

VOL.1 (2024/25) – AUTUMN 1ST HALF-TERM



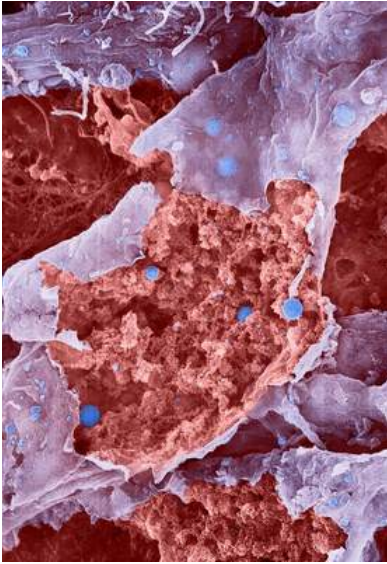
CAFÉ SCIENTIFIQUE

~ LIFE AND DEATH ~



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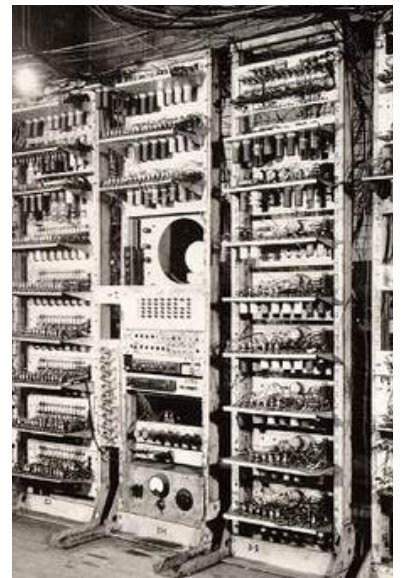
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Message from this Year's Newsletter Team

Events

Quizzes - Mon-Fri weekly

- Test your scientific knowledge with our weekly quizzes
- Collect a copy from outside the Science Prep Room
- Hand in your named entries to the Submission Box outside the Science Prep Room
- Answers to the previous weekly quizzes will be published

“Spooky Slime”: KS3 Science

Club - Fri 18th Oct 2024

- Halloween-themed Science fun!
- Come along to KS3 Science Club at 13:35 in the **Ansell Lab** on the last day of the half-term to create slime!



Future Event Plans

Science Spotlight

- From next half-term, we will be introducing a form, where you ask science-related questions
- We will then answer them in the upcoming newsletter

Fortnightly Science Quiz

- We will be sending science quiz per fortnight via email to all of you.
- By the end of each fortnight, we will announcing the top 3 participants. You will be rewarded with a certificate and edible rewards if it's you!

Talks

- Keep an eye out for upcoming talks!

Debates/Interactive Events

- Debates will be hosted after half term. Keep an eye out for leaflets along corridors and on weekly bulletins.



A NEW BEGINNING

As we launch the first edition of Café Scientifique's newsletter for the 2024/25 academic year, we're thrilled to welcome students on journey of intellectual exploration and discovery. This year's newsletter team – Sahana Karthik, Cherrie Li and Karine Lo – hope bring to you a newsletter that sparks curiosity and inspiration. Naturally, we also aspire to continue the exceptional legacy left by Amelia Kanwar and Lucy Jennings (last year's newsletter team).

We invite you to undertake this brilliant opportunity – submit your articles/reviews, engage with new topics, and connect with fellow students at our events. Together, let's sustain the newsletter – and more widely, Café Scientifique society – as a catalyst for innovation and academic curiosity.

Ultimately, while we're here to showcase and celebrate your contributions, we see this more than just a publication – rather, it's the beginning of a new chapter across our school's scientific community!

THIS HALF-TERM'S THEME

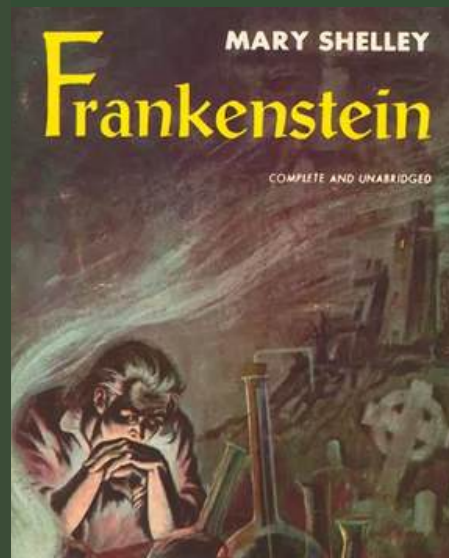
For this half-term, and with Halloween fast approaching, we have selected the theme of '**Life and Death**'.

Scientific discoveries reflect on life (by creating convenient solutions or delving deeper into our biological systems), yet are nonetheless synthesised by mortal minds: new discoveries emerge as we strive to deepen our knowledge about both life itself, and the processes that lead to its conclusion. This has recently been highlighted by the Nobel Prize announcements earlier this month, with the discoveries of microRNA (Physiology/Medicine), machine learning with artificial intelligence (Physics) and advanced protein structure prediction using AlphaFold2 (Chemistry).

This contrasting theme looks at two sides of the same coin, exploring the elaborate relationship of Life, Death (and even what lies beyond). Ultimately, life only finds completeness with the inevitable presence of death.



The Scientific Basis of Mary Shelley's 'Frankenstein'



Written By *Sophia*, 12G

Although Mary Shelley's *Frankenstein* was a work of fiction, she was heavily inspired by the scientific experiments and discussions of the time. As a child, her parents had links with the scientific community, and Mary spent her life an avid reader of scientific journals and an attendee of lectures. Specifically, her father was friends with the electrochemist Humphry Davy, who was a co-discoverer of electrolysis and who, when adding to the debate of the essence of life/what separated the animate and inanimate, proposed a life force as a chemical force like heat or electricity. Shelley has noted that when writing *Frankenstein*, she was also reading Davy's *Elements of Chemical Philosophy*.

Although Shelley never revealed exactly how The Creature was brought to life, she makes clear it had something to do with the (at the time) new science of electricity. Shelley recounted how before writing *Frankenstein*, she was involved in a discussion of the boundaries of life and death, speculating the reanimation of a corpse as "galvanism had given token of such things."

What this referenced was the works of Luigi Galvani and his nephew Giovanni Aldini. Galvani, in 1781, had famously caused a dissected frog to move by touching a scalpel to its leg while working near a static electricity machine, concluding that the muscle tissue had spasmed in response to the electrical current.

Aldini was able to build on this when, in 1803, he took one of the only legal routes for experimentation on human bodies, and procured the corpse of a hanged criminal, George Foster. He then conducted a demonstration at Newgate Prison, London where he inserted metal rods into Foster's body. It is said that his jaws began to quiver, his muscles contorted, one eye was open, that his right hand was raised and clenched, and his legs and thighs were set in motion. People saw this as the start of technology that could bring the dead back to life, a troubling concept. It was this concept that also seems to have deeply struck Mary Shelley, who then utilised electricity as the 'Spark of Life' in her gothic novel.

SOURCES

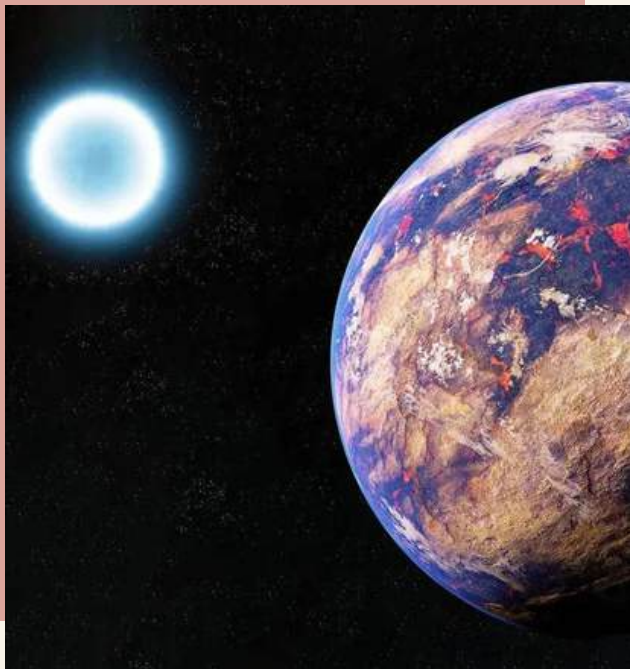
How Real-Life Science Inspired Mary Shelley's *Frankenstein* | Mental Floss

The specter of *Frankenstein* still haunts science 200 years later | Science | AAAS

The science behind Mary Shelley's *Frankenstein* - Science Museum Blog

The Distant Planetary System Reveals Earth's Fate in 8 Billion Years

Written By *Cherrie, 12K*



HOW MICROLENSING DISCOVERED THE PLANETARY SYSTEM

Microlensing brightened stars by a factor of 1,000, allowing this far-away planetary system to come to astronomer's attention in 2020. This uses the gravity of the system to act as a lens to focus and amplify the light from the background star.

Analysis of the microlensing data reveals the Earth-like planet was between 1 and 2 astronomical units from the star- equivalent to about twice the distance between Earth and the sun. However, it was unknown what kind of star the host was as its like was lost in the glare of the nearby magnified stars. Scientist could only derive their conclusion based on ruling out scenarios, where a normal star would have been easily seen. Since the lens is both dark and low in mass, they concluded that it can only be a white dwarf.

SOURCES

This rock planet around a white dwarf resembles Earth -- 8 billion years from now | University of California | 2024

A 2020 microlensing event discovered an Earth-like planet 4,000 light years away from the Milky Way galaxy. It provided a vision of one possible fate of our sun-Earth system in 8 billion years' time: the sun has turned into a white dwarf, and the blacked and frozen Earth is pushed beyond the orbit of Mars. Luckily, the plant survived the red giant phase of its star, which Earth might as well. However, it is still uninhabitable.

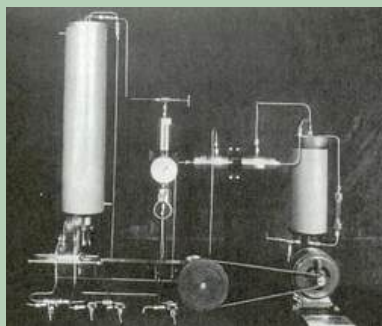
Astronomers at the Univeristy of California identified this distant planetary system with the Keck 10-meter telescope in Hawaii. It resembles our sun-Earth system as it consists of a white dwarf about half the mass of the sun, and an Earth-sized companion with orbit double the Earth's today.

This describes a potential Earth's fate: The sun will eventually inflate larger than Earth's orbit today, engulfing Mercury and Venus in the process. Then, the sun expands into a red giant, decreasing in mass, and forcing planets to migrate to more distant orbits, offering Earth a slim chance of survival. After, the outer layers of the red giant will be blown away, leaving a dense white dwarf no larger than a planet, but with the mass of a star. If Earth survived by then, it would end up in an orbit double its current size.

Scientists also revealed this process could begin with our sun in about 1 billion years when Earth's ocean vaporises and Earth's orbital radius doubles (if the expansion of the star does not engulf us first). Eventually, in 8 billion years, what is left is a dense, glowing ball- a white dwarf- with half the mass of the sun, but smaller in size than Earth.

Despite the planetary system providing an example of a plant that survived the red giant phase, it is unlikely any habitat will survive. On the bright side, humanity might find refuge in the outer solar system. Several moons of Jupiter, such as Europa, Callisto Ganymede, and Enceladus around Saturn, seem to have from water oceans which froze as red giant expands.

Fritz Haber: Sowing Life, Reaping Death



Written By *Sahana, 12L*

*"It is the chemist who must come to the rescue...
It is through the laboratory that starvation may
ultimately be turned into plenty"*

- William Crooks (1898), British Chemist

SOURCES

Fritz Haber: Jewish chemist whose work led to Zyklon B | BBC News - World

Fritz Haber - Bibliographical | The Nobel Prize in Chemistry 1918

Fritz Haber and Carl Bosch - Feed the World | The Chemical Engineer

No scientist can embody the theme of 'Life and Death' as Fritz Haber does – from optimising crop cultivation to being directly responsible for the deaths of soldiers on WW1 battlefields – Haber has since been regarded as a controversial character.

