerful computers struggle to solve them. This is because even classical supercomputers can take extremely long times to process certain calculations. Therefore, scientists have been developing a new type of computer based on the unusual laws of quantum physics. These quantum computers have the capacity to potentially solve problems that in comparison would take a classical supercomputer thousands or millions of years. This article will explore how quantum computers can solve problems that classical computers cannot.

Classical computers store and process information using bits. A bit is the smallest piece of information a computer can store, and it can only be one of two options: 0 or 1. Computers operate using what is called binary logic, which is essentially long sequences of these two numbers. In order to solve problems, computers must test many different combinations of these bits. However, some problems require an enormous number of possible combinations, which results in very long processing times. Factoring extremely large numbers (e.g., breaking the huge numbers used in internet encryption to check security), modelling complex molecules (e.g., simulating how new medicines interact with proteins in the human body), or solving complex optimisation problems (e.g., finding the fastest delivery routes for thousands of parcels) can take classical computers an extremely long time to calculate.

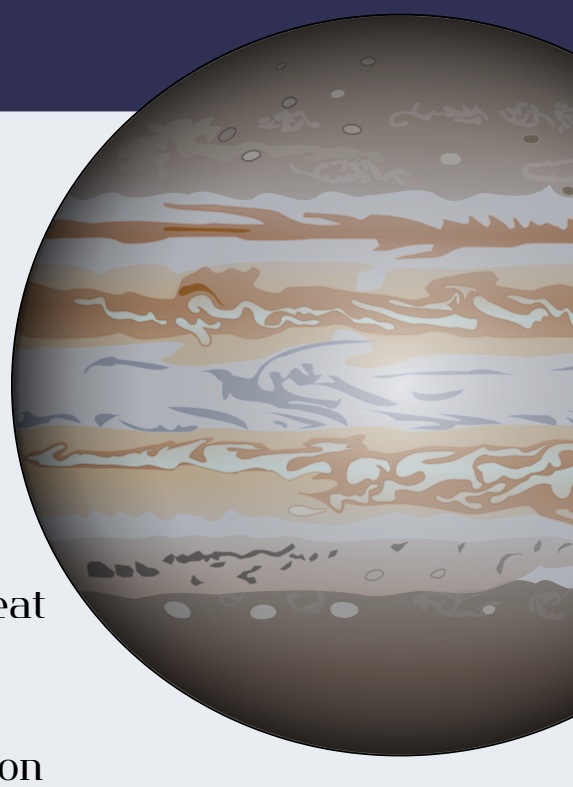
However, quantum computers work differently from classical computers because they use qubits instead of bits. A qubit (a quantum bit) is based on a quantum particle. Unlike bits, qubits can exist in multiple states at the same time (they can be 0, 1, or a combination of both) – this phenomenon is known as superposition and allows quantum computers to explore many possibilities at once. One way to imagine this is a spinning coin that is both heads and tails while it is spinning, only becoming one or the other when it lands.

Another critical property of quantum physics is entanglement. This occurs when qubits become linked together, and the state of one qubit can affect another, even when separated. When many entangled qubits work together, the number of possible combinations grows exponentially.

This means quantum computers could potentially process far more information at once than classical computers for certain tasks.

Because of their unique properties, quantum computers have the potential to help solve essential real-world problems. For example, they could assist scientists discovering new medicines by accurately modelling molecules, improving climate models, strengthening cryptography, and advance artificial intelligence. They may also be able to simulate atoms and chemical reactions far more effectively than classical computers. Experimental quantum computers already exist, with some containing hundreds of qubits, although they are still limited in what they can currently do. Solving these problems could lead to major technological and scientific breakthroughs.

Although quantum computers are promising, they are still in the early stages of development. Qubits are very fragile and difficult to control, and scientists are continuing to develop more stable systems. If these challenges can be overcome, quantum computers may eventually solve problems once thought impossible. The strange laws of quantum mechanics may therefore play an important role in shaping the future of computing.



From Earth to Jupiter: Understanding the Great Red Spot Through Hurricanes

This article explores how hurricanes on Earth can help us understand Jupiter's Great Red Spot (GRS)—a massive, long-lasting storm—and how it may have formed and persisted for so long. To understand the origin of Jupiter's Great Red Spot (GRS), it helps to first examine how tropical storms—such as hurricanes and cyclones—form on Earth. Although the two storms occur on hugely different planets, they are shaped by similar atmospheric forces.

How Tropical Storms Form on Earth:

On Earth the temperature for a storm to form needs to be over 26.5°C. These hurricanes are commonly formed around the Equator, but not on it. This is because Earth's rotation causes the Coriolis effect, which influences the movement of storms. If these tropical storms tried to form on the Equator, the Coriolis would not be enough to form. However, if they are between 5° - 10° latitude it is perfect because the temperature of the sea is high enough and the latitude is big enough for the Coriolis effect to work. They begin at an area of low pressure, this means that the air is rising, cooling and the condensing to form large cumulonimbus clouds. As increasing amount of air rises and condenses, the clouds get thicker and lower in the sky and a tropical storm will begin to develop. The air is moving from high to low pressure which generates winds called the trade winds, these converge and meet which causes the storm to spin. The tropical storm travels across the oceans in the direction of the prevailing wind and only slows down once it reaches land, as the oceans are what fuels tropical storms.

Jupiter's Atmosphere and Its Effect on Storms:

Now that we understand how tropical storms form on Earth, we can look at how similar processes shape Jupiter's Great Red Spot. When tropical storms form, or an anticyclonic storm in Jupiter's case, they form in the same way. But there are some differences. For example, tropical storms are only temporary and low pressure on Earth whereas Jupiter's GRS is a permanent, high-pressure anticyclone. Jupiter gets its' temperature from the thick atmosphere, due to all the hydrogen and helium in it, which traps heat. The Coriolis effect which happens on Earth, is the same on Jupiter but only with much more force. Jupiter has a fast rotation, with a day being only 9.9 hours (the shortest in the solar system)! Making it the perfect conditions for forming an anticyclonic storm. This can also be seen in Jupiter's size and atmospheric depth. Because Jupiter is a gas giant with no solid surface, it means there is nothing stopping the cyclone, apart from the planet running out energy, which is very unlikely.

The Great Red Spot Today:

However, the Great Red Spot has been shrinking in size, meaning it could be ending. Jupiter's GRS was once the size of more than three Earths and can now only fit in one. The first sighting of the Great Red Spot was in 1831, but researchers aren't sure they were looking at the same storm. A continual record of the planet has been kept since the 1878, where they look at Jupiter through an eyepiece scored with crosshairs and it has shown it shrinking since then apart from a small growth in the 1920s. This could pose a threat to The Great Red Spot's existence. Nevertheless, scientist think that the Red Spot has increased in height, meaning it could just be the GRS undergoing structural changes. This means that scientists think the GRS on Jupiter will continue for many years to come.

Written By: Rebekah

How can chromatography be used to solve murders?

Who knew that chemistry is an essential part in solving a crime? Chromatography a powerful forensic tool has helped solve many murders by identifying unknown substances, linking suspects to crime scenes and analysing trace evidence such as drugs, toxins and inks. This simple technique that we learn in GCSE plays a significant role in solving crimes which is why I was passionate to write about this.

What is Chromatography?

Chromatography is a laboratory technique used to separate complex mixtures into their individual components. It works by passing a mixture (dissolved in a 'mobile phase') through a material (the 'stationary phase'), causing different compounds to move at different speeds depending on their solubility, which leads to their separation. Chromatography relies on two distinct phases that I have mentioned before: stationary phase and mobile phase. The stationary phase is where the solid or liquid-supported solid that stays fixed and the mobile phase is a liquid or gas that moves through the stationary phase, carrying the sample mixture with it. The separation occurs because components of the mixture have different affinities for the stationary vs mobile phase.

You may think that is it to chromatography, but you are mistaken – there are many diverse types of chromatography and some that are used in forensics are paper chromatography, gas chromatography and high-performance liquid chromatography. Paper chromatography is the technique that most people learn in school which is chromatography done to separate pigments (e.g. separating ink colours on filter paper). Gas chromatography is where you use an inert gas as the mobile phase to separate volatile substances and this is extensively used in forensics and environmental testing. High- performance liquid chromatography is when you use high pressure to force solvents through a packed column, offering high resolution and speed.

How is chromatography used in forensics?

Chromatography as we know plays an important role in solving crimes and some of the ways it can help is by identifying unknown substances – this is like detecting drugs, poisons or toxins in blood, urine and tissue samples (e.g. identifying cyanide or illegal drugs in a victim's body). Another way, it aids a murder mystery is by comparing samples – this is things such as comparing substances from a crime scene to a substance from the suspect (e.g finding matching paints, inks or fibres in the crime scene and on the suspect). Furthermore, chromatography helps with analysing trace evidence – this is by analysing very small samples collected from the crime scene like explosive residue, fire accelerants (arson cases linked to murder) etc.

Hypothetical case

To further understand how chromatography helps so much in solving crimes, I want to take you through a hypothetical scenario. It starts off with a victim being poisoned. To find out what has caused the death of the victim, investigators use gas chromatography to analyse blood samples. A specific toxin is then found. This specific toxin is then found in the suspect's possession. This shows that chromatography provides objective scientific evidence and this is essential nowadays, especially in court where this can be used as valid evidence for the justice of the victim.

Advantages and limitations of chromatography

As we know, chromatography has so many advantages to it, some being the fact that it is extremely sensitive and accurate, it works with tiny samples, and it can identify complex mixtures. However, some limitations can be the fact that it requires expensive equipment for gas chromatography and high- performance liquid chromatography, it requires skilled technicians and there is a risk of contamination if not handled properly. But I do think that chromatography is one of the most effective techniques used in forensic methods even with its many limitations.

In conclusion, chromatography separates and identifies substances, it helps detect poisons, drugs and trace materials which provides strong forensic evidence. This is why we know that it is an essential tool in modern murder investigations and through scientific breakthroughs , I hope that advances in chromatography continue to improve the accuracy and efficiency of solving crimes for the people who deserve justice.

Drawn by our Newslettter Team

Written By Anandiya

Reference:
Coskun O. Separation techniques: Chromatography. North Clin Istanb. 2016;3(2):156-160.

Physics

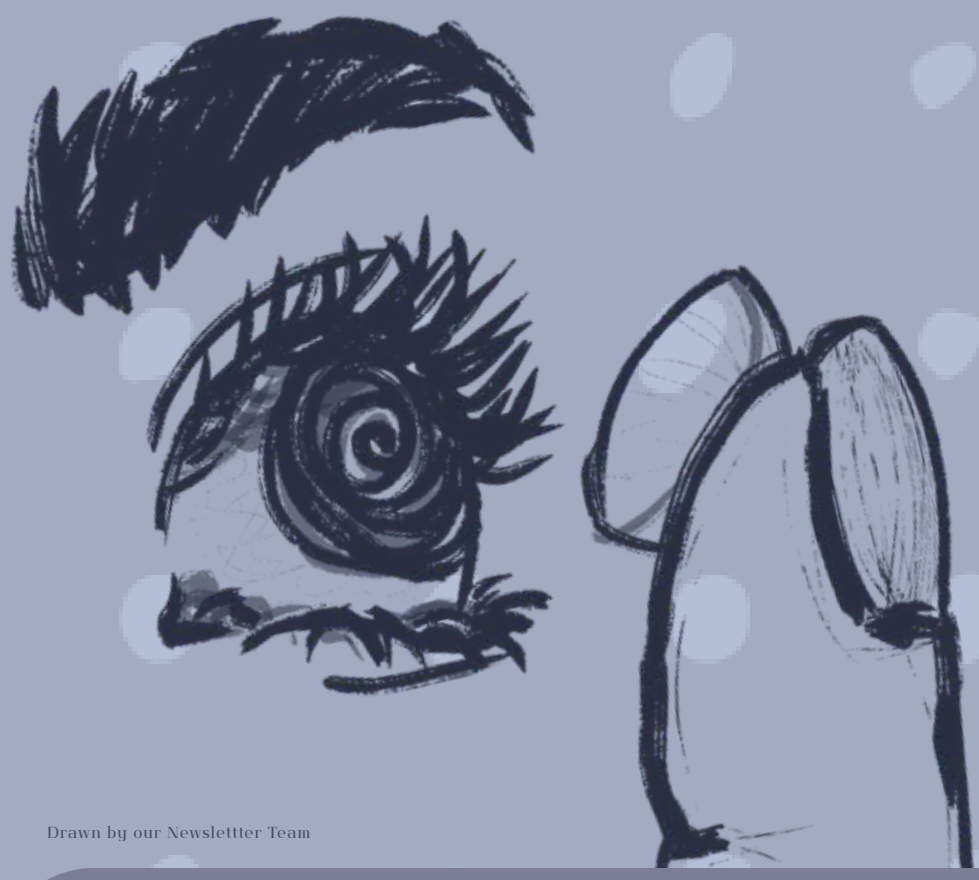
Beyond the range of Human Sight: Night-Vision Contact Lenses

Written By: Ellen

Recently we have created contact lenses that give people super-vision, allowing them to see beyond visible light as well as picking up flickers of infrared even in the dark. Potentially they will be replacing night-vision goggles, since they don't require a power source. Goggles like these are notably used in the military: introducing contacts changes modern warfare and defence immensely. But these are just ideas and rumours, what is actually happening, and how do they work?

Created and developed in China, infrared light can be seen through these lenses, which is beyond the range of what we can see. This infrared technology is already around, like night-vision goggles, however they're big, clunky, and require a power source. To have something as small as a contact lens which doesn't need charging and be able to visualise infrared is an amazing discovery! A scientist at the University of Science and Technology of China, Prof Tian Xue, is optimistic for a range of contact lenses that give people this sort-of "super-vision", along with the benefits of helping people with colour blindness and other optical conditions optical conditions. This involves an understanding of electromagnetic waves, and why humans can't naturally see infrared light.

In order to simulate this at such a small scale, nanoparticles are used in our contact lenses. These nanoparticles are tiny microscopic structures that are made up of several hundred atoms. They absorb and change near infrared light into blue, green and red light, which is visible to the human eye since it can then correlate with the cones we have. People have said they could see signals flashed from an infrared light, and could tell what direction the light came from during testing. What's more, their infrared vision seemed to improve when they closed their eyes, possibly because our eyelids are designed to block visible light, not infrared, so there'd be less visible light to interfere.



Drawn by our Newslettter Team

The seven types of electromagnetic (EM) waves are made of light and radiation, making up what we call the electromagnetic spectrum. There are lots of types like radio waves, ultraviolet light and infrared light, but we can only see 'visible light', which makes up our colour spectrum. It's why the discoveries of other colours, or people with a larger colour range is so interesting: it suggests that we can see beyond this range. Over time, scientists have developed technology like sonar in order to 'see' sound, and different types of night-vision cameras, such as the ones showing infrared light using temperature.

Despite all of the research and experiments so far and our strong understanding of EM waves, right now the lenses are not sufficient to see low levels of infrared light since they're not sensitive enough yet, so they only demonstrate partial thermal vision, and won't be a replacement for goggles and glasses anytime soon. But, we hope that future work can help to improve them, especially when we've started off super strong.

References:
https://www.bbc.co.uk/newsround/articles/c0mrjmejkdmo%20,%20
https:/theweek.com/health-and-science/1019386/recent-scientific-breakthroughs

Spacious Molecular Structures:

Written By: Rebecca

The unyielding increase in global greenhouse gas emissions is an increasing cause of concern and it is becoming ever more pertinent for an effective antidote to be designed. The recent 2025 chemistry Nobel Prize winning discovery may offer a solution in the form of Metal-Organic Frameworks. Their unique crystalline structures offer themselves to a wide range of applications which may hold the solutions to some of humanities largest problems.

A metal-organic framework are metals that are connected by organic molecules, due to this structure there are large areas of empty space, pores. The metal ions (either individual ions or groups of atoms) form the nodes of the structure, these are connected using "organic linkers" known as MOF ligands. Through experimentation with the different potential structures of MOF, one of the three Nobel Prize winning scientists: Robson designed a framework which was formed of nitriles as the organic molecule connections and copper ions, the final crystal that he produced is reminiscent of the structure of diamond due to its pyramidal shape which inspired his work. Despite his research demonstrating that these structures could be used to capture and exchange certain chemicals, his MOF structures were susceptible to collapsing. Succeeding the research of Robson, Kitagawa (also a laureate) continued researching MOF structures and developed a 3D MOF that could be used to exchange methane, oxygen and nitrogen. Through his work, Kitagawa also hypothesised that these structures could be made flexible. This holds importance because it introduces the possibility for the alterations in the size of the cavities. Around this period of time the third Nobel prize winning scientist Yaghi developed a stable MOF, a two dimensional framework using copper and cobalt which worked as a net and could absorb molecules. Further work carried out by Kitagawa and Yaghi showed the creation of different flexible MOFs and showed that the shape of the structure could be altered by filling them with certain substances and could return to their original structure when emptied.

The work of these three scientists built a foundation for the development of a myriad more MOFs with a wide range of applications. The flexibility of MOFs offer a particularly unique avenue of applications previously difficult to explore. By exploiting the flexibility of MOFs it is possible to manipulate the proportions of different gases captured/ absorbed by these structures. This was explored in a study carried out by professors at the University of Sheffield.

During this study, a particular MOF structure was experimented with and could form wider pores through the removal of chloroform. This meant that the structure favoured the absorption of CO2 over CH4. The characteristics of these MOFs could potentially be used for drug delivery, carbon capture, water purification.

Drug Delivery:

The Pores of certain MOFS have the ability to hold (encapsulate) drugs and then deliver the dose in a controlled fashion, thus introducing the possibility for MOFs to be used as smart nano-carriers. This would allow for the administering of drugs to precise locations within the body as stimuli specific to the target location would trigger the release of the drug from the pores. By increasing the control over the rate and location that a drug is delivered at, it is possible to further minimise the adverse effects from certain drugs.

Water Purification:

Structurally, MOFs are optimal for use as absorbents due to their high surface area to volume ratio, high porosity and pore tunability. Specifically, these characteristics can be exploited for the removal of impurities in water including: dyes, metals, organic compounds etc. Furthermore, many MOFs that can be used as absorbents are easily able to be regenerated and reused therefore not being a highly wasteful form of pollutant absorber.

Carbon Capture:

With carbon dioxide emissions increasing and global warming remaining as prevalent an issue as ever, the need for technology to decrease the CO_2 entering our atmosphere (known as point source capture) as well as removing CO_2 from the atmosphere (direct air capture) is extremely high. Similarly to the characteristics of MOfs which make them ideal for water purification ,the MOF structure also makes them an ideal new option for Carbon capture.

Meghan Rosen, Chemistry that works like Hermione's magic handbag wins a 2025 chemistry Nobel, *Science News*, 2025

Tanner Gerschick, unlocking the potential of metal-organic frameworks (MOFs): from cutting-edge science to real-world applications; *The Calculated Chemist*, 2025

Julia Rock-Torcivia, Chemistry Nobel goes to 'molecular architecture' with spaces big enough to trap gases, *RD world*, 2025

Doaa S R Khafaga, Manar T El-Morsy, Habiba Faried, Ayah H Diab, Shaimaa Shehab, Ahmed M Saleh , Gomaa A M Ali, Metal-organic frameworks in drug delivery: engineering versatile platforms for therapeutic applications: PubMed Central, *National Library of Medicine*, 2024

Ihsanullah Ihsanullah, Applications of MOFs as adsorbents in water purification: Progress, challenges and outlook, Current Opinion in Environmental Science & Health: *Science Direct*, vol. 26, 2022

Shreya Mahajan, Manu Lahtinen, Recent progress in metal-organic frameworks (MOFs) for CO_2 capture at different pressures, Journal of Environmental Chemical Engineering: *Science Direct*, vol. 10, 2022

Plastics From Potato Starch

Science behind making plastic from potato starch:

Plastics can be made from potato starch into bioplastics. This works by heating water, vinegar and glycerine to make a biodegradable polymer.

Process:

Starch is made of two natural components: Amylose and Amylopectin. To make it flexible enough to be plastic, we have to change its structure through two main processes:
•Gelatinisation: by heating the starch in water, the tiny starch granules soak up the liquid, swell, and turn into a thick paste.
•Destructurisation: this breaks down the starch's rigid, crystalline structure, transforming the tough starch into Thermoplastic Starch (TPS)—a material that is flexible and durable.

Equipment:

- Water
- Potato starch
- Vegetable glycerine
- Vinegar
- Teaspoon
- Tablespoon
- Bowl
- Spatula
- Pan
- Food colouring (optional)
- Stove food
- Greaseproof paper
- Foil

Biodegradability:

Starch-based plastics are designed to break down. When starch is hydrolysed, it breaks into smaller chains called dextrin. These are hydrophilic so invite microbial consumption. When microorganisms consume the material, it destroys its structural integrity allowing it to naturally decompose.

Industrial Use:

Thermoplastic starch are used to make eco-friendly plastics, such as packaging and bags, by shaping them using industrial machinery.

Method:

1.Take 1 level tablespoon of potato starch
2.Add 7 tablespoon of water and mix in a bowl
3.Add 2 teaspoons of vinegar
4.Add 2 teaspoons of glycerine (and 2 optional 2 drops of food colouring), then mix
5.Pour in a pan on a medium-high heat with continuous stirring
6.Stir with a plastic spatula until the mixture thickens (2-5 minutes)
7.When jelly-like, pour onto greaseproof paper with foil underneath
8.Flatten with a spatula to roughly 8 inches in diameter, trying to get the same thickness all over

Written By: Simran

Making plastic from milk

Written By: Anandiya

Introduction:

Plastics and proteins are made from polymers which are very long chains of carbon atoms joined together. Casein is a type of protein found in milk and can be used to make plastic buttons. In this experiment, we will be extracting casein from milk and using it to make our own plastic.

How to make plastic from the milk:

Heat milk and add vinegar to create curds. Let the mixture cool, then strain it through cloth to separate the solid curds from liquid. Squeeze out excess moisture, shape the curds into a flat piece, and dry it in an oven for a few days until it becomes a brittle plastic-like material.

Common Uses for Milk Plastic:

Historically and in modern niche markets, milk plastic is used for items that require a high-quality, polished finish:
•Fashion Accessories: High-end buttons, belt buckles, and decorative knitting needles.
•Jewellry: Imitation ivory or tortoiseshell beads, brooches, and hair combs.
•Stationery: Fountain pen barrels and luxury letter openers.
•Household Goods: Knife handles and small ornamental boxes.

Component	Role
Casein	The primary protein in milk that acts as the "monomer" or building block.
Acetic Acid	The active ingredient in vinegar that triggers the structural change.
Heat	Increases the kinetic energy, speeding up the separation of solids from the whey.

Other proteins that make plastics :

Gelatin: Derived from collagen (animal bones, skins, and waste), it can form biodegradable films, though it is usually water-soluble unless cross-linked. Keratin (Feather/Hair Protein): Chicken feathers and wool contain high amounts of keratin, which can be denatured to create strong, water-resistant bioplastics, often for plant containers. Wheat Gluten: Extracted as a by-product in the bio-ethanol industry, wheat gluten is highly promising for forming biodegradable polymer films.
Zein (Corn Protein): Derived from maize, this prolamin is used in specialised plastics, particularly for edible coatings, medical applications, and horticultural items.
Pea Protein: An abundant and sustainable plant source used to create biodegradable films and moulded products.
Rapeseed/Canola Protein: A byproduct of oil extraction, this is being researched for creating biodegradable films, often blended with other polymers to improve properties.

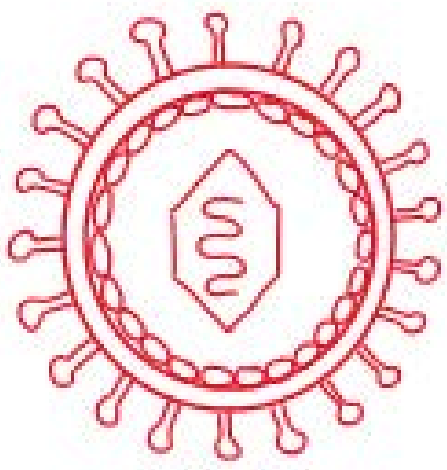
Why do people make plastic out of milk ?

In the early 20th century, before petroleum-based plastics became the industry standard, galalith (milk stone) was a popular choice because it is biodegradable, odourless, and non-flammable. Unlike modern plastics that can leach chemicals or pose fire risks, milk plastic is made by isolating casein—the protein in milk—and hardening it with a chemical like formaldehyde. This process created a durable, bone-like material that was relatively easy to produce without the complex machinery required for fossil-fuel polymers. Today, it is making a small comeback among hobbyists and eco-conscious creators because it is a renewable resource that can be made right in a home kitchen.

The Science behind turning milk to plastic:

Turning milk into plastic - often called casein plastic - is a classic example of a polymerisation reaction fueled by a simple acid-base interaction. Milk contains a specific family of proteins called casein, which normally exist as folded, suspended molecules (micelles) that repel one another, keeping the milk liquid. When you add an acid like vinegar (acetic acid) to warm milk, it changes the pH of the solution. This acidity neutralises the negative charges that usually keep the casein molecules apart, causing them to unfold and reorganise into long, interconnected chains.

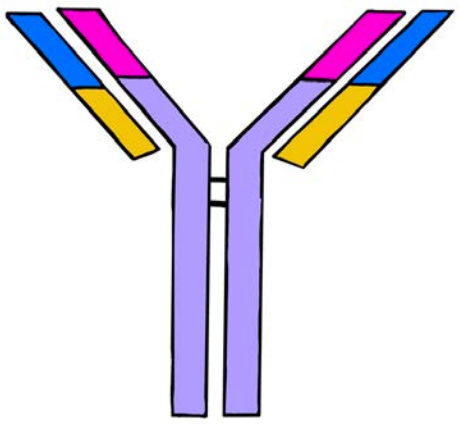
Could we make a universal antibody to fight any disease or virus in the future?