Crop production became increasingly challenging as harvesting lessened the supply of available nitrogen in the soil. This then meant that not enough chlorophyll was produced in plants for photosynthesis. Thus, farmers' yields drastically dropped. Humanity faced a predicament of insufficient food production due to a rapidly growing population and diminishing sources of viable nitrogen*.

As a result, chemists attempted to restore soil nitrogen. Georg Hildebrandt attempted to create ammonia in 1811 by combining nitrogen and hydrogen in a sealed flask. He then submerged the flask underwater to raise the pressure to ≈ 300 atm, which though unsuccessful, was an effective strategy. This experiment was repeated several times in more complex formats – all of which concluded in failure.

Fritz Haber – an academic at the University of Karlsruhe, Germany – worked on this issue for five years. His idea involved combining nitrogen and hydrogen at high pressures and temperatures in the presence of a catalyst. As a technical consultant for a lightbulb company, he had access to Osmium – a scarce metal at the time. Haber managed to produce ammonia using an Osmium sheet (as he thought it would be the ideal catalyst for his experiment) in conditions of 500°C and 200 atm. For his production of ammonia, Haber was awarded the Nobel Prize for Chemistry in 1918.

Haber's process was commercialised by Carl Bosch of BASF, Germany's leading chemical company. In just four years, they established a factory in Oppau that created 5T of ammonia per day. Farmers could now produce 4x as much food, thus it has been speculated that Haber's discovery contributed to the existence of 40% of today's world population. Fritz Haber became wealthy due to his work and founded the Kaiser-Wilhelm Institute for Physical Chemistry in Berlin.

Crucially, Haber was a patriot and wanted to aid Germany in the First World War. Within months of the conflict, the German army was rapidly running low on explosives and gunpowder. While being an incredible fertiliser, ammonium nitrate is also highly explosive. Haber advocated that his ammonia factories should produce ammonium nitrate instead, and soon the German forces relied heavily on his manufacturing.

Subsequently, Haber turned part of the Kaiser-Wilhelm Institute into a chemical weapons laboratory and began developing a gas that was lethal at low concentrations and denser than air, ensuring it would sink into enemy trenches. In its initial attack, Chlorine gas (2.5x heavier than air) killed 5,000+ Allied soldiers by rigorously irritating the mucus lining of lungs, causing them to fill with fluid.

Shortly following WW1, Haber's institute created a colourless cyanide-based insecticide. To notify people of its presence, it was given a foul odour – the resulting gas was termed as Zyklon-B. A decade after Haber's death, Nazis ordered chemists to eliminate the its unpleasant odour, and this form of Zyklon-B was thereafter used to effectuate the Holocaust.

Fritz Haber's legacy makes us consider the double-edged nature of science, having the potential to both nurture life and trigger destruction. The life story of Haber demonstrates the importance of the fragile equilibrium continues to test the boundaries of human ethics.

* Though nitrogen ($\text{:N}\equiv\text{N:}$) makes up 78% of air, this is not used by plants or animals since it takes 9.8eV to break the triple bond between two nitrogen atoms - hence this form of nitrogen is practically inert. We therefore rely on the process of "nitrogen-fixing," accomplished by lightning and soil-dwelling bacteria. But lightning strikes too seldom to fix nitrogen, and micro-organisms take long periods of time to produce ammonia.

The Immortal Jellyfish



We are told life is short and death will come quicker than it seems, however not for this incredible creature. *Turritopsis dohrnii*, also known as the immortal jellyfish, is capable of reverting from a completely sexually immature being after becoming a sexually mature being, which is why it earned its title.

The *Turritopsis Dohrnii* is bell-shaped, and its maximum diameter being up to 4.5 millimeters. It is about as tall as it is wide. The walls of the 'bell' are classed as thin, except for some thickening at its apex. The relatively large stomach is a vibrant red colour. Young specimens, reaching about 1mm, have only 8 evenly spaced tentacles, however adult specimens have 80-90 tentacles.

Written By *Grace, 7G*

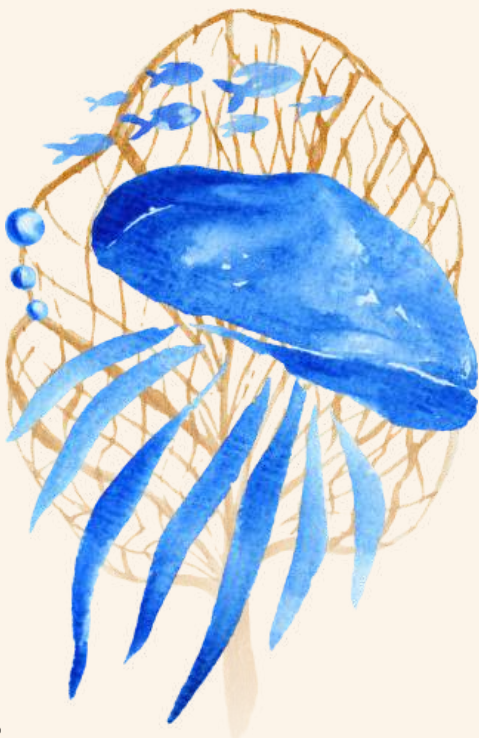
These magnificent animals can be found in the countries of Mexico, Spain and Italy. More specifically, in the oceans of the Pacific and the Atlantic- and in the seas of Philippine Sea, Gulf of Mexico, Mediterranean Sea, Caribbean Sea, Ligurian sea, Adriatic Sea, Ionian Sea. It is believed to have originated in the pacific but as spread further across the planet due to migrations and has separated into different populations that are relatively easy to distinguish.

Turritopsis Dohrnii are a carnivorous species, and they mainly feed on zooplankton. Their diet commonly consists of plankton, fish eggs, and small mollusks. They both ingest and excrete food and waste through their mouth. This creature hunts by using their tentacles when drifting through water. Its tentacles, which have stinging cells called nematocysts, spread and sting its prey before eating it. Sometimes, they also use their bell to capture prey.

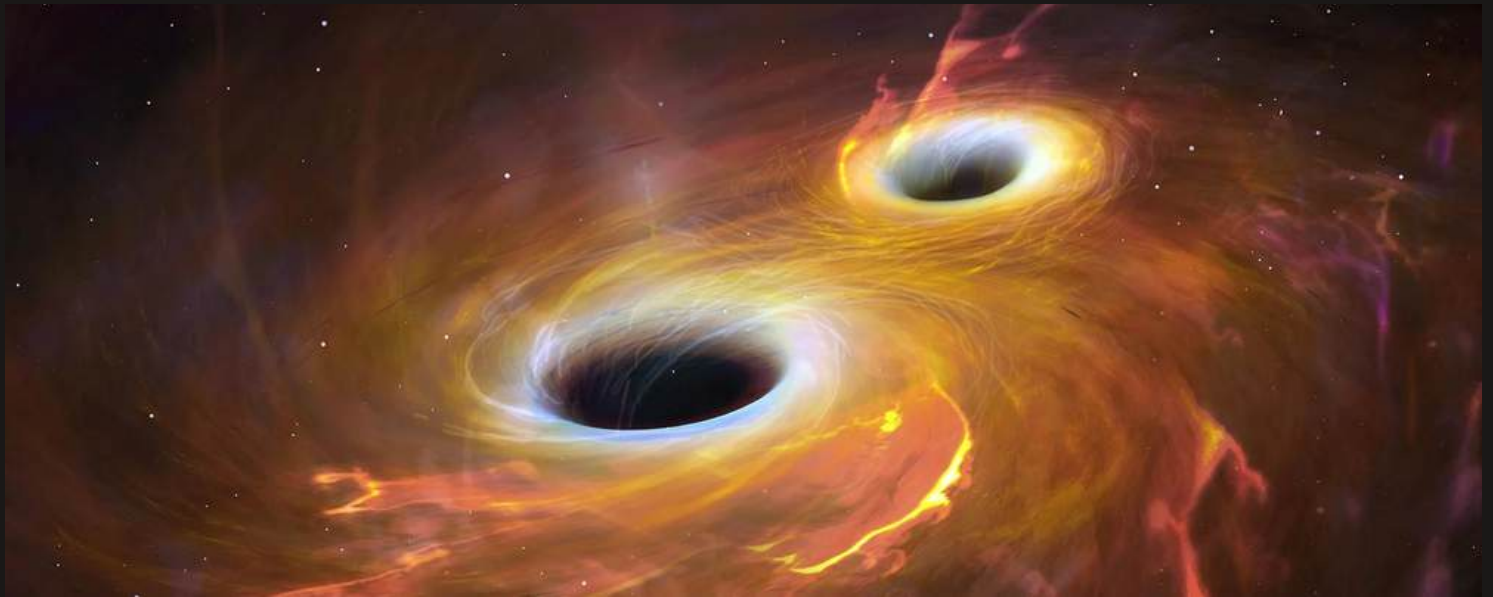
The eggs develop in the females medusae, which is in the walls of the stomach (manubrium.) Mature eggs are thought to be fertilized and spawned by sperm produced in the males medusae. Once the eggs are fertilized, they develop into planula larvae, which settle onto the sea floor and then further develop into polyp colonies (hydroids.) The hydroids bud new jellyfishes, which are released at about one millimeter in size and then grow and feed in the plankton, becoming sexually mature after a few weeks.

Scientists have discovered how specifically they are able to transform to grant them with this eternal life, they do this using a process called trans differentiation. The following steps of this and how it works is the following:

- **Gene activation.** Certain genes within the *Turritopsis dohrnii* genome become activated when the jellyfish encounters stress, injury or reaches old age. These genes signal the cells to initiate trans differentiation.
- **Cell transformation.** During trans differentiation, mature cells in the jellyfish's body change their form and function, effectively turning into different types of younger cells that would make up a juvenile polyp. This transformation involves altering the expression of numerous genes, turning some on and others off, to revert the cells to a state where they can divide and grow anew.
- **Regeneration and reversion.** The transformed cells then work together to reconstruct the jellyfish's body into the polyp stage.



Merging Black Hole May Introduce New Particle



Written By *Cherrie*, 12K

Black holes are invisible traps that not even light can escape. They are created by the death of a star which is massively greater in mass compared to our Sun. Two black holes can merge to form a large binary black hole merger if massive binary stars are isolated during their evolution, or there is a dynamic encounterment within a dense star cluster. A recent paper published by physicists from Amsterdam and Copenhagen suggests that observations of merging black hole pairs (a.k.a binary black hole mergers) might allow us to discover new particles.

As two black holes merge, gravitational waves are emitted. These waves tell us about the shape and evolution of the orbits of the components in the black holes. This could reveal the existence of new particles in nature.

Black hole superradiance is the mechanism that makes the detection of new particles possible. The process involves a black hole spinning fast enough for it to shed some of its mass into a 'cloud' of particles around it. Due to its similarity with an electron cloud around a proton, this black hole cloud system is known as a gravitational atom.

Superradiance occurs best with superlight particles, lighter than the ones scientists have found in experiments so far. This makes it a unique way to research ultralight boson cloud particles. These particles could resolve several unknowns in astrophysics, cosmology, and particle physics.

In the past 6 years, scientists have been studying orbital evolutions of merging black hole pairs in the presence of ultralight boson clouds. Two new phenomena were discovered: The first phenomenon is resonant transitions, where particle cloud 'jumps' from one state to another, similarly to how electrons jump between orbits in atoms. The second phenomenon discovered is ionization, where part of the cloud is ejected, similar to the behaviour of atoms.

These two new phenomena leave a distinct characteristic on gravitational waves emitted by merging black hole pairs. However, the expression of these imprinted characteristics depends on the state of the particle cloud, and the detail of imprinting is still unknown. Studies are being carried out now to fill in the details of this process.

Scientists found two possible causes of the two new phenomena:

Firstly, if the black holes and the clouds rotate in opposite directions, then the clouds remain in the state produced during superradiance, which becomes detectable through its ionization and leaves a distinct imprint on the gravitational waves.