Throughout our years of living, we have encountered diseases and deadly viruses - so many medications and treatments have been made but even these are not 100% effective due to viruses and pathogens mutating all the time. That is when I thought, could we make a universal antibody that can fight any disease or virus we have? One would say that this would never be possible, but through my research I thought of a hypothetical way that this could be achieved – antibodies. Antibodies are a key aspect of medicine and have been used to cure deadly viruses like COVID-19, Ebola virus, Rabies, Hepatitis B and many more. They are so effective as they can be pre-made and can work immediately so in a crisis, they would be very ideal.

What are antibodies?

Antibodies are proteins which have a specific binding site that is complementary to an antigen. They are made by B-cells and secreted by plasma cells. They are Y-shaped proteins made of 4 poly-peptide chains. The central, longer pair of chains are called the heavy chains, and the outer, shorter pair of chains are called the light chains. The chains are held together by disulphide bridges to form the quaternary structure of the protein. The most important parts of the antibodies are the ends of the arms which are the antigen binding site. The shape of the antigen binding site is different in every antibody making it very specific- this is known as the antibody's variable region. The rest of the antibody has a standard structure which is known as the constant region.



Illustrated by our Newsletter Team

The concept of a universal antibody

For the concept of a universal antibody, we want to make an antibody that cures as many diseases as possible: cancers, auto-immune diseases, viruses and infections- this could either be in the form of a universal vaccine or in the form of Broad neutralising antibodies (unlike regular antibodies that only target a specific strain, broadly neutralising antibodies can adapt and defend against many variations of a virus). To make a universal antibody, we need to make something like the Broad neutralising antibodies because it is better to have an immediate response rather than an immune response made by the body through vaccination which takes longer due to the time lag from clonal selection and expansion. For this to happen, we need to isolate one clone of B-cells to produce just one, pure type of antibody which are known as monoclonal antibodies. For these monoclonal antibodies to work they need specific receptors which allow it to attach to a specific cell – these could either attack in the 'direct monoclonal antibody therapy' way where the antibody itself will kill or signal the T-cytotoxic cells to kill the cell. In addition, there is 'indirect monoclonal antibody therapy' where a drug can be attached to the other end of the antibody so that when the antibody binds to a cell the drug affects only that cell and not all the neighbouring tissues. I think the concept of a universal antibody would only work if we made an antibody that changes its antigen binding site to be specific to any pathogen's antigen by genetically mutating the protein structure. This could only really work if it attacked in the 'direct monoclonal antibody therapy' way, as attaching drugs to the antibody may not destroy the specific cell and we would need to produce more drugs and there is more cost to that. By the antibodies binding site genetically mutating instantly when in contact to any pathogen's antigen, it would create an ultimate universal antibody that would kill any foreign cell.

Limitation to antibodies

Some limitations to antibodies do mean that this ideal universal antibody would not work due to issues like mutations and evolutions and viruses. Viruses like the cold or the flu show great antigenic variability- this is when the antigen structure is changed by mutation of the gene which codes for the antigen protein so therefore their antigen structure changes shape. However, with our idea of a universal antibody, the antibody supposedly mutates its antigen binding site so this problem would be solved. Another prominent problem would be the diversity of pathogens. This is a major problem as the universal antibody should be universal but there is such a broad range of pathogens that the different types of mutations to change into a specific antigen binding site can be limited. It would only work on viruses and infections, various forms of cancer, autoimmune disease, neurological and cardiovascular and osteoporosis and organ transplant rejection. Another major problem could be the side effects. Monoclonal antibodies can have serious, unwanted side effects such as fevers, chills, weakness, headache, nausea, diarrhoea, low blood pressure and rashes. Therefore, I think we should do only give people small doses of the antibodies the first time, to see make sure no allergic reaction has happened, then give a larger second dose.

Current research

As technology and science develops, our research for treatments and cures have increased. An example of this are 'Broad neutralising antibodies' or 'bNAbs', which are antibodies that can adapt and defend against many variations of a virus. BNAbs also activate other immune cells to help destroy the infected cells. However, these only target HIV-1 but is still considered a major breakthrough in HIV-1 treatment, prevention and cure research. In Genetic engineering, scientists have created 'Bispecific antibodies' which are antibodies that can bind to two different targets at the same time – such as one arm binding to a tumour cell and the other to a T-cell, forcing the immune system to destroy the cancer. This does not really align with the concept of a universal antibody, but it shows progress where the antibodies are binding to two different sites at the same time which is a major development.

Ethical, economic and global considerations

Making antibodies, especially ones that can mutate to destroy infected cells, is very expensive due to the extreme complexity of their discovery, development and manufacturing which often requires specialised, high volume production technologies. Moreover, if they are effective, they would be manufactured more and they need to be quality controlled to ensure the safety and purity of the antibody. To keep the workplace sterile and contamination- free there would be an added expense to the production of antibodies. Another factor that is important to consider is the accessibility of the antibody – these antibodies should be accessible to everyone but due to hierarchy most things that are of high value are consumed and none are left for the poor. That is why there should be a limited number of antibodies and priority must be given to the people who need it the most for this to be fair. Another problem of producing these antibodies that we need to consider is the risk of over reliance. Once everyone starts getting their hands on these magical antibodies, it is a risk for the world to be over dependent, as pathogens can mutate to become better than these antibodies, which could result in a fatal disease out-break with a pathogen that cannot be cured with the universal antibodies. Furthermore, there would be inequality in countries due to more privileged countries getting more supply of the universal antibodies and less privileged countries get less supply of the universal antibody, so there is an unfair distribution of the universal antibodies that creates hierarchies between countries and doesn't allow less developed countries to develop.There are ethical issues regarding religious and moral beliefs as the first step to making most antibodies is to inject a mouse with an antigen, then after it has produced antibodies, a small operation removes spleen cells which then continue to make antibodies. Some people disagree to the use of animals in the production of monoclonal antibodies which is also another problem opposing the development of the universal antibody.

Is it realistic?

Recent advancements in genetic engineering, AI- driven structural biology and the discovery of broad-spectrum antibodies has given hope for scientists that it may be possible to make a universal antibody. AI and computational designs have helped designing things like 'headless' vaccines or antibodies that focus on the immune response specifically on these conserved regions rather than highly variable surface proteins, so there is some scientific and technological evidence that a universal antibody is possible but challenging to achieve. However, with significant breakthroughs like BnAb and AI, I think universal antibodies will be accessible to us one day.

Conclusion:

I think these universal antibodies would be a great breakthrough for our world especially in the time where viruses are rapidly increasing and death by disease spirals day by day. We might have never had hope of making these universal antibodies before, however broad neutralising antibodies and genetic engineering have proved otherwise. This universal antibody would be so beneficial for countries that are less privileged to buy medication, and I strongly believe that these universal antibodies should be distributed to everyone equally, as this is a continuous problem globally today. No one should be in control of these antibodies as they should be made and given to everyone, and they should be used in a morally right way.

References:

➢ National Cancer Institute (U.S.). Monoclonal Antibodies (https://www.cancer.gov/aboutcancer/treatment/types/immunotherapy/monoclonal-antibodies). Posted 9/24/2025. Accessed 3/10/2026

➢ Thavarajah JJ, Hønge BL, Wejse CM. The Use of Broadly Neutralizing Antibodies (bNAbs) in HIV-1 Treatment and Prevention. Viruses. 2024;16(6):911. https://doi.org/10.3390/v16060911. [Accessed 20 February 2026].

➢ Malik B, Ghatol A. Understanding how monoclonal antibodies work. Updated June 26, 2023. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing. Accessed from https://www.ncbi.nlm.nih.gov/books/NBK572118/ on 14 March, 2026.

Written By: Anandiya

Beyond What's Real

What are imaginary numbers:

When faced with the even root of a negative number (for example $x^2 = -9$) your first thought may be the taught approach: to couple ignoring those solutions with a small written note stating "no real solutions". However, this glosses over the fascinating mathematical area of Imaginary numbers.
Fisrtly, to lay an initial foundation for the exploration of imaginary numbers the basic notation will be required:
$\mathbf{i}^2 = -1$
Therefore, **i** denotes the square root of negative one.
Whilst imaginary numbers, as the name suggests, seem intangible, they aren't far removed from negative numbers. Like negatives, imaginary numbers aren't values that can physically be possessed or observed. Instead they can be used to represent and describe different situations.

What is a complex number?

Complex numbers are often denoted using the letter **z**, and they are defined as a combination of a real number and an imaginary number, for example: $1 + \mathbf{i}$.

Along side being mathematically fascinating numbers, complex and imaginary numbers can be used to produce some beautifully intricate patterns. For example the Mandelbrot set.

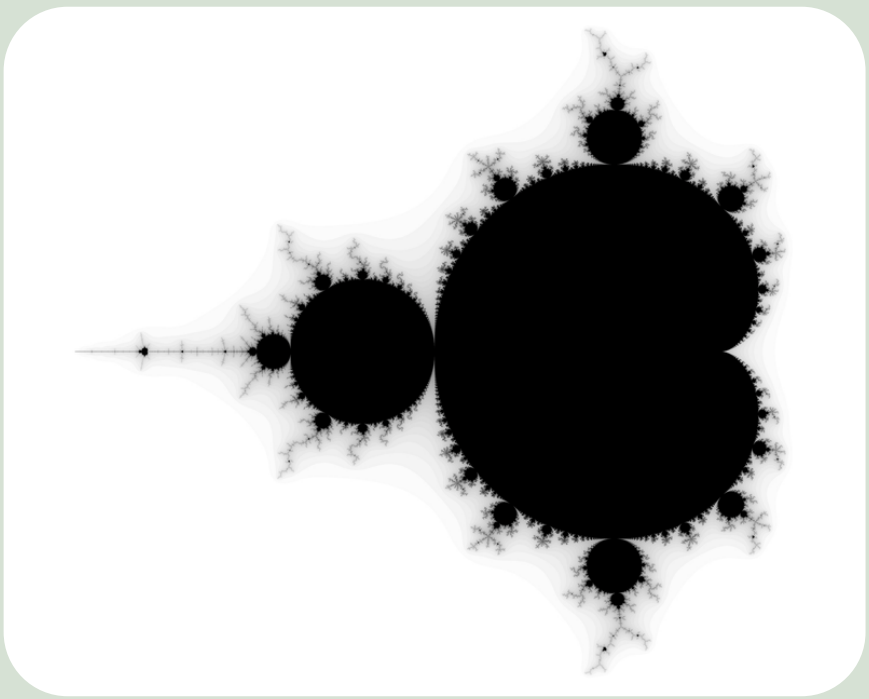
Mandelbrot set:

Benoît Mandelbrot known as the "father of fractals" coined the term for and developed the area of mathematics known as fractal geometry. This subset of geometry explores uneven and irregular shapes often found within nature. Fractals are examples of geometric repetition as within their contours the same shapes are repeated thus forming a deeply complex pattern.

One of the most famous and conceptually simplistic complex number fractals is The Mandelbrot (named after Benoît Mandelbrot), it is a pictorial representation of the series:

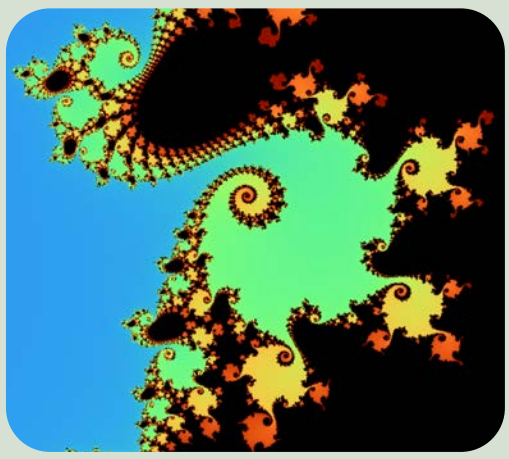
$$z_{n+1} = z_n^2 + z_0$$

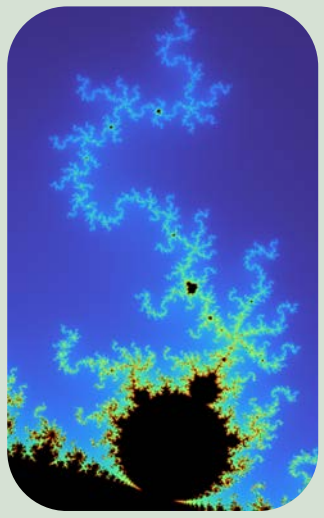
As stated previously, the **z** represents a complex number. The image generated by this series depicts the following: every point on a complex plane (a 2D geometric representation of complex numbers where real numbers lie along the horizontal axis and imaginary numbers lie along the vertical axis) is set to the first term of the series (z_0). Depending on whether the series diverges or converges, the colour of that specific point is determined i.e. white if it diverges (or a specific colour of an intensity linked to how fast it escapes to infinity) and black if it converges. The values that don't go to infinity are said to lie within the Mandelbrot set, whilst the values that do escape to infinity lie outside of the Mandelbrot set.
Typically, the Mandelbrot set is generated through the use of an escape time algorithm, allowing for a range of different colour values to be used to represent the speed at which that series escapes to infinity.