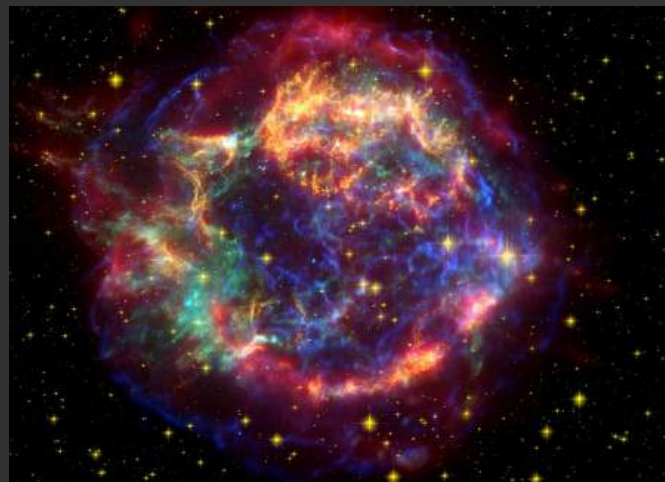
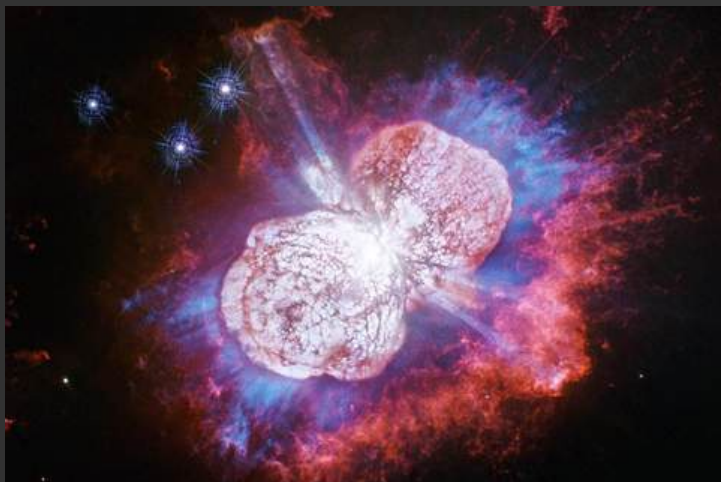
Secondly, resonant transition (where particle cloud 'jumps' from one state to another) destroys all the particle clouds, and the binary system's orbit gets specific eccentricity and inclination values, which can be measured in gravitational waves.

This finding of new particles could provide ways to search for new particles. Scientists can either detect the ionization effects of gravitational waveforms or observe a number of systems with predicted eccentricity and inclination values.

SOURCE

Black hole pairs may unveil new particles | Universiteit van Amsterdam - Sep 2024

Study Suggests Nearby Supernovae May Have Influenced Life on Earth



Written By *WSS Student*

A recent study by researchers at UC Santa Cruz suggests that nearby supernovae may have significantly influenced the evolutionary trajectory of life on Earth. Identifying the iron isotope Fe60 in seafloor sediments, a by-product of supernova explosions, implies that Earth has encountered such cosmic phenomena multiple times. These supernovae, which occurred approximately millions of years ago, likely released high-energy radiation that impacted biological processes and may have shaped the planet's biodiversity.

Supernovae represent some of the most powerful explosions in the cosmos, emitting vast quantities of radiation and high-energy particles capable of traversing extensive distances in space. The research focuses on how supernovae that transpired between two and three million years ago, along with another event occurring five to six million years ago, may have elevated radiation levels on Earth's surface. Exposure to such radiation can result in considerable DNA damage, including double-strand breaks, which are detrimental and can lead to mutations, chromosomal alterations, or even cell death. These mutations may have subsequently facilitated a rapid diversification of species and evolutionary transformations.

A particularly compelling aspect of the study is the identification of two separate Fe60 deposits on the seafloor. The more recent deposit is associated with a supernova explosion that likely coincided with the solar system's passage through an area of increased cosmic radiation. The older deposit is believed to have originated from Earth's traversal through the "Local Bubble," a region of hot gas spanning 1,000 light-years, formed by the remnants of several supernovae. These findings indicate that the planet has been subjected to waves of cosmic radiation over millions of years, potentially leaving enduring impacts on life.

While the evidence provided by Fe60 deposits suggests a potential connection, there is a possible chance that cosmic events such as supernovae may have directly influenced periods of evolutionary change on Earth. The heightened exposure to radiation could have initiated genetic alterations to adapt to the cosmic environment.

SOURCE

Life in the Bubble: How a nearby supernova left ephemeral footprints on the cosmic-ray spectrum and indelible imprints on life. By Caitlyn Nojiri Noémie Globus, and Enrico Ramirez-Ruiz



Life & Death in Animals



The way animals live in the same as humans, we live and die, we respire, we grow, we have a way of communicating and can reproduce. Animals and humans are vastly different; however, we still share some of the same characteristics.

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The average lifespan for pets in general is dependent on the animal, for example, the average dog's lifespan is 12 years;



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...and for cats, it is approximately 13 years, and the average life span for a fish is 3-5 years.



Mayflies have a life span of 1-2 days, however the tubeworm *Escarpia laminate* have a lifespan of over 1,000 years and lives in the sea. Why do mayflies have a much shorter lifespan than tubeworms? Is it because of the environment, structure or reproduction?



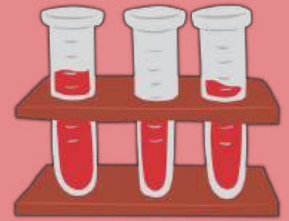
EDITOR'S NOTE

It is a combination of all these factors! Mayflies, like many other insects, live by freshwater bodies such as lakes, ponds, and rivers. This makes them susceptible to prying predators; such as fish and birds. On the other hand, tubeworms are what we would call extremophiles - creatures that live in extreme conditions. In this case, tubeworms live in pockets under the deep sea called hydrothermal vents, in depths with a water pressure that even humans cannot withstand and within temperatures up to 380°C.

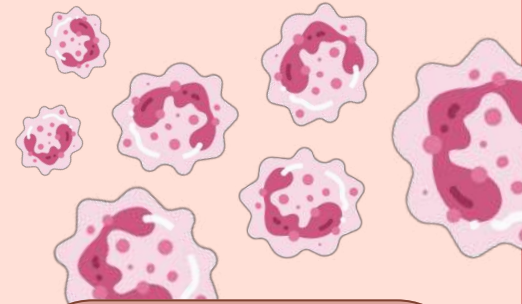
Moreover, mayflies are structured to not have mouths or a fully developed digestive system, meaning that they are unable to have food in their adult phases. Their adult phases can sometimes only last up to hours; as their sole purpose in this phase is reproduction. Tubeworms do not possess digestive organs either - instead they have a particular kind of bacteria that thrives on the high sulphide content of the water spewing out of the vents, and this in turn provides everything the worm needs to live.

Life-saving Technology: Using Blood tests to identify cancer

Written By *Eleanor, 12G*



Sadly, cancer affects so many people every year, with over a thousand people being diagnosed with cancer every day and almost half of diagnoses being stage 3 or 4 cancer. However, due to exciting new developments, blood tests could universally screen for lots of types of cancer, allowing early detection and drastically lowering the mortality rate.



Blood tests to try identifying cancer are currently in clinical trials, with significant success. For example, scientists at John Hopkins University have been trialing a blood test that looks for eight common types of cancer. Their test, *CancerSeek*, was trialed on 1,005 patients all already diagnosed with cancer, and the test was able to identify 70% of the patient's cancers. This could be potentially groundbreaking for the future as 5 out of the 8 cancers the blood test looks for have no early screening programme, meaning they are often not diagnosed until stage 3 or 4. For example, pancreas cancer only has a 1% survival rate, the lowest of all cancers in the UK, as it is detected too late as it has very few symptoms. A blood test like this, which could eventually be an annual test for everyone, could save countless lives by increasing the number of cancers detected early so they can be treated as fast as possible.

Furthermore, in the UK, the Galleri blood test is in clinical trials with the NHS. This, like the *CancerSeek* test, works by detecting mutated DNA which is released by the tumours into the bloodstream. The Galleri blood tests have even more potential than the *CancerSeek*, as they are looking to test for 50 different types of cancer. In a test completed with people who already have cancer, they detected cancer in 51.5% of the cases and could identify where in the body the cancer was in 89% of cases. This is extremely important as it can then allow more tests looking for a specific type of cancer.

From there, the NHS has recruited **140,000** volunteers from across the UK aged 50-77 and is now focusing on whether this test is a viable option for early detection of cancer in people who are not suspected to have cancer. The participants will be given annual blood tests and half will be tested using the Galleri test and the other half not to see whether the Galleri test increases the number of early diagnoses. Those who are given a positive result from the Galleri test, will then be referred onto the hospitals for further investigations and treatment.

If this trial is successful, the positive effects on the individuals and the NHS as a whole could be huge. Early diagnoses for cancer is one of the most effective ways to increase survival rates therefore a test like the Galleri test could save countless lives. There is still a lot of work to be done before a universal cancer test is available to all, however this research is extremely promising for the future and have the potential to revolutionize cancer treatment.

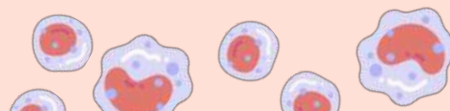
SOURCES:

Cancer Statistics for the UK | Cancer Research UK

Cancer blood test 'enormously exciting' | BBC News
The Galleri multi-cancer blood test: What you need to know | Cancer Research UK

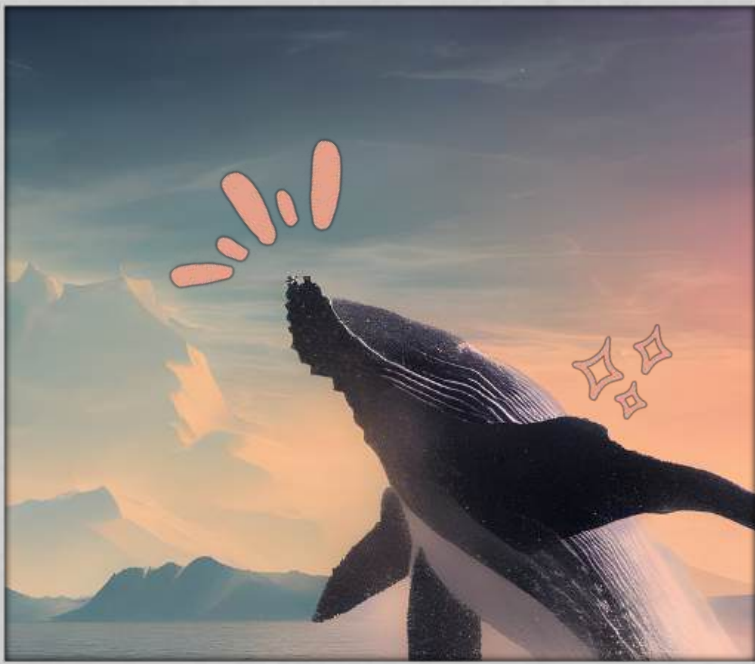
What is the Galleri blood test? | Tests and scans | Cancer Research UK

NHS-Galleri Trial | About the trial



In the Carcass of a Gentle Giant

Written By *Karine, 12K*



Whales – said to be the largest mammals in the world, are one of the many complex and mysterious creatures in the deep sea. We all remember them for their elegant leaps and majestic dives in photos from the National Geographic, but these creatures will inevitably meet their deaths, too. But what will become of their carcasses? What is the legacy they leave behind for other critters in nature?

As whales die, decay starts to happen as their internal organs decompose. Much like humans, they expand with gas and sometimes float to the ocean surface. Eventually, the ocean giant sinks, falling mile after mile and resting on the seabed – where it signifies the demise of a beast, and the revival of a brand new ecosystem.

One of the genus that benefit tremendously from the nutrients left behind by a whale are the *Osedax*, or the bone-eating worm. I thought this sounded grim at first, too, but how they use the whale's body is fascinating. In fact, a lot of species of bone worms were first discovered on whale bodies, such as the *Osedax mucofloris* - which literally means 'bone-eating snot-flower'. They, along with some sea bacteria, make acid and enzymes that break down different elements of the bone, which helps in reproduction. Female *Osedax* then usually release lots of eggs into the water column, most of which settle on the whale's body itself, where this cycle can repeat for as long as a whole decade to harvest the remains of a single whale carcass. Think about it – a whole ecosystem formed at the hands of a whale's death.