Picture from: https://paulbourke.net/fractals/mandelbrot/

Screen shots taken from: https://mandelbrot.site/





Sources:

https://complex-analysis.com/content/mandelbrot_set.htmlPaul%20Bourke,%20The%20Mandelbrot%20at%20a%20glance,%202002https:/www.ibm.com/history/benoit-mandelbrot

Written By: Rebecca

The Science Behind Interstellar

Written By: Shahmeen

The movie Interstellar is a 2014 science fiction, directed by Christopher Nolan, set in a dystopian future where Earth is suffering from catastrophic blight and famine. The story follows a group of astronauts who set out into the emptiness of space in search of a new home for humanity. While being a riveting watch and international success, to most sci-fi fans the question arises: How accurate really is the science behind it? This award-winning film pushes the boundaries of science fiction, standing out as one of the most scientifically grounded entries in the genre. Theoretical physicist Kip Thorne was an executive producer and scientific consultant on the film; by using real physics to inform its visuals, it achieves a level of accuracy in its effects that enhances both realism and credibility. This article will explore and explain some of the key scientific concepts presented in the film, following them in chronological order.

1: The dying Earth & Blight

The story is set in the future (around 2067) where the environment is Humanity is facing possible extinction due to all crops dying except for corn. However, corn, the only remaining food source able to be grown, is inevitably going to die. Professor Brand (from Interstellar) explains that roughly 80% of the atmosphere is nitrogen which humans don't breathe, however the blight is believed to consume nitrogen for nourishment. As it spreads at an exponential rate it consumes plant life and gradually disrupts the balance of oxygen needed for survival, meaning that humans aren't only facing the risk of starvation but also suffocation. While this scenario is dramatized, the underlying concept is rooted in real agricultural science. Blight itself is not fictional, it refers to a plant disease often fungal or bacterial that can spread through wind, water or insects. Research has even shown that changing environmental conditions, such as rising carbon dioxide levels, can accelerate the spread and severity of plant viruses, increasing their reproduction and impact on global agriculture . This makes the idea of widespread crop failure plausible, particularly in a future shaped by climate change and ecological instability.

However, the scale in which Interstellar presents blight is far less realistic. In reality, plant diseases are usually species-specific, meaning the likelihood of a single pathogen wiping out all crops simultaneously is limited. Additionally, such diseases often depend on environmental conditions, particularly moisture. Therefore, would struggle to spread uniformly across different climates. Human intervention also plays a significant role in the management of such diseases; modern agriculture has methods to contain, treat, and genetically resist many plant diseases. Therefore, while the film's depiction of a dying agricultural system is scientifically grounded, the idea of one universal blight destroying nearly all plant life is highly improbable. Instead, it serves as a dramatic exaggeration of real biological and environmental threats, used effectively to set the stage for humanity's desperate search for survival.

2: Wormholes

With Earth becoming increasingly uninhabitable, the focus shifts from survival to escape, leading to the discovery of a wormhole near Saturn. Wormholes arise from solutions to General Relativity, first developed by Albert Einstein, and are theorised to act as shortcuts through spacetime, linking two distant regions of the universe. The film's depiction (a sphere that distorts the surrounding stars) is notably accurate, as extreme gravity would bend light in this way. However, several aspects remain highly speculative. Wormholes would likely be unstable, collapsing almost instantly unless stabilised by "exotic matter" with negative energy, something that has never been observed. Additionally, the idea that a wormhole could be safely placed and maintained near Saturn suggests an advanced external influence rather than natural occurrence. While grounded in real mathematics, Interstellar ultimately presents wormholes as a scientifically inspired but currently unachievable method of interstellar travel.

3: Time Dilation and General Relativity

As the crew travels through the wormhole and approaches distant planets, the effects of General Relativity become central to the story. One of the most striking examples is Miller's planet, where intense gravity causes time to pass far more slowly, one hour on the planet equating to seven years on Earth. This phenomenon, known as gravitational time dilation, is well-established in physics and has been experimentally confirmed, even affecting satellites orbiting Earth. The film's portrayal is therefore rooted in real science, particularly as the planet orbits extremely close to a massive black hole. However, the scale of this effect pushes the limits of plausibility. For such extreme time differences to occur, the black hole would need very specific properties, such as immense mass and rapid rotation, and the planet would need to orbit at a precise distance without being torn apart by tidal forces. While theoretically possible, these conditions are extraordinarily unlikely, making the scene a scientifically informed but highly idealised scenario.

4: Black holes (Gargantua)

The journey ultimately brings the crew face-to-face with Gargantua, a supermassive black hole whose depiction is one of the film's most celebrated achievements. Developed with the guidance of physicist Kip Thorne, its appearance closely matches predictions from General Relativity, particularly in its glowing accretion disk and the way light bends around it through gravitational lensing. This makes Gargantua one of the most accurate visualisations of a black hole ever created. However, the film becomes more speculative when exploring what lies beyond the event horizon. In reality, approaching a black hole would expose an object to extreme tidal forces, likely destroying it long before entry. The concept of a singularity, a point of infinite density within a black hole, remains poorly understood, and current physics cannot describe what happens inside it. The film's portrayal of surviving this environment and interacting with higher dimensions moves beyond established science into theoretical and imaginative territory, blending real physics with narrative necessity.

Interstellar masterfully blends scientific accuracy with imaginative storytelling, grounding its narrative in real physics while exploring the extremes of human curiosity and survival. From the devastating effects of blight on Earth's crops to the mind-bending possibilities of wormholes, time dilation, and black holes, the film introduces viewers to complex concepts in an accessible and visually stunning way. While certain elements are dramatized or speculative, these creative liberties serve the story without undermining its scientific foundation. Ultimately, the film reminds us that the universe operates according to remarkable laws, and that understanding them can both inspire awe and shape the human drive to explore, adapt, and survive.

Solar System

- The Solar System was formed 4.6 billion years ago
- Our Solar System is part of the Milky Way galaxy
- The Sun is 93 miles away from the Earth
- On Mercury a day is twice as long as a year
- All the other planets can fit between the Earth and moon
- The Earth was born on the 23rd of October 4004 BC

by Ella

The Mighty Marvellous Elephant

Washing:

The elephant's skin is very sensitive, it needs to be washed often to keep away insects, bacteria and to keep the elephant cool. It uses its trunk like a hose pipe to spray water over it's body

The mighty trunk:

The elephant uses its trunk like a hand to pull leaves off of trees for its dinner. It is also used to communicate with other elephants - to say 'hello', and 'you've made me cross, go away!'.

Family:

Female and young elephants roam their land in groups called herds. They look after each other. Male elephants live on their own - I think they must get lonely. Usually, about 8 to 10 elephants make up a herd.

Fun Fact File on the African Bush Elepants:

- African Bush elephants are the largest land animals in the world, with males reaching over 6,000kg and even 3m in height.
- They are an endangered species as humans have destroyed where they live (habitat), and killed them for their ivory (tusks).
- They have massive, continent-shaped ears which are used for cooling and even have two "fingers" at the end of their trunks for gripping.
- They eat a huge 130kg of food every day.

Written By: Elizabeth

DOGS

All about Dogs.

Treo in 2010, a black Labrador, Treo was awarded the Dickin Meadl, the Uk top military honour for animal bravery!

A Dobermann Pinscher, called Sauer, once tracked two thieves 160 km across the Great Karoo desert in South Agrica just by following their scent.

Manay dogs don't have family trees. These dogs are crosses between different breeds.

When you take your dog for a walk, does he or She keep Stopping for a wee? This is just one of the manay other things way to communicate.

Dog Quiz

1. which animals are dogs deScend from?

a) jackals

b) Foxes

c) Wolves

2. Which cartoon dog has its own Tv Show?

a) Seaman

b) Scooby Doo

c) Theo

3) What are Queen Elizabeth II's favourite dogs?

a) corgi's

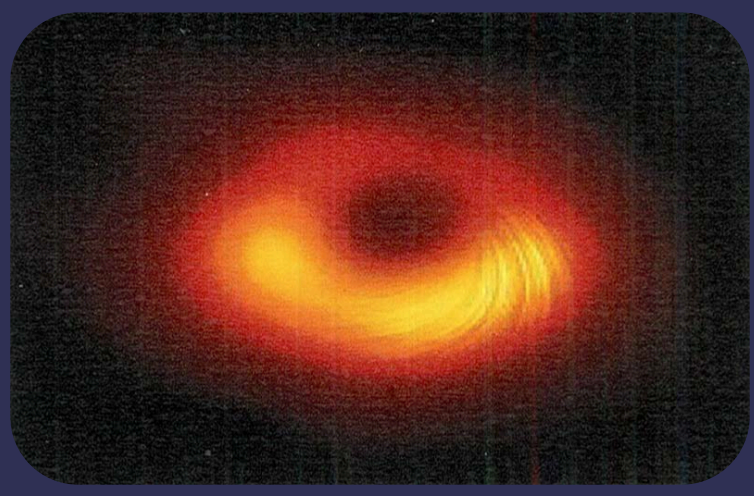
b) dachShunds

c) great danes

Shiloh ... Y5

Prep School Student Article

Black Holes



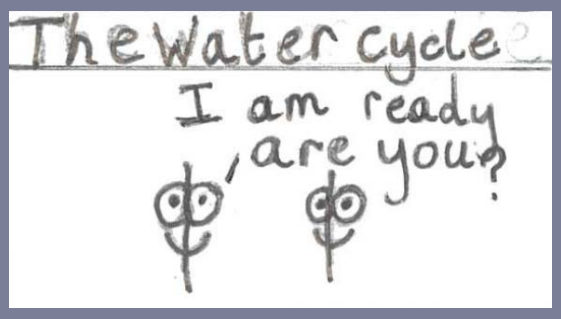
A black hole is an astronomical body so compact that its gravity prevents anything, even light, from escaping.

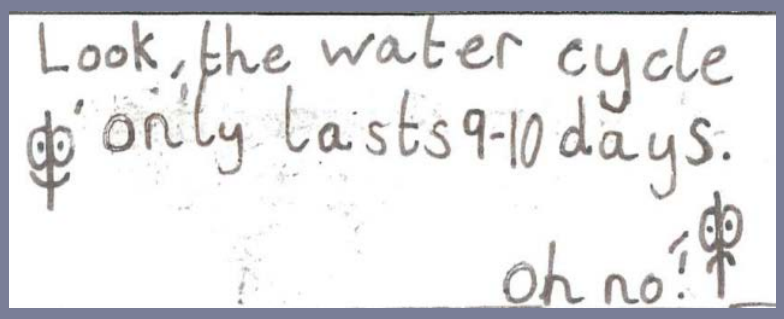
General relativity predicts that every black hole should have a central singularity where the curvature of spactime is infinite.

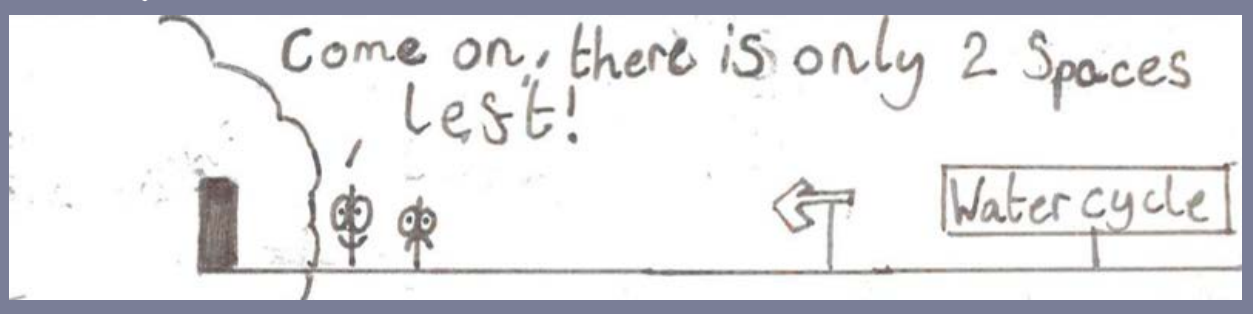
Black holes typically form whem massive stars collapse at the end of their life cycle.

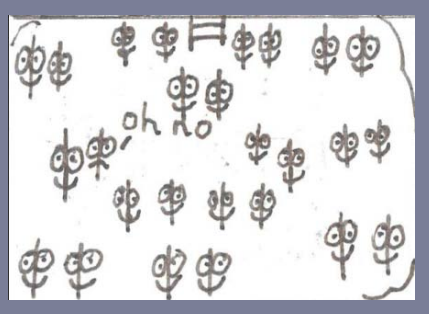
Written By: Erin & Emma Y5

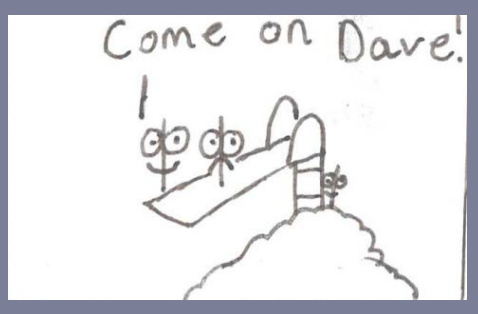
The Water Cycle:

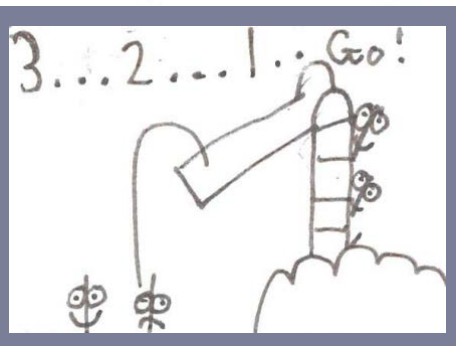


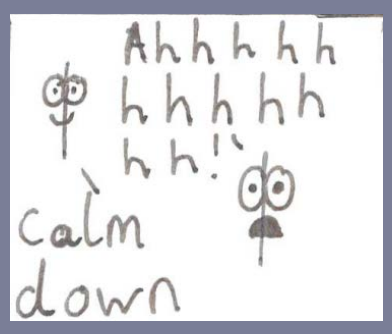


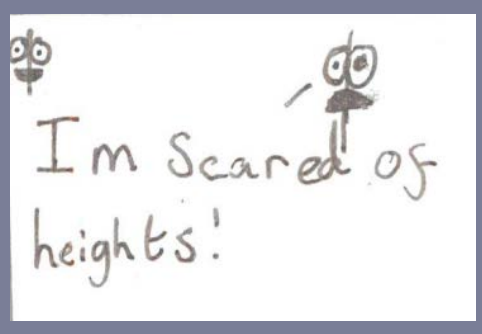


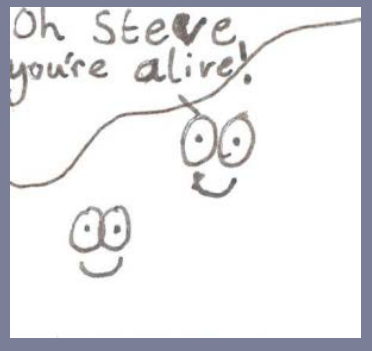


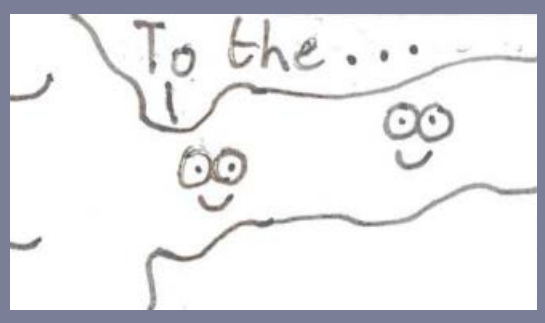


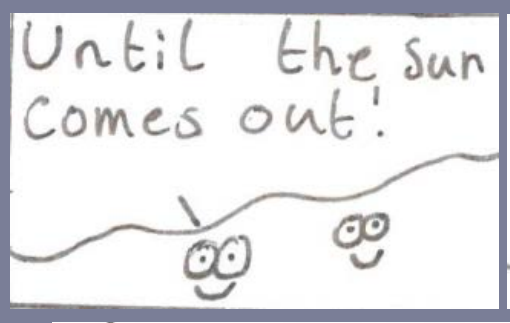


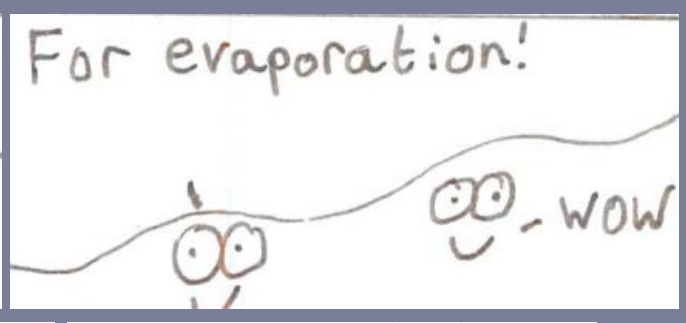


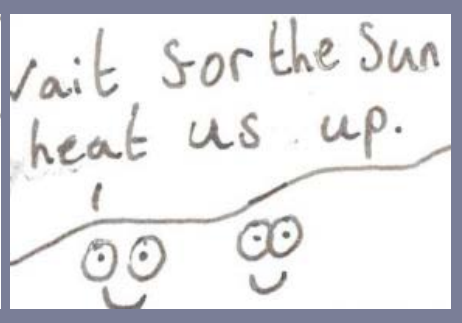


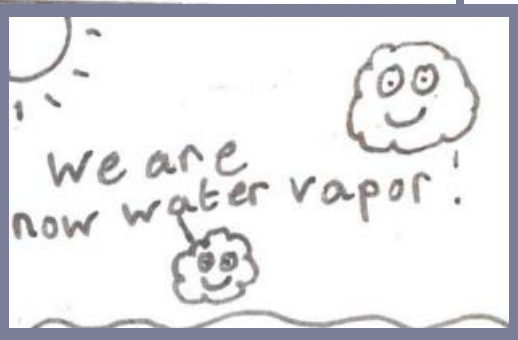


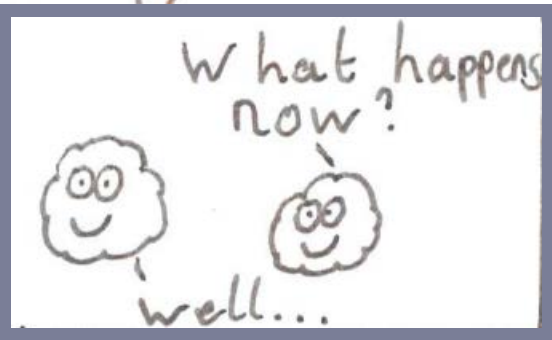


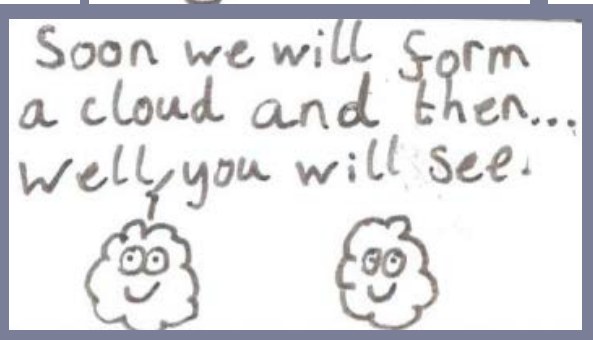


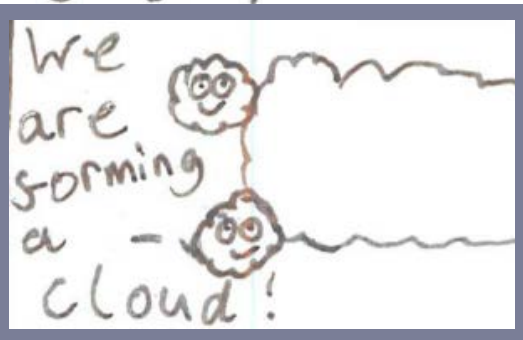


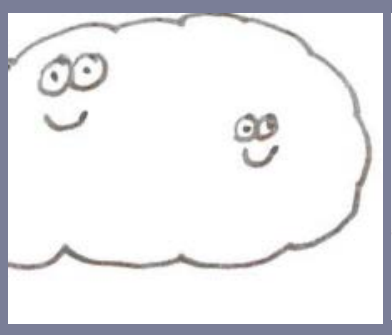


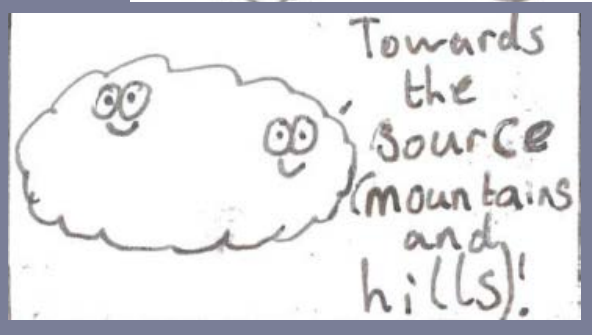


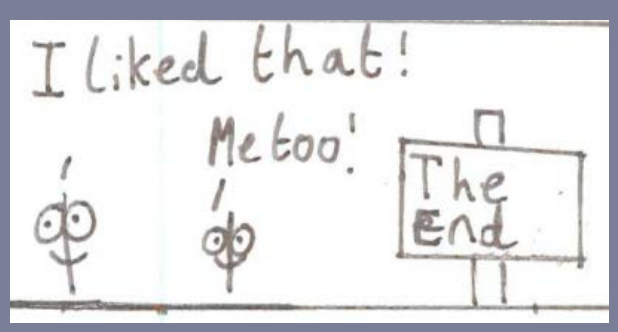












Written & Illustrated By: Anna

Short-Sightedness & Long- Sightedness

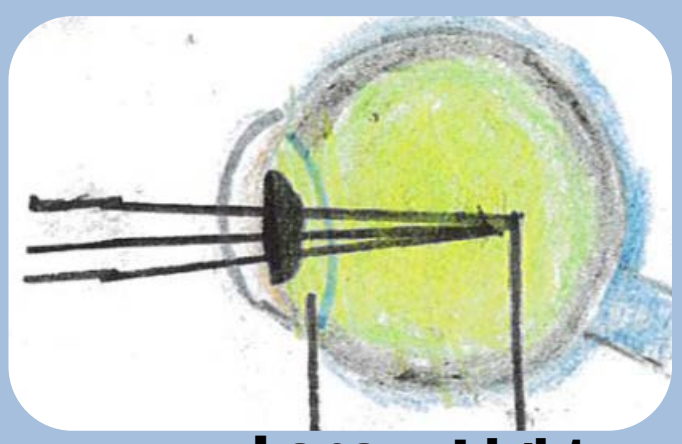
Written & Illustrated By: Lucy Y5

Short-Sightedness:

Before:

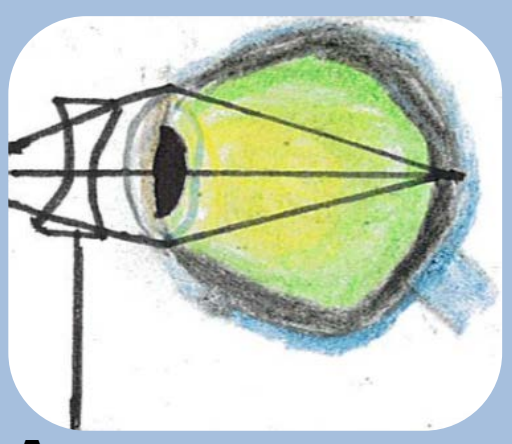
After:

As short-sighted people see far away, things blurred. Therefore you must put a concave lens in front of the eye which shortens the light's path.



Lens

Light Focuses in front of the retina



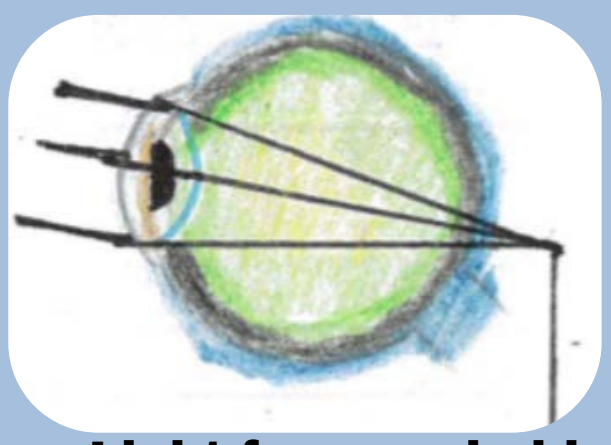
A concave lens spreads the light out before it hits the eye

Long-Sightedness:

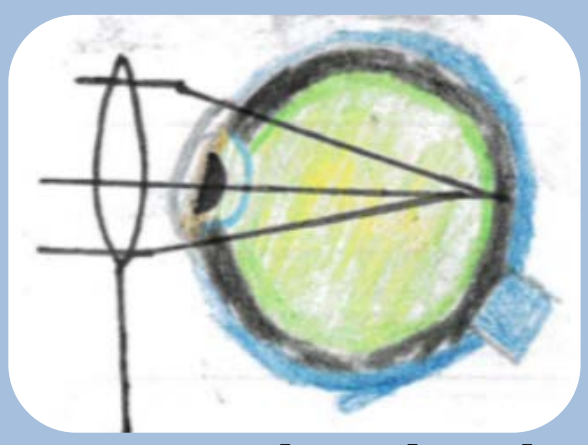
Before:

After:

As long-sighted people see distant things blurred. You have to put a convex lens in front of the eye which shortens the light's path.