On top of this, many other sea creatures feast on the leftovers of a whale. Hagfish, crabs, shrimp, and many more all feast on the blubber and muscle of a whale, which can provide animals with sustenance for up to 2 years during this scavenging stage.

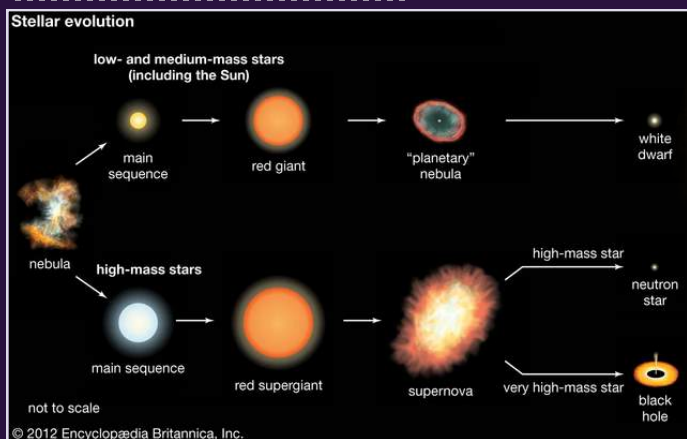
What about stranded whales?

You may have encountered the occasional viral news report of whale bodies found on the beaches of Europe. Well, these are usually due to them being flushed to shore before the mass of their body start to weigh them down into the ocean floor. As horrible the stench of 100 tonnes of decomposing flesh can be, marine biologists may find this a golden opportunity to study a creature that is frequently inaccessible to humans, as happening upon a natural whale fall is so rare.

In death, whales provide life for tens of hundreds of marine animals for up to 5 decades, supplying many generations to come with sufficient sustenance, in turn contributing to the marine ecosystem even after their death. The vital role they play in the ocean life cycles is the legacy that each whale leaves behind.

From Nebular to Nova: The Life Cycle of Stars and their Effects

Written By *Isabel, 12H*



Stars form, exist, and die in a complex cycle that has continued for billions of years in the vast performance of the universe. These glowing giants contribute significantly to the formation of the components necessary for life. Stars' life cycle, from their minuscule origins in vast gas clouds to their dramatic end as supernovae, white dwarfs, neutron star or black hole displays the dynamic forces that control our universe.

I'll start with a short summary of the star life cycle. Stars are born within molecular clouds, in these clouds clumps of gas and dust collapse into protostars due to their own gravity. Protostars generate energy through nuclear fusion, turning hydrogen into helium and then becoming a main sequence star (like our sun). Main sequence stars sustain stable fusion for millions or billions of years, during this time gradually changing in size, luminosity and temperature. Low-mass stars expand, shedding their outer layers as planetary nebulae, leaving behind white dwarfs. Higher mass stars (20x that of the Sun) undergo fusion processes. This can result in a supernova explosion leaving behind a neutron star or black hole. These supernova explosions enrich the cosmos with heavy elements, which can be used for future generations of stars going back to the beginning of the cycle.

However, these processes are occurring on a scale which is hard to comprehend. Here are some of the few examples of events that take place in our universe **every second**:

- 120 blackholes are formed
- 60,000 stars are born
- Milky Way will travel 600km
- 1,200 stars die

Which only makes the fact that we are living today even more impressive. With all that birth and death occurring in only one second, makes it even more incredible how perfectly the universe aligned for life and death to occur on are planet. We are positioned in what is known as the 'goldilocks zone'. This is when a planet is at the correct distance from the star so that water can be in liquid form on the planet, which is necessary for life on earth. Not only is the life cycle of stars very interesting, but it is also necessary for life on Earth as it is today. The death of stars can create some of the most useful elements such as silicon, sulfur and iron. Linking this into the theme of the half-term these elements can be used to prevent death on earth through various ways of engineering. For example, silicon is used in the production of many technological devices such as smartphones which can help people in life threatening situations.

To conclude, the life and death of stars reminds us that even the brightest lights must eventually fade, but their remnants also give birth to fresh beginnings, enriching our solar system and stimulating the potential for life itself.

The Death Throes of Stars

SOURCE:

The Death Throes of Stars | science.nasa.gov

Continuation from previous student article - editor's notes

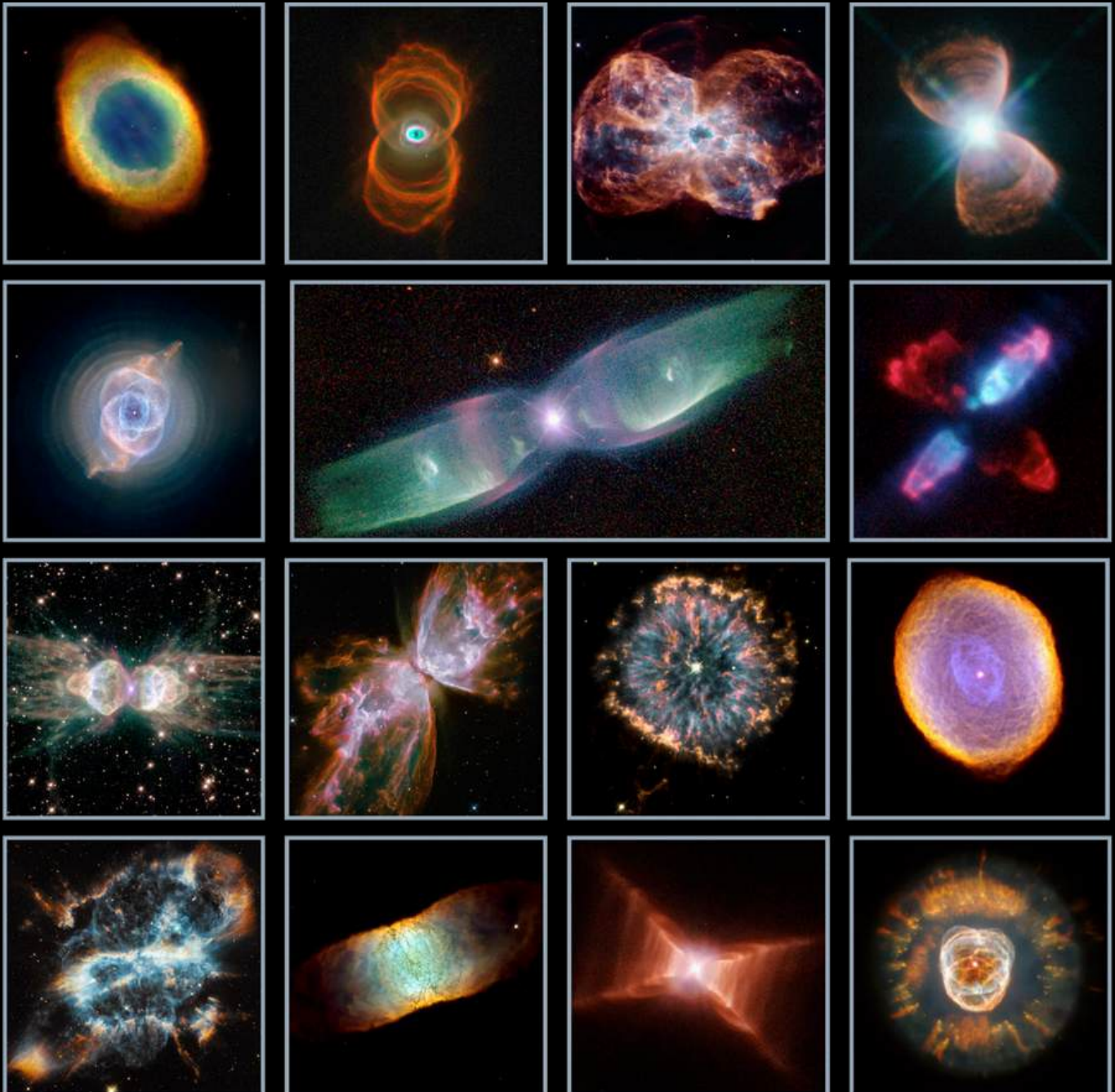
Inspired by *Isabel, 12H*
Written by *Cherrie, 12K*

Hubble reveals details of the mysterious death of stars, ranging from colliding neutron stars to exploding supernovae.

As mentioned in the student article on the left, when a medium-sized star begins to die, they shed their outer layers, forming a shell of gas and dust called a "planetary nebula".

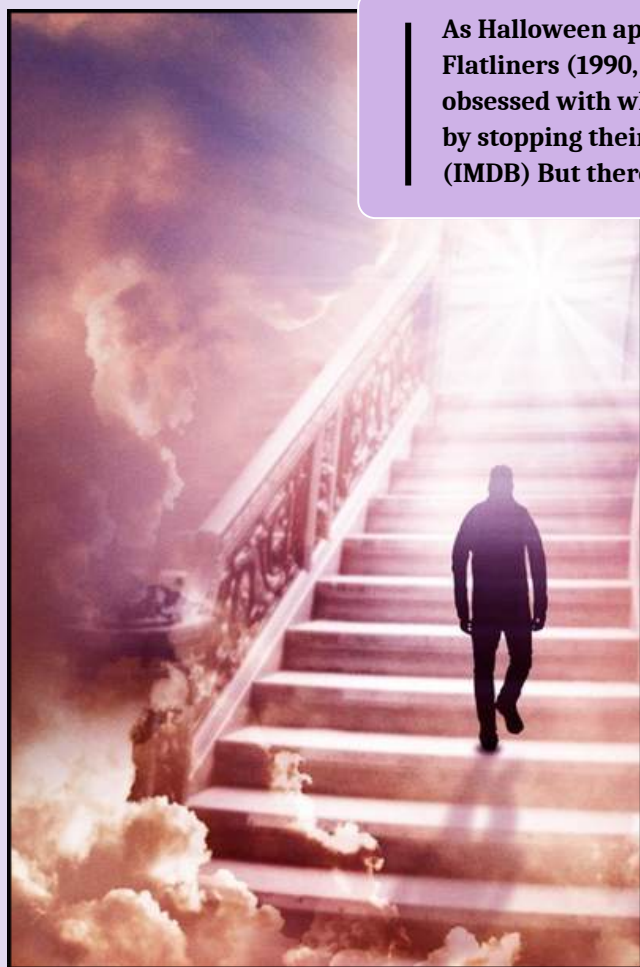
Before the discovery of Hubble in 1990, ground-based images suggested that planetary nebulae have simple, spherical shapes. However, the Hubble discovered the unexpected details, showing planetary nebulae as much more varied and complex. These details offer astronomers insights into complex dynamics a dying star, which they releases their outer gaseous layers before they collapse to form a white dwarf or neutron star.

Here is a series of photos captured by Hubble:



Life after Death?

Written By *Erica Corrigan*, 12W



In a medical setting, 'clinical death' occurs when the heart stops pumping blood, this is known as cardiac arrest. In the minutes that follow, there is a loss of oxygen to the brain and other organs, however the termination of activity in the heart and brain (known as 'flatlining' or 'brain death') may not take place for hours. But still the question stands – what happens in the window between clinical death and brain death?

The idea of cardiac arrest being the 'end of the line' changed in 1960 when CPR was formalised. A large campaign launched to educate clinicians on CPR led to the resuscitated of the once thought dead. As more were revived, the general understanding became that death is a process rather than a point. Now, it is not unheard of for someone to be revived, even hours after being declared clinically dead.

As Halloween approaches, many of us may be watching Halloween thrillers. *Flatliners* (1990, remake 2017) is a movie that is described as 'five medical students, obsessed with what lies beyond the confines of life, embark on a daring experiment: by stopping their hearts for short periods, each triggering a near death experience.' (IMDB) But there is some scientific basis for the movies premise.

For example, in 2011, a young woman was found in a forest the morning after an overdose stopped her heart and, through the use of advanced technology, was revived six hours later, and walked out the hospital after only 3 weeks of care.