Light focuses behind the retina



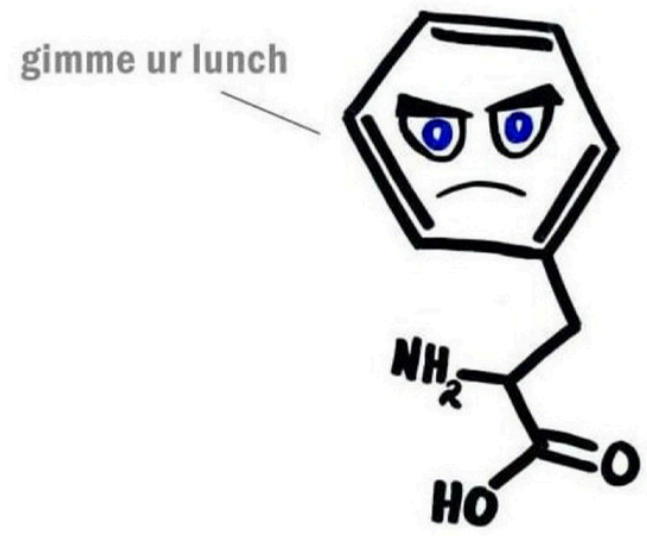
A convex lens bends the rays together in front of the retina

if someone is short-sighted distant objects look blurred and close objects look clear. With Long-sightedness close things look blurry and distant things look clear. Glasses or contact lenses help focus the light in the right place

Memes & Jokes:

Compiled By Jiya Matharu and Abil Gibbons

WHAT DO YOU CALL AN ACID WITH AN ATTITUDE?



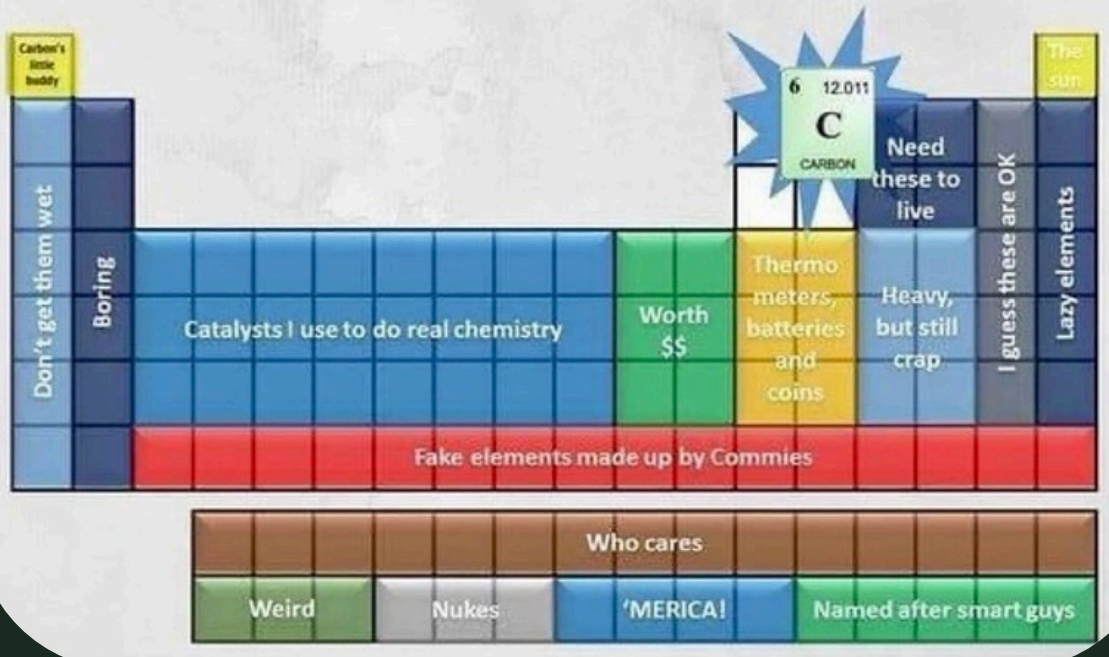
A-mean-oh acid.

Cellfie:

What kind of fish is made up of only two sodium ions?

2Na

The Periodic Table:
as seen by an organic chemist.



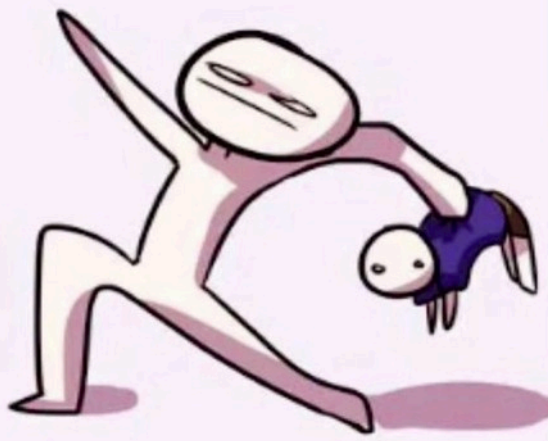
Chemist:What chemicals would be safe or harmful to the child

Biologist: What's the child's bloodline like

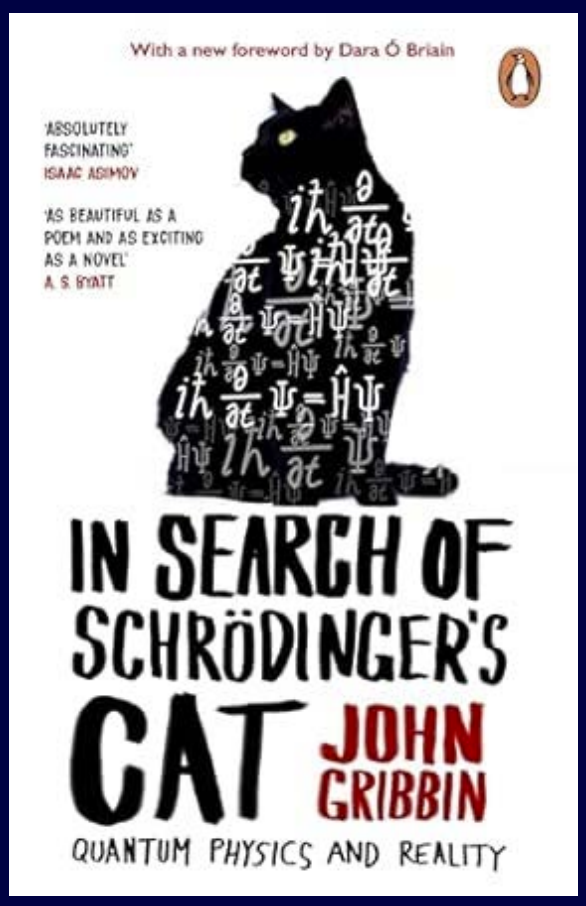
Philosopher: What is a child

Physicist:

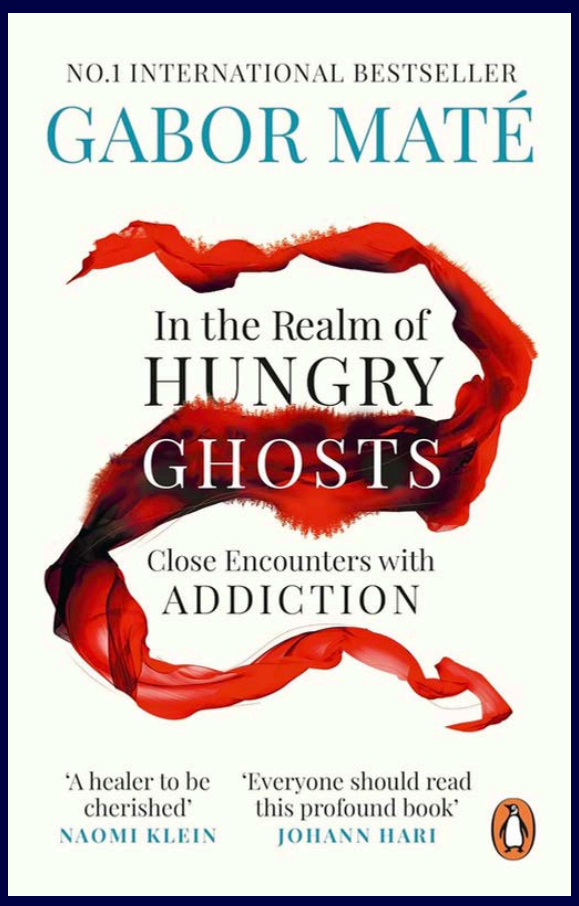
Yeet the child



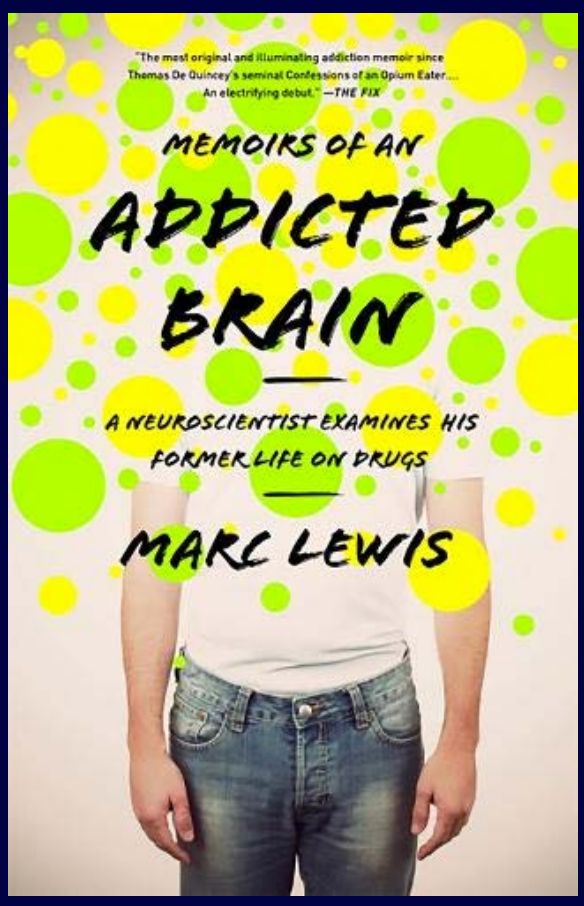
Book Recommendations



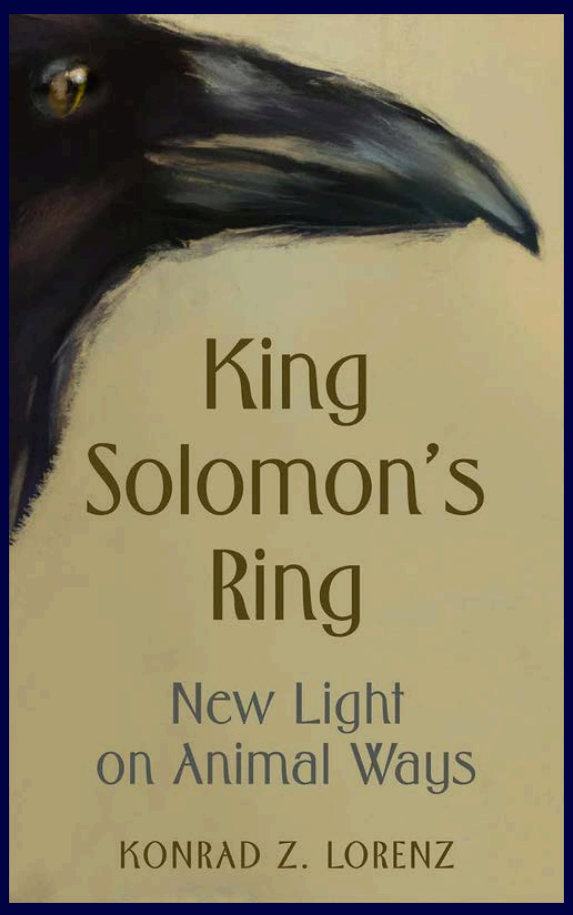
In Search Of Schrodinger's Cat
By: John Gribbin



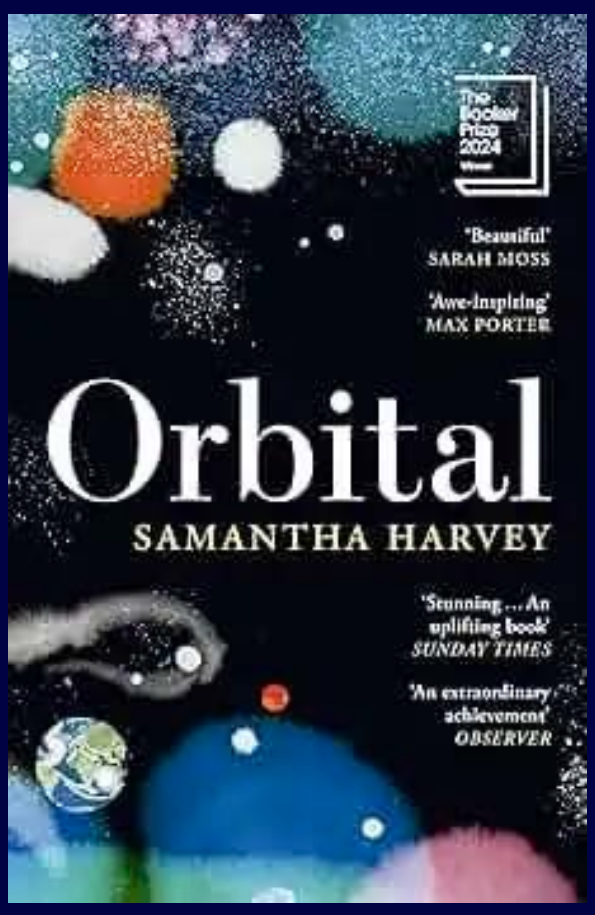
In the Realm of Hungry Ghosts
By: Gabor Maté



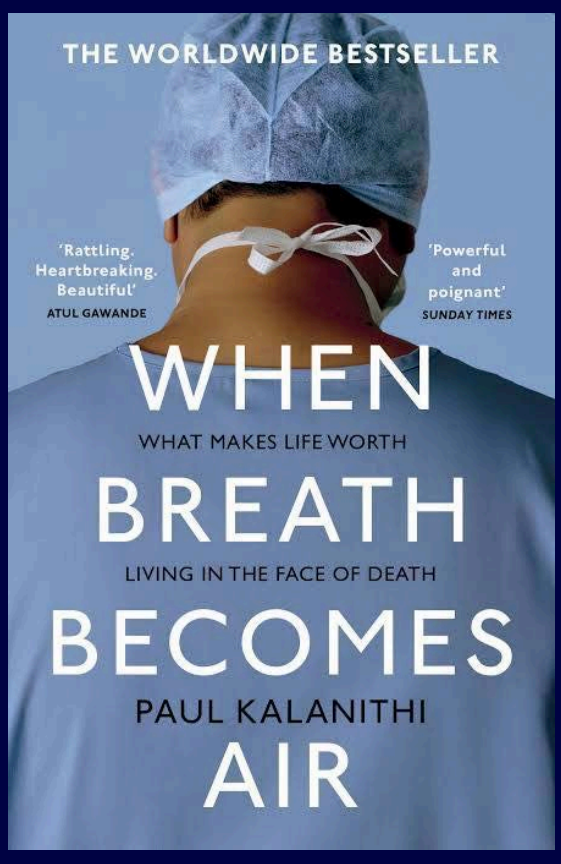
Memoirs of an Addicted Brain
By: Marc Lewis



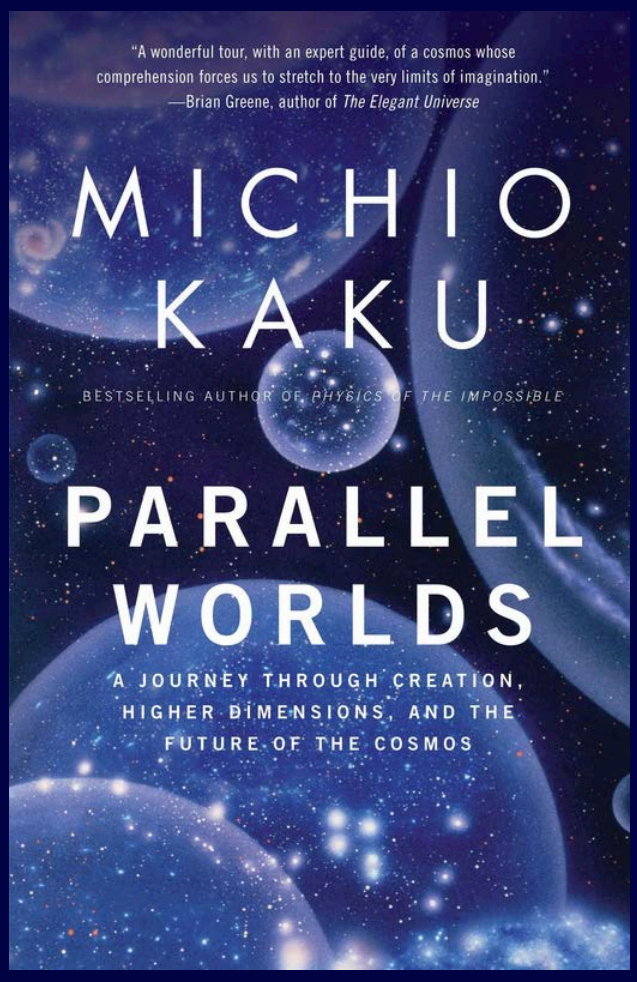
King Solomon's Ring
Konrad Z. Lorenz



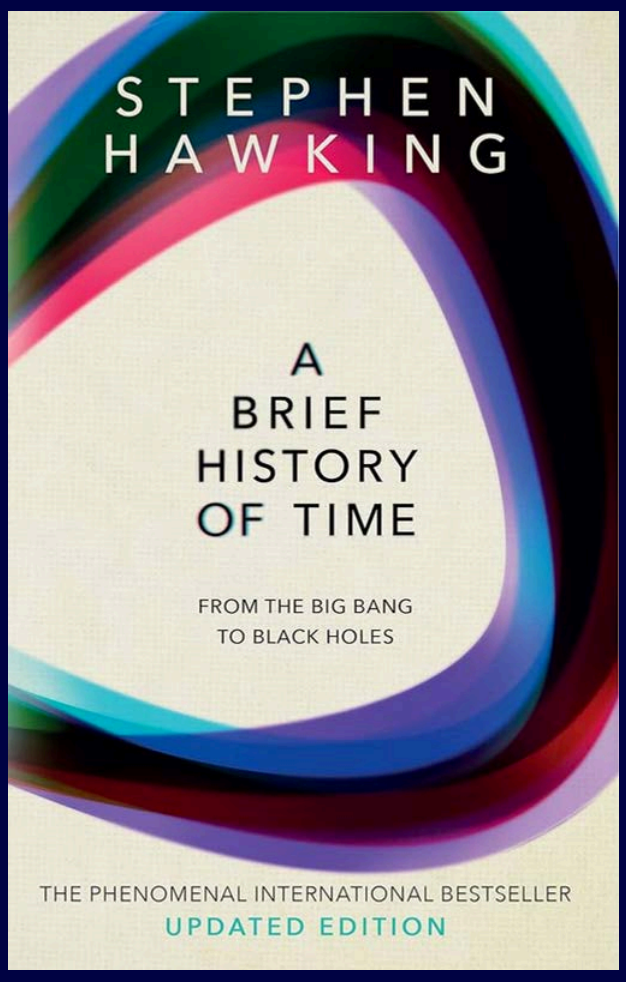
Orbital
By: Samantha Harvey



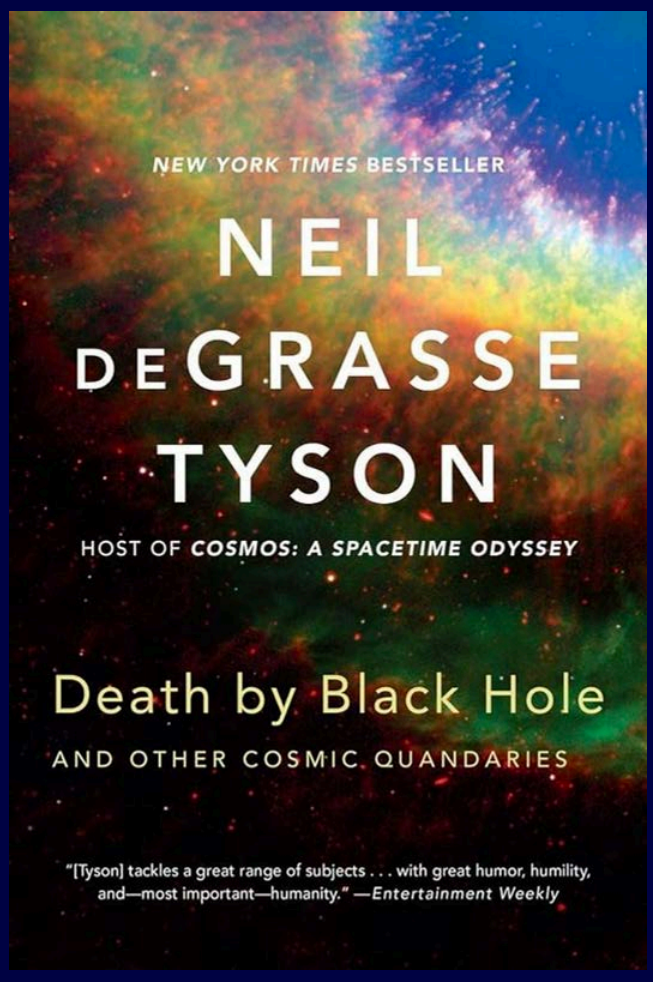
When Breath Becomes Air
By: Paul Kalanithi



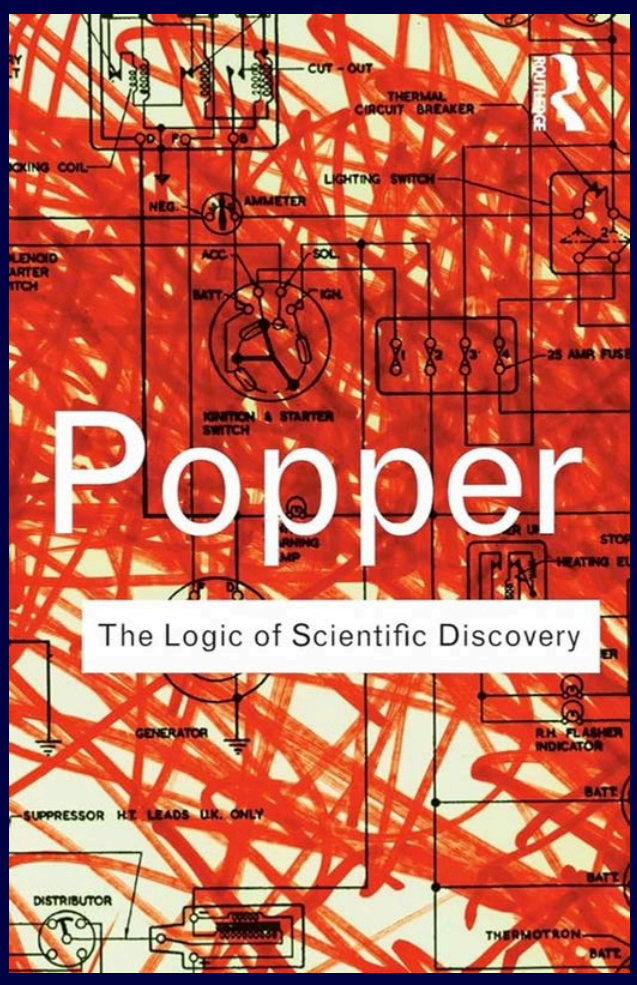
Parallel Worlds
By: Michio Kaku



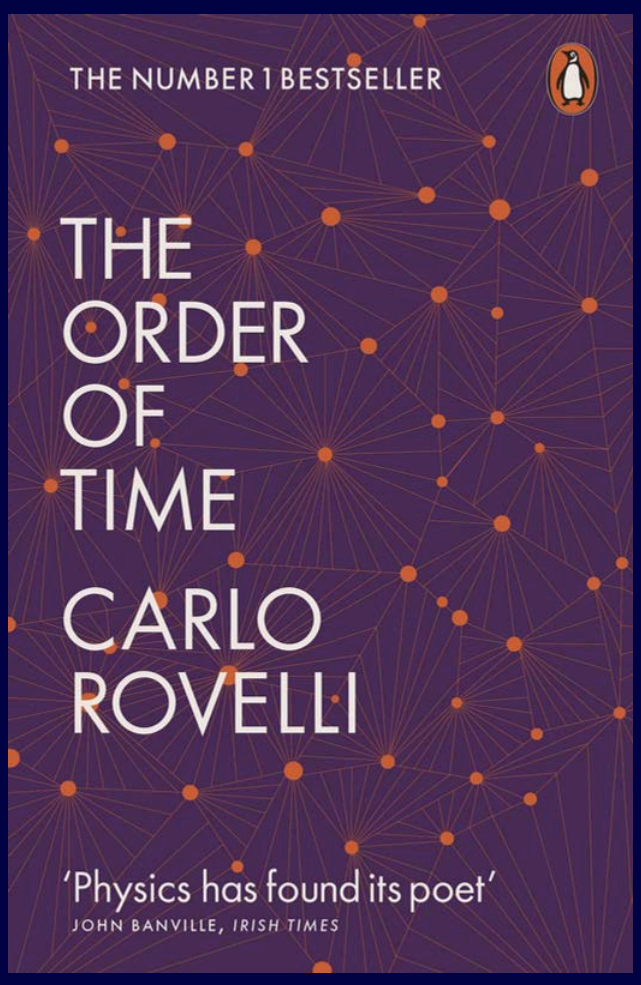
A Brief History Of Time
By: Stephen Hawking