Many neurologists are committed to a strictly biological account of 'near-death' experiences, suggesting that, like dreams, these experiences may reveal psychological truths through hallucinations emerging from the brain. In fact, it was reported in a recent study that near-death experiences can be achieved by administering a large dose of ketamine. The basic premise was that no functioning brain means no consciousness and thus no 'life after death'. This was the general theory until Jimo Borjigin (Professor of Neurology at the University of Michigan) took up the challenge of attempting to discover what happened during a 'near-death' experience on a physical level in 2015.

This is the intriguing case of 'Patient One'. Patient One was diagnosed with a disorder that caused an irregular heartbeat causing her to suffer from seizures and faints. When Patient One was 4 weeks pregnant with her third child, she collapsed again, by the time ambulance arrived, she had been unconscious for over 10 minutes and her heart had stopped. After being driven to the hospital, her chest was shocked three times with a defibrillator before they managed to restart her heart and placed on an external ventilator and fitted with a pacemaker. The neuro-intensive care unit found she was unresponsive to external stimuli and had large swelling in the brain and, after being in a deep coma for 3 days she was taken off life support. However, what followed would make Patient One, one of the most fascinating scientific subjects in recent history.

A few moments after she was taken off oxygen, there was a large surge of electrical activity in her dying brain, previously silent areas were filled with gamma waves (high frequency electrical signals). Particularly, the parts of the brain associated with consciousness became energetic, in one section the signals were 12 times higher than before the ventilator was removed and remained detectable for more than six minutes. These levels of activity and connectivity in certain areas of her dying brain suggest that as she died, she experienced something similar to life. However, as she did not recover, we cannot prove that the extraordinary occurrences in her brain had experimental counterparts. There have been similar cases to Patient One however none have recovered, so this is still undetermined.

Still the questions beckons, is there such a thing as a life moments after death?

"To die is such an essential part of life, but we know almost nothing about the dying brain"

~ Jimo Borjigin, neurology professor at the University of Michigan

Preservation of the Dead (Egyptian style)



Written By *Cherrie Li, 12K*

Mummification is a religious ritual performed by the ancient Egyptians, where special processes were carried out to preserve dead bodies. This method was so successful that even after 3,000 years, we can have a good idea of what the mummified body looks in real life just by looking at the corpse.



History

Unexpectedly, mummification was discovered accidentally. The process has been practised ever since the rise of the Egyptian Empire in the New Kingdom (570-1069 BCE).

Coincidentally, due to the lack of rainfall in Egypt, the dry sand and air preserved some bodies buried in shallow pits. Around 2600 BCE, the Egyptians started intentionally mummifying the dead. This practice continued for the next 2,000 years into the Toman Period (30 BCE- CE 364). Some of the best-preserved mummies are from the eighteenth to twentieth century (1570- 1075 BCE), which includes those of Tutankhamun.

Process

The mummification process takes 7 days. Firstly, all internal parts were removed as they decay rapidly. The brain was removed using special hooked instruments to pull out bits of brain tissues from the nostrils.

Then, abdomen and chest organs are removed through a cut made on the left side of the abdomen. The only organ left behind is the heart, as it was believed to be the center of a person's being.

SOURCES

The Surprising Substances Ancient Egyptians Used to Mummify the Dead | Smithsonian (smithsonianmag.com)

Chemical residue reveals ancient Egyptians' mummy-making mixtures (sciencenews.org)

Saqqara: New research reveals rare ingredients that ancient Egyptians used to preserve mummies | Culture | EL PAÍS English (elpais.com) How Mummies Work- Tom Harris

Recipe to the Sacred Oil:

- Oil:** Plant oil prevents oxidation and masks odours
- Tar:** Tar from cedar and juniper trees has antibacterial properties, and is used to seal bodies
- Cedar:** Cedar oil has antimicrobial properties, and helped in dehydrating bodies
- Juniper:** Used similarly to cedar for its qualities to preserve bodies
- Cypress Trees:** Also provides antimicrobial properties, used to slow down the process of decay
- Pistachio Resin:** A resin that provides antibacterial properties to preserve bodies
- Castor oil:** Used to moisturize and protect the skin
- Animal fats:** Used to create a barrier against moisture and bacteria
- Beeswax:** This is used to seal the body and prevent moisture from entering bodies
- Bitumen:** This is used to seal bodies and prevent decay
- Elemi:** A resin that is used as preservative and provide antibacterial properties
- Dammer:** Used to preserve bodies

Other organs, including the stomach, liver, intestine, and lungs, were wrapped in linen with their sacred oils (which dehydrates the body, prevents bacterial and microbial growth, and prevents the body from decaying), and placed in Canopic jars made of limestone, calcite or alabaster. These jars were placed alongside the body.

Then, all moisture was removed from the body. This was done by covering the body with natron (a natural mixture of **sodium carbonate decahydrate**) - a type of salt that has great dehydrating qualities. Next, the mummy is wrapped in linen to keep moisture away from body to prevent decomposition. This also maintains the mummy's shape, and keeps everything together. Lastly, the funeral processions were performed by the priests.

The Science behind Mummification



Find out how modern day chemistry helps us look back in time and explore the ancient world!

Written By *Erica, 12W*

THE STEPS INVOLVED IN MUMMIFICATION

The mummification procedure would begin with the organs removed from the mummy apart from the heart. These organs were stored in various canopic jars. The brain was almost removed but in a different way – in most cases, a hole was made at the base of the skull, the brain was then cut into small pieces, removed and discarded.

The first step of the embalming process was to dry out the body this was achieved by surrounding the body with natron, a salt mixture which was found in dry lake beds, it was predominantly made of sodium chloride and sodium sulphate which made the mixture hygroscopic, so it absorbed water easily, which made it a very effective drying agent. The natron also prevented the decomposition of the body, and after it was applied, the mummy would be left for up to forty days sometimes even longer!

Mummies are arguably the easiest go-to costume, grab some bandages or toilet paper and wrap yourself up. However, there is a little bit more behind the Ancient Egyptian's embalming process than this! (And a surprising amount of chemistry!) Many substances have been identified from chemical residues from Egyptian mummies and containers found in individual tombs which were used to store the substances known as 'embalmers'.

The main focus of mummification procedures and rituals were to keep the body fresh so that the dead could proceed to what was believed to be an eternal afterlife. These procedures are believed to have changed over time, evidence for this was provided by Maxime Rageot (biomolecular archaeology) who excavated a cemetery site called Saqqara in 2016 which was dated back to Egypt's 26 dynasty (664BC-525BC).

The mixtures that were used different from those used around 700 years earlier for the mummification of King Tutankhamun. Archaeologists have been able to outline the steps involved in mummification through the analysis of mixtures in vessels and writing on the walls and vessels which named the different embalming substances and what they were used for such as 'to put on his head'.

After these forty days, the body was packed with sawdust and linen as well as other materials to improve the smell of the body like cinnamon, cassia, frankincense, myrrh and even in some case onions!

Unbeknownst to the ancient Egyptians, some of these substances actually contained compounds which can protect microorganisms. For example, cinnamon contains cinnamaldehyde is known to have some antibacterial properties.

Once the body was prepared, it was coated in oil and covered with resin-soaked bandages. Often a cedar or coniferous resin, and in some cases beeswax or even bitumen were used as the oil. This enables modern day chemists to identify what was used during the embalming process due to the chemical signatures left behind by the resins and oils. By analysing the bandages using gas chromatography with mass spectrometry, marker compounds are identified, which indicate types of resins.

And finally, whether you are dressed as a vampire, a witch or a mummy, have a brilliant Halloween!

Supporting Life and Saving Lives Through Engineering

Written By *Emma Green, 12H*

Biomedical engineers combine science, technology and engineering to save lives. They are involved in many life saving processes such as rapid disease detection, drug delivery systems, prosthetics and vaccine development.



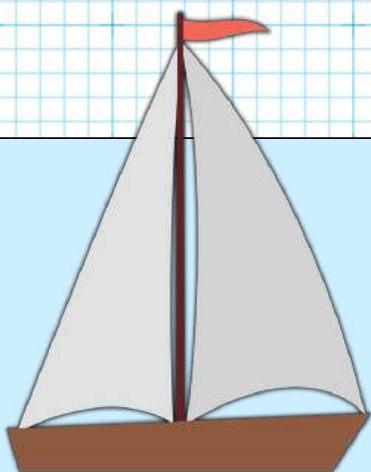
Vaccines

Vaccines are crucial as they teach your immune system how to create antibodies, which protects you from diseases. Once your immune system knows how to fight a disease, it can often give you lifelong protection. Biomedical engineers design processes for creating and delivering vaccines to ensure they are as safe and efficient as possible.

COVID-19

The work of biomedical engineers was life saving during the COVID 19 pandemic. The COVID 19 vaccine is a specific type of messengerRNA (mRNA) vaccine which uses mRNA created in a laboratory - by biomedical engineers - to teach cells how to make a protein that stimulates an immune response inside our bodies. It is estimated that the development of the vaccine prevented 1.4 million (World Health Organisation statistic) deaths across Europe.

Would you drink your toilet water? What about if your life depended on it? Drop by drop, freshwater resources are becoming scarce. Representing just 2.5% of all available water on the planet, freshwater is coming under ever-increasing pressure, linked predominantly to population growth.



Would you trust engineers with the most precious resource for life?



Engineers including civil, process, chemical and biological are working together to mitigate drinking water shortages.

Did you know that since 1968, the city of Windhoek in Namibia has been treating wastewater to deal with population growth and an arid climate. Now, fifty-five years later, 30% of wastewater is recycled into drinking water in less than ten hours.

However, in the United States in 2000, a wastewater treatment plant in a Los Angeles neighbourhood, which had cost \$55 million to build, had to close down a few days after its opening, because "never make people drink toilet water" had become an election promise of the politician running for mayor. It could be coming to the United Kingdom...with a £1.2bn scheme, Southern Water wants to treat effluent – wastewater from the sewage system – at a plant in Hampshire and pipe it into a nearby spring-fed reservoir to boost drinking water supplies. The scheme would ensure that less water is extracted from two rare chalk streams.

Life and Death: AEDs (Automatic External Defibrillators)

Written By *Tiffany Lee, 12L*

Brief Introduction

AED (Automatic External Defibrillators) are medical devices that attempt to resuscitate a person who is experiencing sudden cardiac arrest. They pass a prescriptive electric shock across the heart, causing the heartbeat of the patient to stop temporarily for the natural pacemaker to resume Sinus Rhythm -normal heart rhythm. Ideally, the patient should be defibrillated as early as possible can. Resuscitation Council UK states that survival rates can be as high as 50%- 70% if treated within 3-5 minutes of SCA. From then, operators would proceed to continue CPR in addition of checking for vital signs ABCDE. This follows the Chain of Survival in event of a medical emergency.

Sudden Cardiac Arrest

Sudden Cardiac Arrest occurs when irregular heartbeat deprives blood and therefore oxygen supply from vital organs like the brain. The major symptoms of SCA may include unconsciousness, unresponsiveness, collapsing, and abnormal breathing (shortness of breath). Others include palpitations and faintness.

There are **2** main causes to Cardiac Arrest under the umbrella term, **Arrhythmia**, being:

- **VT (Ventricular Tachycardia)** *simply put, literally embodying Usain Bolt*
-sustained rapid heart rhythm leading to reduced blood flow to tissues and cells
- **VF (Ventricular Fibrillation)** *jazzing out with Ella Fitzgerald*
-irregular heart rhythm leading to a lack of blood flow where blood does not get pumped from the heart at all.