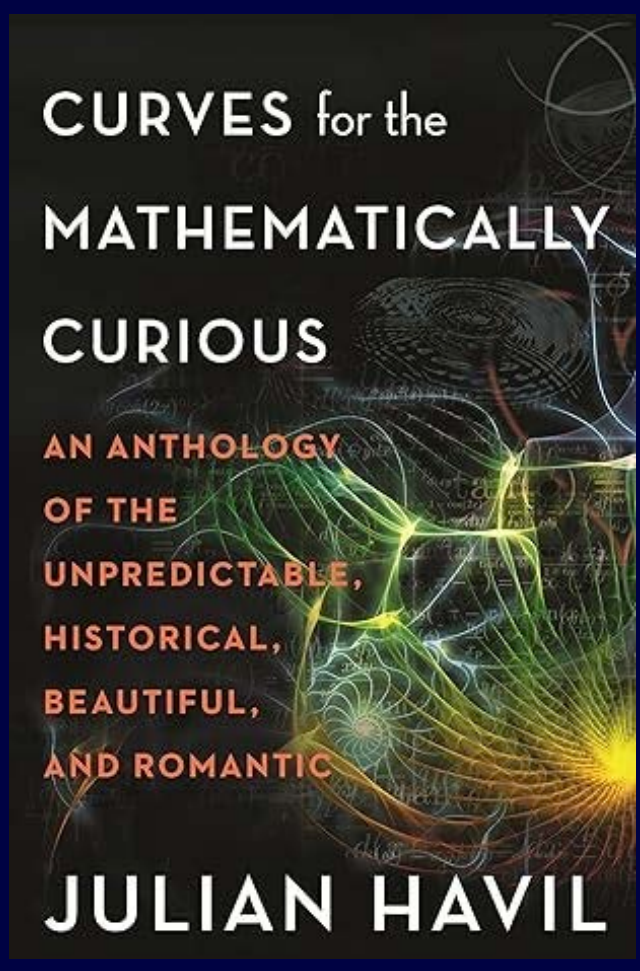
Death by Black Hole
By: Neil Degrasse Tyson



The Logic of Scientific Discovery
By: Karl Popper

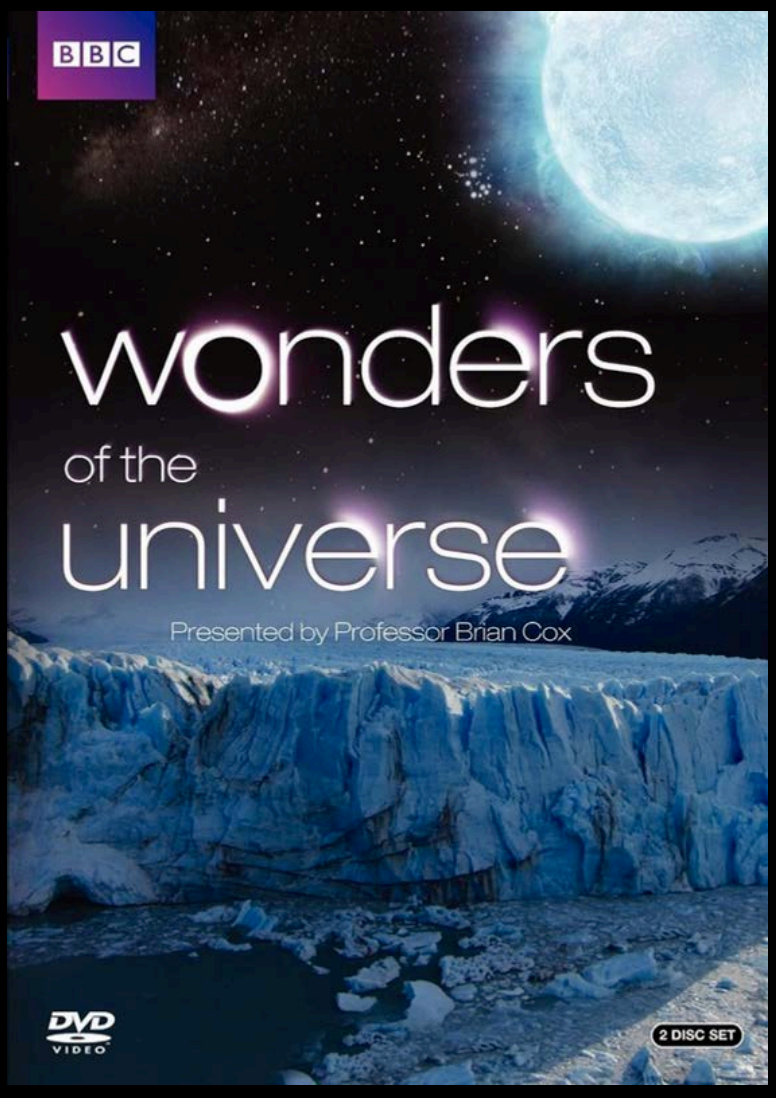


The Order Of Time
By: Carlo Rovelli

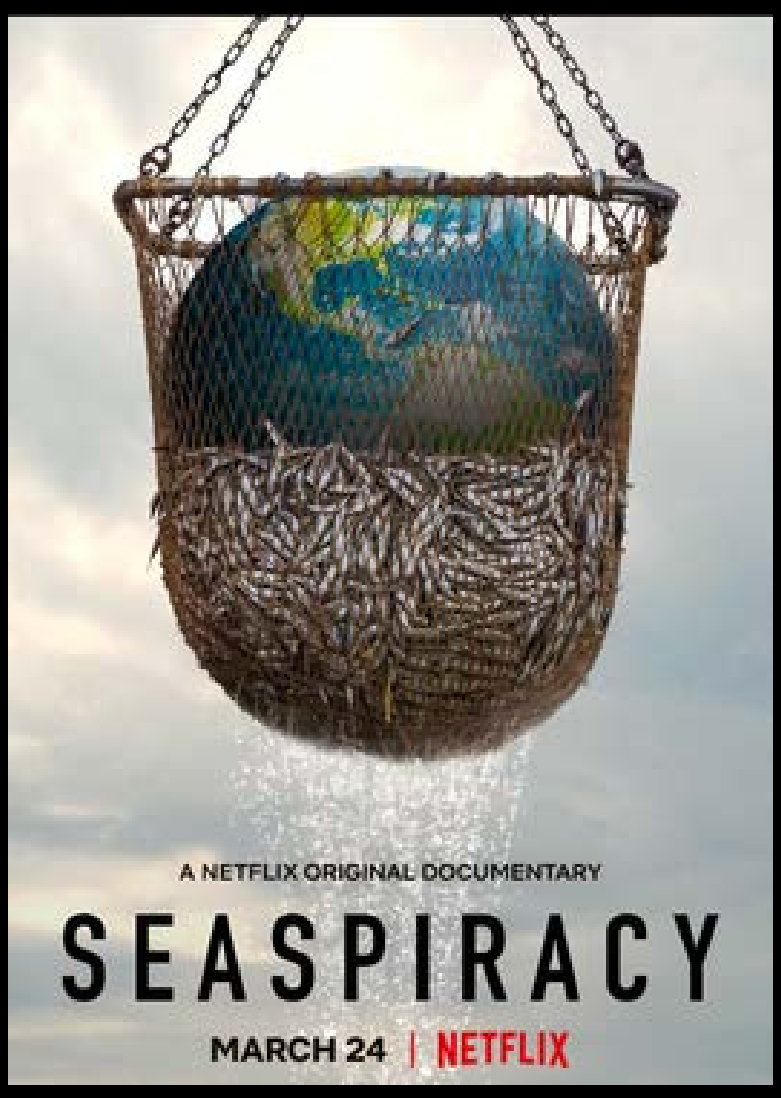


Curves for the Mathematically Curious
By: Julian Havil

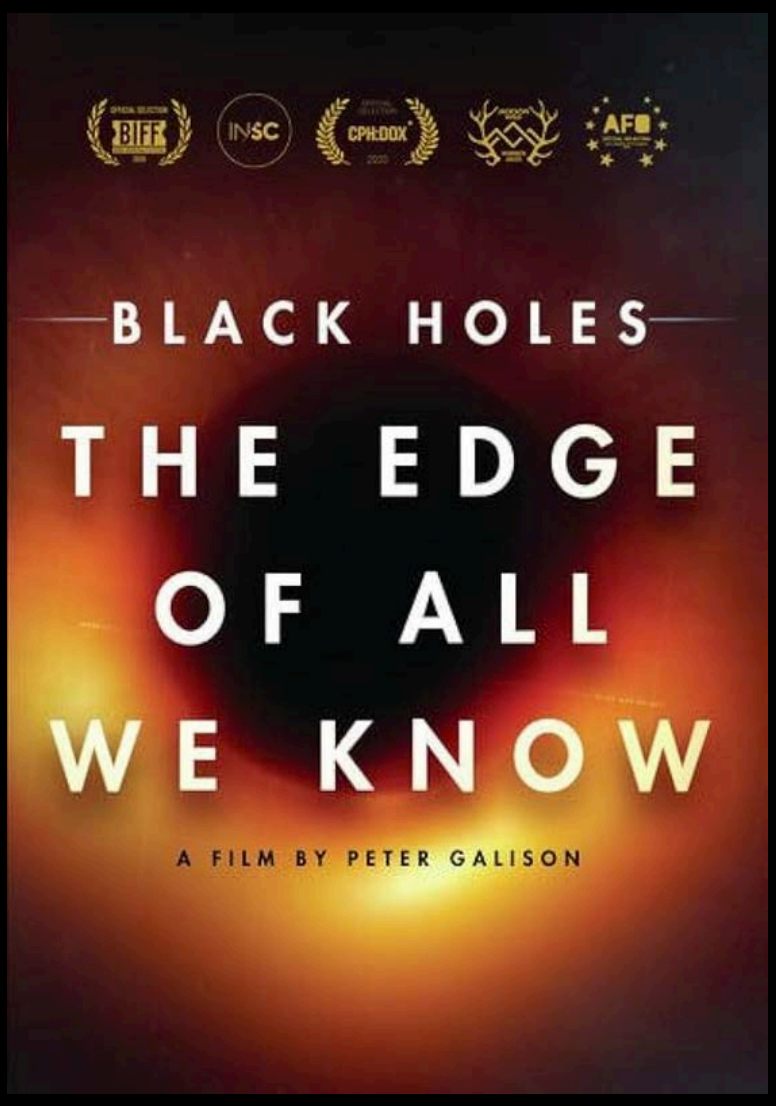
Film Recommendations



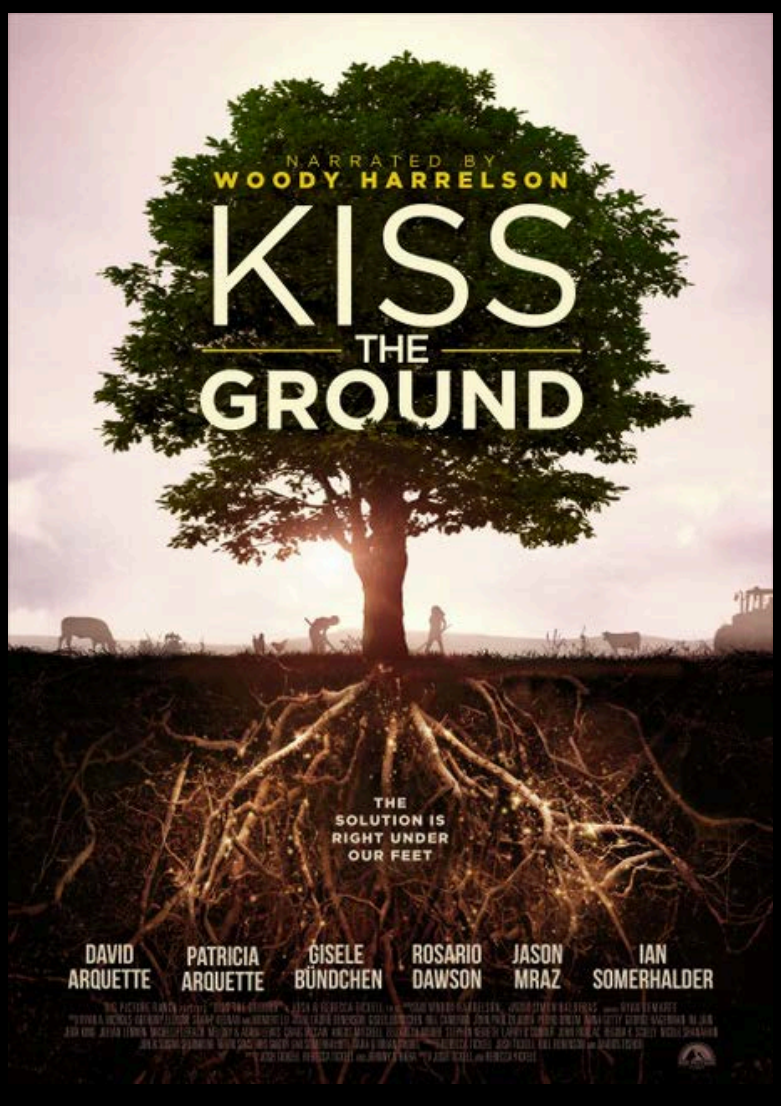
Physics



Biology



Physics



Biology

Compiled By Shahmeen

Podcast Recommendations

The Numberphile Podcast
By: Brady Haran

Startalk
By: Neil Degrasse Tyson

The Titanium Physicists
Podcast

Hidden Brain
By: Shankar Vedantam

ACKNOWLEDGEMENTS

We would like to thank the following students for their contributions...

KHS Students:

Zoë

Charlotta

Rebekah

Aimée

Harishana

Prep School Students:

Erin

Emma

Lucy

Anna

Elizabeth

Ella

This Newsletter is presented to you by:

Rebecca

Anandiya

Jiya

Ellen

& other members of the Café Scientifique team

VOL. 2 (2025-26) - SPRING TERM

~ABOVE AND BEYOND~

Café Scientifique

Graphics sourced from Canva™