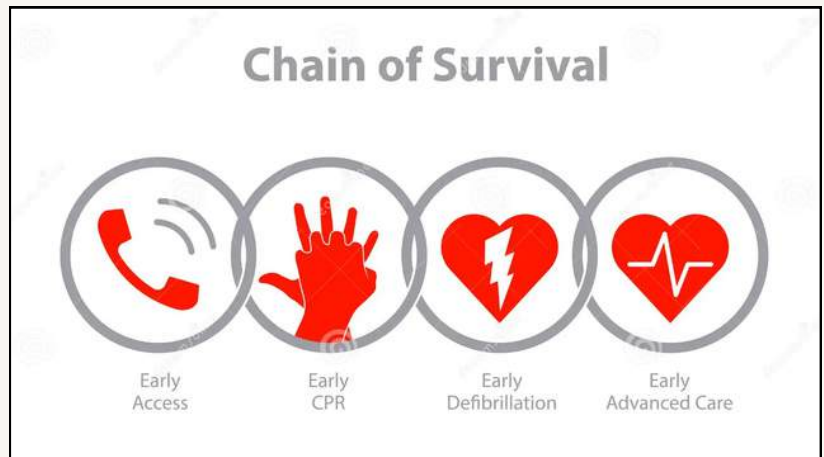
Both types of Arrhythmia underline disordinate muscle contractions in the ventricle heart chambers. In terms of pressure, hearts of VT struggle to fill the normal volume of blood into its chambers (Imagine a 3-year-old preschooler trying to inflate a balloon: he's not letting the pump fill up and is hopelessly going as fast as he can). On the other hand, hearts of VF have quivering ventricular muscle walls which disallows the heart to pump blood with enough force around the body (imagine the same preschooler beating a balloon thrice his size: still hopelessly desperate, yet doing negligible work).

It must be clarified that AEDs cannot be of use to Asystole – flatlining, as Heart Muscle/Nerves have no biopotential (electrical activity){1}, it is categorised as a non-shockable rhythm. Furthermore, unlike SCA, electrical stimulation administered by AEDs will not aid treatment of heart attacks. The reason being that the root of heart attacks lies in physical blockages to the heart created by buildup of cholesterol.

How to Use AED Machines (in event of Sudden Cardiac Arrest)



1. Before using the machine, call for emergency services and perform CPR on the patient while bystanders fetch for the AED until a shock is administered. Please note that one must never leave a patient unsupervised unless they are stable or when assistants are at risk of harm.
2. Turn the AED on, ensuring the patient is not lying in wet/conductive surfaces.
3. Follow the auditory-visual instructions as stated on the panel and voice buzzer.
4. Remove any obstructions that will affect the placement of the electrode pads (eg: clothing, body hair, metal object).
5. Attach the self-adhesive electrode pads on the abdomen- one just below the clavicle(collarbone), the other on the bottom of the pectoral muscle in closest proximity to the dorsal side. This is slightly different for children where one is placed slightly right from the sternum. the other between the shoulder blades on the back.



6. Pause CPR so the ECG analysis is not interrupted. The AED will decide whether an electric shock is to be administered.
7. If so, all assistants must stand clear of the patient. Once the shock is delivered, restart CPR. Continue to follow AED instructions unless otherwise.

The Actual Bits & Bobs That Do Wonders

AED machines involve 3 fundamental groups of synchronised electrical components operating either automatically or semi-automatically with human feedback. Ultimately, the goal is to efficiently detect the irregularities of ECG, record, then deliver precise Joules of electrical energy from an electrode pad to another.

For starters, the most important components is the Control Computer (including programmed IC chip). The group's main function is to constantly process ECG records of the patient's heart while the electrodes are attached. An ECG record measures biopotentials that make up each heartbeat (specifically the P-waves, QRS pulse and T-waves during contraction and relaxation of the coronary muscles) as collected at the electrodes. The ECG is referenced against factors of Transthoracic Impedance {2}, etc. to diagnose the health problems and generate the decision of administration/magnitude of shocks. The response travels in a set of binary electric signals to the output components. In addition, the computer is programmed to relay corresponding user feedback input with sequential visual/auditory output of instructions via user interface.

On a related note of the User Interface Group, they are components that enables communication with human operators using inputs such as switches/indicator lights and outputs such as graphic display/voice buzzers.

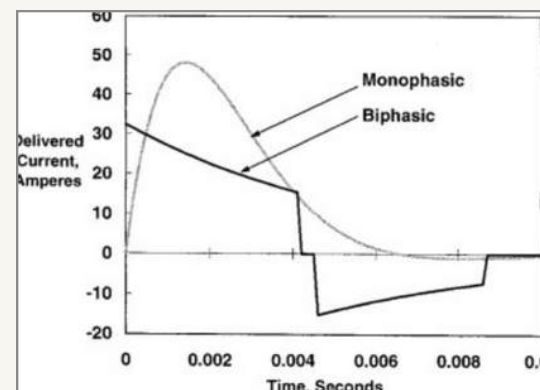
Finally, the energy supplying group, namely consisting of the Battery Pack, Capacitors and Electrodes which control the electric energy around the circuit. The battery pack provides electrical power. Consequently, it is vital that they are replaced 4-5 years depending on the AED. A large proportion of that electrical energy goes to the capacitors. Capacitors accumulate a set amount of both positive and negative charge, generating an electrical field that is then released as current on command. The electric current travels across electrode conductors that contact non-conductive surfaces, subsequently reverses to return to the first, this is known as a Biphasic waveform. This type of release requires low energy and is statistically deemed as more efficient. The reduced current strongly diminishes potential of skin burns and heart injuries compared to monophasic waveforms (used in the past, current only passes across the heart once). The electrodes which are also capable of detecting electrical impulse emit by the nerves, hence the ECG recording.

The integration of automated systems in defibrillators allows usability while reducing critical risk of human error, meaning people without first aid training are more likely to be able to provide defibrillation. Alongside portability given by means of the battery pack, the accessibility of AEDs increases the coverage for immediate SCA treatment.



The Future of AEDs

Since the widely recognised invention of external defibrillators by William Kouwenhoven in 1930, AEDs have been gradually developed to reawaken lives that have a 7-10% deterioration in survival rate per minute. Perhaps in the very near future, AEDs will be delivered instantly by drones at call and desperation wherever you are in the midst of your endeavours. Be it sky or sea, you may seek them, and they shall meet thee.



REMARKS & SOURCES

1. For more on Biopotential & ECG : [ISBN 0 435 68682 8: Options in Physics Medical Physics Jean A Pope], available at KHS Library
2. Transthoracic Impedance refers to the resistance of the body against the AED shock.
3. Biphasic waveforms have truncated currents since exponential ones still have a slight disruption on the altered biopotential.

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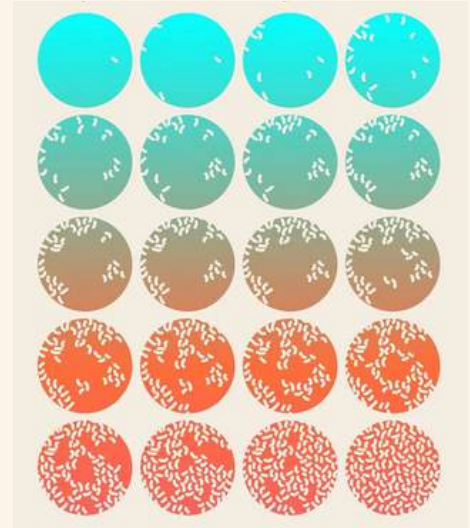
2024/2025

CAFÉ SCIENTIFIQUE

PATHOGENESIS- HOW GERMS MADE HISTORY

- **Johnathan Kennedy**Written By *Lucy*, 13

Over the Summer, I read the book Pathogenesis by Jonathan Kennedy, which I would highly recommend to anyone who is interested in the link between History and Science, Epidemiology or how disease influences the world we live in.



The book begins with an insight into Palaeolithic and Neolithic illnesses which according to James Scott was arguably the most lethal period in human history. It outlines how Homo sapiens were able to outcompete the equally intelligent Neanderthals, and how everyone has approximately 2% of their DNA from Neanderthals, mostly involved in immune response. This was a fascinating topic.

The Yersinia Pestis bacterium makes frequent appearances in the book: from the plagues of Justinian, arguably ending the Roman Empire, to the Black Death in the 1350s in which 40-60% of Europe's population were wiped out by a single 'Great Pestilence'. Kennedy powerfully argues that this was an extreme form of Natural Selection as a response to overpopulation and the cultivation of more agricultural land. The bacterium continued to decimate European populations for the subsequent 200 years, the population declining until the reign of Edward VI (1547-1553). This example demonstrates how devastating repeated outbreaks of disease can be on the human population.

Later in the book, Kennedy shows how colonialism led to the spread of disease, using the example of

how the Spanish were able to colonise South America through deadly outbreaks of smallpox in particular. The opposite was true during the colonisation of Africa where diseases such as sleeping sickness, yellow fever and malaria decreased the survival time of colonial administrators to just 4 months. Anyone who had survived either of these diseases in infancy was unaffected. Colonialism led to the globalisation of disease, something which COVID-19 was also able to utilise.

The chapter on diseases of poverty, including tropical neglected diseases was a useful insight into where research into disease is centred. I found it shocking to learn about how wealth disparities can massively affect life expectancy, between countries and even within them. For example, people who live in Kensington in London can expect to live 27 years longer than if they lived in Blackpool, just 4 hours away. This difference is the same as the difference in the average life expectancy between living in the UK and living in the Horn of Africa. This chapter also explored the factors which can affect life expectancy, including access to healthcare, diet, living standards and access to preventative treatment such as vaccines. It also explored the alarming rate at which non-communicable diseases are being diagnosed.

Pathogenesis ends with a powerful thought. Diseases have shaped human history and despite having now the resources to diagnose and treat disease, more than 1.2 million people die each year from illness previously treatable with antibiotics. COVID-19, despite not being quite as deadly as first predicted, has highlighted how wealth disparities affect life expectancy and susceptibility to disease. With the rise of antimicrobial resistance, Science will need to adapt to ensure treatments are available to all and are still effective.

FEATURED BOOK TITLES

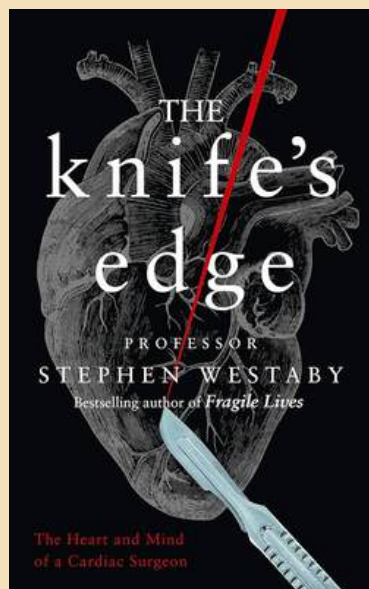
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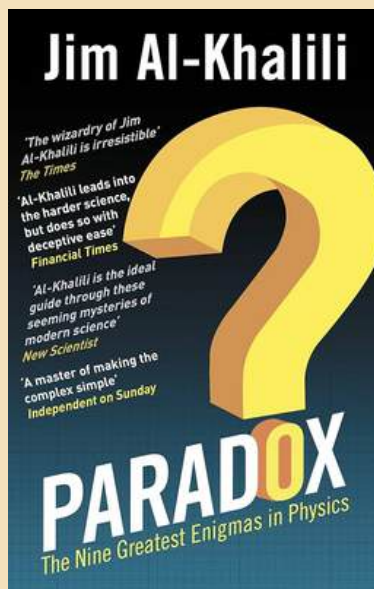
Suggested by *WS/KHS Students* and *Newsletter Team*

Collated by *Sahana, 12L*



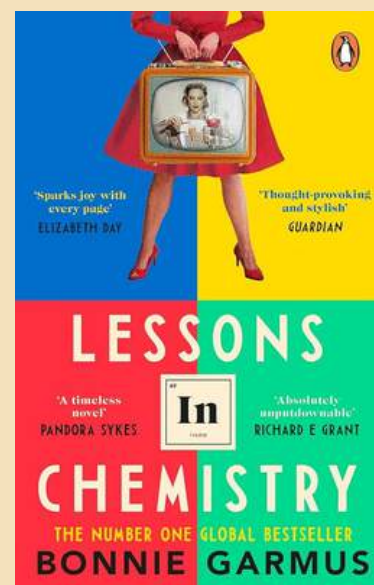
MEDICINE

The Knife's Edge
By *Stephen Westaby*



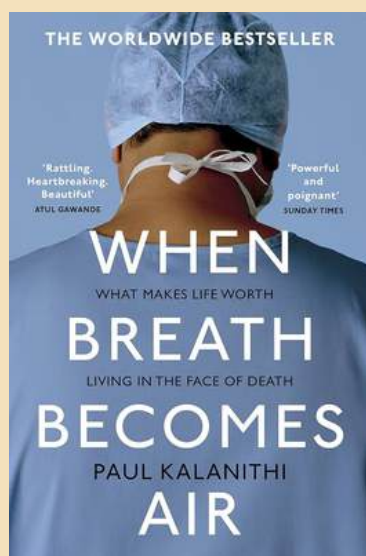
PHYSICS

**Paradox: The Nine Greatest
Enigmas in Physics**
By *Jim Al-Khalili*



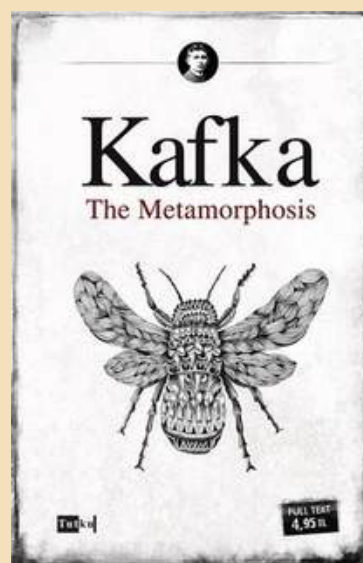
CHEMISTRY

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CAFÉ SCIENTIFIQUE

Written By *Cherrie, 12K*

SCIENCE WEEKLY - THE GUARDIAN

Around **72%** of Greek centenarians were involved in pension fraud cases in 2012, and this is definitely a unique way to achieve longevity.

Dr Saul Newman, an interdisciplinary researcher at the University College of London and Oxford University, just won an Ig Nobel Award for his research into skewed longevity data. This is what he found: "You don't need the Mediterranean diet for longevity. You just need bad paperwork."

Saul first got interested in ageing data after finding errors in a 2016 study published in Nature, in which they stated it was impossible for humans to live above a certain age. Then in 2018, another paper came out, claiming there was potentially no limit to human existence. This was when Saul looked deeper into this skepticism.

He came up with a theoretical reason that most old age data are "junk", and worked on proving his hypothesis. So what is this theoretical reason? Newman assumed there is a group of "young liars"- people who identify as older than they actually are, and take up a very small percentage of the population. Over time, these groups of "young liars" survive at a higher rate than people of their actual age, which creates false data about their age, affecting the database. This could be caused by loss of birth certificates, poor government census, and poor data processing.

ARE THE WORLD'S OLDEST PEOPLE REALLY THAT OLD?

There are 5 blue zones in the world: **Sardinia in Italy, Okinawa in Japan, Acadia in Greece, Nicola in Costa Rica, and Loma Linda in California.** People in these blue zones are identified to regularly reach 100 years of age, with scientists claiming it is "simply a product of their environment". *But do they live for that long?*

Dr Newman also tracked down 80% of all the extremely old people in the world and mapped out their place of birth and death simply using Google Sheets. He discovered a few interesting things:

- Most of the supercentenarians in France come from the very poorest regions of France.
- The best place to reach age 105 in England was Tower Hamlets- which is coincidentally the worst place to be an old person according to the English government.
- There is a negative correlation between the number of 90-year-olds with the number of 105-year-olds, meaning the more 90-year-olds you have, the fewer 105-year-olds you have.
- People who reach 110 have a 150% higher chance they're born on the first day of the month compared to the previous day.
- The United Nations shows some of the regions which have the best survival age of 100 age include Puerto Rico and Malawi, some of the poorest countries in the world.

Newman followed up his findings by saying the best way to achieve old age is to live in a place with a high rate of poverty, a lack of birth certificates, and fewer 90-year-olds.

HOW DO THE FINDINGS CONTRADICT THE BLUE ZONES?

So there are 9 central claims of blue zones: The first is to move naturally. Despite being a blue zone, **Okinawa** consistently since 1975 has the **highest BMI** in Japan, and they are the **3rd last** for the number of people **who do gardening**. The 2nd and 3rd central claims are purpose and downshift. Okinawa is also ranked **4th last for rest and relaxation time**. They are also ranked the **4th highest suicide rate for over 65s** in Japan. The 5th central claim states to plant slant (meaning to eat more vegetables). However, people in Okinawa are the **last for all vegetable consumption** (roots, pickled, leafy, etc). They eat over **40 kg of meat per capita**, and the **least sweet potato** in Japan. The 7th and 9th central claim states to be in the right tribe and belong to some faith-based community. As predicted from previous contradictions, **93.4% of people in Okinawa are atheists**. Obviously, Okinawa does not seem to fit into these 9 central claims. So where does the data from the blue zone even come from?

What the blue zone described- gardening, community, having a sense of purpose, eating fresh fruits and vegetables- are good advice to be healthy. However, Newman believes these are the idealised lifestyle for wealthy people in the West. Newman states the idea of living a simple, honest lifestyle with moderate physical activity is delusional. These blue zones are just where wealthy people exist. These blue zones are just "clean places with lots of money, and what they spend their money on is exercise and doctors."

Newman concludes there are no physical measures of human age, and longevity just comes down to bad reporting of age and skewed data.

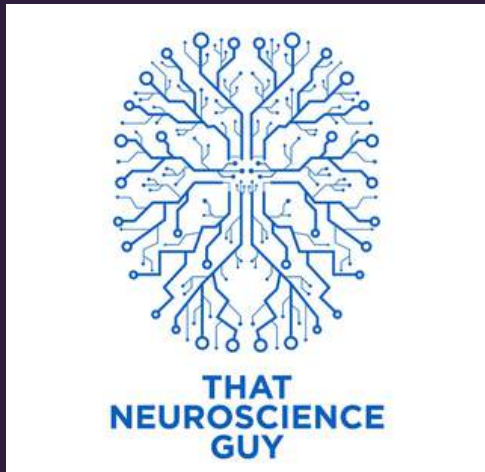
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CAFÉ SCIENTIFIQUE

Written By *Cherrie, 12K*

THE NEUROSCIENCE OF DEATH - THAT NEUROSCIENCE GUY

The Experiment

What is going on in the brain when you die?

Research shows your brain continues living after the body dies!

It is not uncommon that people who came back from a near-death experience say they've seen and experienced things, including a "a sense of looking at the body from the outside; a tunnel and white light; or a sense of reliving important memories" (Papas et.al, 2023). This is very difficult to tell as we don't know what "thing" happened as they "died".

A study led by Jimo Borjigin- a neuroscientist at the University of Michigan Medical School- got permission to monitor people that were about to die. These patients are on ventilators, and they themselves had made the decision to turn off the ventilator. The researchers then recorded the EEG (electroencephalogram) data- brain wave data- right before the ventilator was turned off. And this is what they found: there was a surge of gamma waves in the brain, with oscillations between 31 and 100 hertz. And these gamma waves picked up for a minute or so.

Prior to the actual moments of death (after the ventilator was turned off, and the person's breathing stops but before the brain stops functioning), the person actually lived for a short time for around 30 seconds before actual death. There is an increase in gamma oscillations, as if the brain knows death is coming. "It is reading the body organs, it's reading the information, it says yep, this is the end, we're gonna shut down".

So what do these gamma oscillations mean?

Gamma oscillations are linked to memory cognition and attention, so they are a sign of consciousness. So the surge of gamma oscillation right before death means an increase in activity that's associated with attention, cognition and memory. This surge of gamma oscillations continues for a few seconds after death. This phenomenon is still ambiguous, but now scientists are hoping to collate more end-of-life data to generate an explanation for these gamma-waves.

WHAT CAUSES US TO DIE? WHAT HAPPENS TO YOUR BRAIN WHEN YOU DIE?

Olof Krogolson, a neuroscientist at the University of Victoria reveals the main causes of death, along with debunking the neuroscience behind dying.

In reality, very few people die of old age, and death is not just something that happens. Everyone dies for other reasons other than simply old age. The main causes of death includes (most common -> least common):

1. Heart and circulatory disorders
2. Cancer
3. Respiratory disorders
4. Nervous system disorders
5. Digestive disorders
6. Kidney infections
7. Infections in general
8. Others: non-transport accidents, diabetes, musculoskeletal disorders, suicide, transport accidents, mental health disorders, murder, medical complication, pregnancy, war, etc.

SOURCE

Surges of Activity in the Dying Human Brain Could Hint at Fleeting Conscious Experiences-Stephanie Pappas & LiveScience 2023

So how does ageing cause death? As you age, your body can't maintain homeostasis (so old people are more susceptible to cold and heat), decreasing the ability to adapt to internal and external stresses, and causing damage to body systems. This impacts blood sugar levels, water content, pH levels, body heat, and nutrient levels, which all cause damage to the body and the brain.

In the brain, we lose around 20- 25,000 neurons a day from the time we are about 19 years old. Effectively, your brain is dying from the time you are 20. As our brain slowly deteriorates overtime, this causes us to be more susceptible to mental issues at later stages of life. This includes memory loss, impaired decision-making, and difficulties in learning, which eventually cause our brain to fall apart as we get old, leading to death. These damages are irreversible, and accumulate overtime.

However, WHY do we age? There are 2 main theories:

1. Error theories- basically it is what's mentioned above, where the body fails to maintain homeostasis, leading to stress, and causing irreversible damages that accumulate overtime. This includes...

- 1.1. Cross-linking theories- proteins damaging organs in the body
 - 1.2. Free radical theories- atoms with unpaired electrons damage tissues they encounter in the body.
 - 1.3. DNA damage theories- the DNA itself gets damage
- All these processes create error and damage to tissues and the brain, which are irreversible and eventually leads to death.

2. Programmed theories- some people argued our lifespan is coded in our genetics, aka programmed longevity. But why? No one really knows. There are some theories behind this...

- 2.1. Endocrine theory- your endocrine system is programmed to stop functioning at some point, so hormones stop being produced, causing death
 - 2.2. Immunological theory- our immune system is hardwired to shut down
- All these theories states that our brains and bodies are programmed to die, where we have an expiry date.

But to this date, scientists still can't conclude why we age.

HALF-TERM AI NEWS

CAFÉ SCIENTIFIQUE



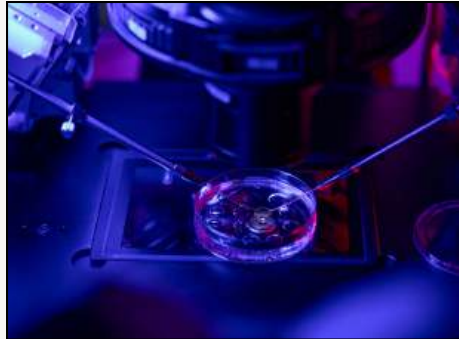
Inside-Out Galaxy Growth Observed by JWST

Astronomers have used the James Webb Space Telescope to observe the inside-out growth of a galaxy in the early universe.



Genomic Study on Man-Eater Lions

Hairs from 19th-century lions' teeth were analysed, and DNA from various prey, including humans, was revealed.



Embryo Development Insights

Scientists have provided new insights into how disorganized cells form a robust embryo.



Fungi Recognizing Shapes

New research suggests fungi may be able to recognize shapes despite lacking eyes or brains.



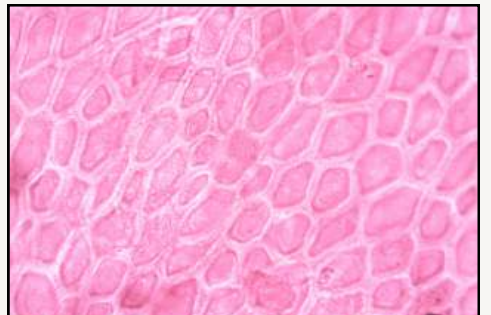
Bilingualism and Brain Efficiency

A study shows that bilingualism increases brain efficiency, especially when learned young.



Skin Tone and Medication Effects

Research indicates that skin tone can affect how medications work.



New 3D Printing Technique

A new method allows for finely tuned 3D-printed objects using only one material.

FEATURED FILM/TV TITLES

NEW

VOL. 1

2024/2025

CAFÉ SCIENTIFIQUE

Suggested by *Newsletter Team*



PHYSICS

Interstellar (2014)



BIOLOGY

Ready Player One (2018)



BIOLOGY

MEDICINE

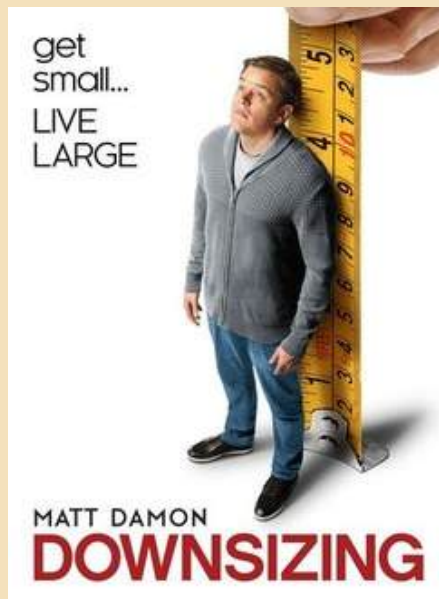
Brain on Fire (2018)



ENGINEERING

The Silent Sea (2021)

[고요의 바다]



BIOLOGY

Downsizing (2017)



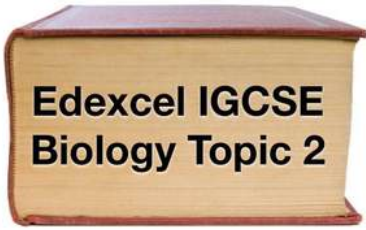
PSYCHOLOGY

The Good Place (2016-2020)

MEMES

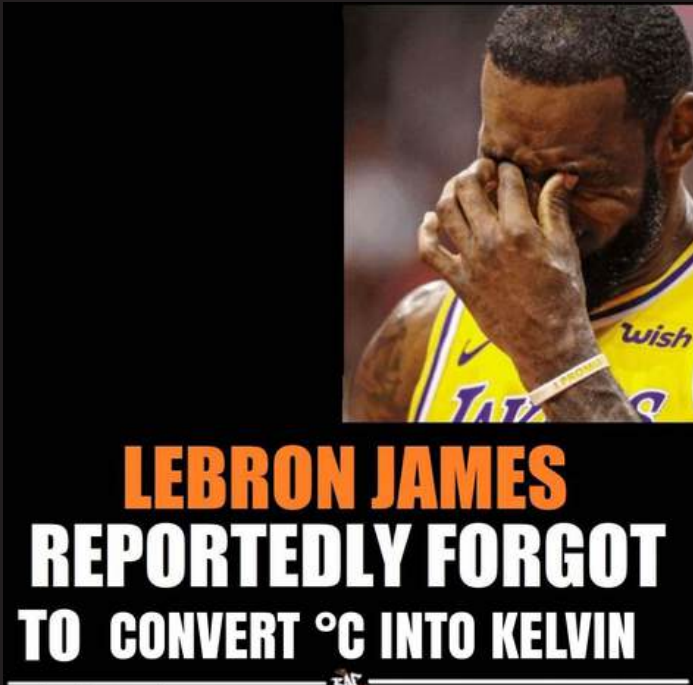
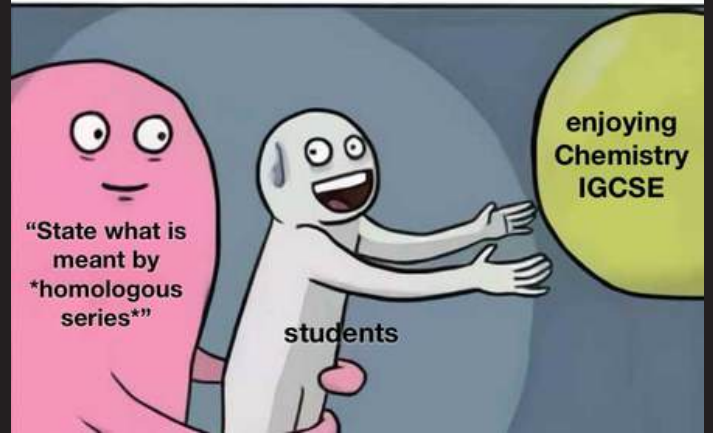
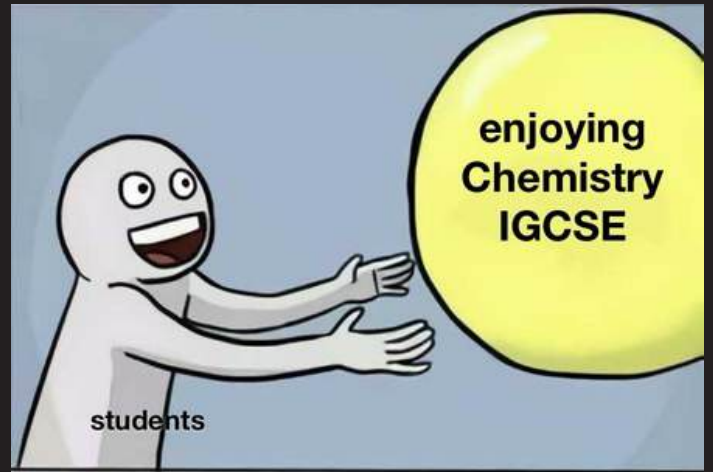
By Sahana, 12K

This half-term's memes show the joys and struggles of life as a science student.



Edexcel IGCSE
Biology Topic 2

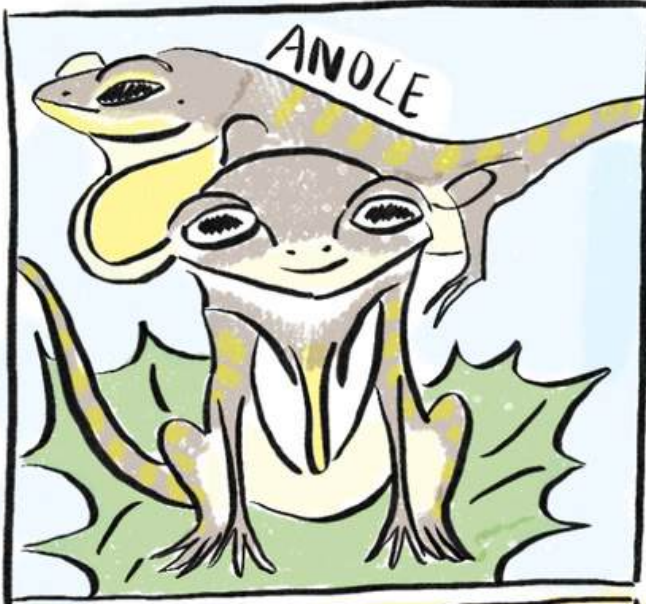
literally every
other topic in
the course



recessive characteristic in cross between heterozygote and dominant homozygote



SURVIVAL GUIDE OF ANOLES



WATER ANOLE IS A SEMI-AQUATIC LIZARD, NATIVE TO SW COSTA RICA



WHEN THEY SENSE THREAT...



THEY MAKE AN AIR BUBBLE AROUND THEIR NOSTRILS TO BREATHE UNDERWATER TO HIDE



THIS LETS WATER ANOLES TO SURVIVE AND PRODUCE OFFSPRINGS

WATER ANOLES JUMP INTO STREAMS WHEN THREATENED & PRODUCE A BUBBLE THAT LET THEM STAY UNDERWATER FOR UP TO 20 MINUTES!

PUZZLES

Life & Death: October 2024



Week 1

1. I eat everything that comes near me, including my own acquaintances. I am born from the death of something very great in mass and very hot. What am I?

1. _____

2. I can be found in beets and canned fish. But I am also the most lethal substance you will ever meet. What am I?

2. _____

3. Whoever I touch, they get buboes, chills, and possibly die. People wear a mask that looks like crows to avoid me. What am I?

3. _____

4. Recycling is my job. I take old or damaged components, and turn them into monomers that can be used as fuel or form new proteins. What process am I?

4. _____

5. I am very old. Although I am the weakest of the 4 amongst my 4 siblings, I hold the universe together. What am I?

5. _____

Life & Death: October 2024



Week 2

1. _____: Life-threatening allergic reaction that occurs quickly; this is caused by a sudden drop in blood pressure and narrowing of the airway, causing difficulties in breathing (Noun)

2. _____: Also known as childbirth, involves 3 stages: dilation, expulsion, and placental. (Noun)

3. _____: All living things require this gas (Noun)

4. _____: A bloody event caused by the build-up of natural gases produced by methane-producing bacteria inside dead organisms during the decomposition process (Noun)

5. _____: Medical term for a heart rate over 100 bpm when at rest, which could also be a sign for organ failure. (Noun)

6. _____: Reproductive way where embryos develop inside eggs within material body until they are hatched, which resembles a live birth, e.g. sharks, ray, and snakes (Adj)

7. _____: The pseudoscientific concept of the sudden explosion of human beings (Noun)

8. _____: The non communicable disease which caused the most death globally in 2021, characterised by narrowed heart arteries. (Noun)

9. _____: A violent and luminous explosion of a star. (Noun)

What does the first letter of all answers spell out? _____

Give a 1-sentence definition to the word. _____

GLOSSARY

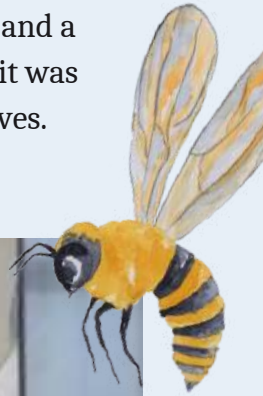
Collated by *Isabelle*

- **Microlensing:** where a massive lens bends the light of a bright background object to generate images of the background source. (pg.6)
- **Glare:** dazzling light. (pg.6)
- **Superradiance:** a form of enhanced emission of radiation occurring when a collection of atoms can emit light as if they were one single quantum mechanical system. (pg.6)
- **Eccentricity:** deviation from a pattern/norm (pg.6)
- **Binary stars:** a system of 2 stars where one orbits around the other, or they both orbit around a centre point. (pg.7)
- **Apex:** top/highest part. (pg.8)
- **Genome:** the genetic material of an organism (pg.8)
- **Genus:** type of category like species (pg.13)
- **Mutation:** where a gene in the DNA changes. (pg.13)
- **Canopic Jars:** an urn in which Ancient Egyptians stored soft internal organs of deceased bodies. (pg.15-16)
- **Bitumen:** a fraction of crude oil. (pg.15)
- **SCA:** Sudden Cardiac Arrest (pg.17)
- **Sternum:** Breast bone connecting the collarbone to the ribs (pg.17)
- **ECG:** Electrocardiogram – a test that measures the electrical rhythm of the heart including rate and rhythm (pg.18)
- **Anti-microbial resistance:** When microorganisms such as bacteria, fungi, viruses, and parasites no longer respond to the medicines designed to kill them. (pg.18)
- **mRNA:** a strand of RNA that transports a copy of the DNA code to the ribosome in the cell to create proteins. (pg.19)
- **Centenarians:** People who reach the age of 100 years. (pg.24)

ANNOUNCEMENT FROM THE ANIMAL AWARENESS CLUB



In Animal Awareness club this Tuesday we learned about bees in preparation for going to see them next week. We learned lots of fun facts like how bees swarm to stay as a colony if moving hives and how there are three different types of bees the queen bee who lays all the eggs, the worker bees go out of the hive to forage for nectar and feed the other bees and the drones who mate with the queen bee. Unfortunately though we also learned these amazing creatures are under threat from mice and wasps who steal the bees stores and food so they eventually die out but there is a guard for this on bee hives, they can also a varroa mite that attack and feed of them that can spread around a colony causing them to die and finally in the winter if the hive gets too cold or they don't collect too many store they can die out too. Rhiannon who runs the club also brought in her bee outfit that is used to protect yourselves from the bees when going near the hives as they can sting and a few of us tried it on me included, it was quite complicated to put on and a bit big but it was fun to try it on and I can't wait to actually need one next week when we go in the hives.



Acknowledgements

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



Isabel
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Eleanor
WSS Student



We would like to thank last year's Café Scientifique team...



Millie
Isabella
Lucy

Amelia
Alais
Neha
Tamika



This newsletter is presented to you by...



Sahana
Cherrie
Karine
& Members of Café Scientifique





VOL.1 (2024/25) – AUTUMN 1ST HALF-TERM

~ LIFE AND DEATH ~

CAFÉ SCIENTIFIQUE