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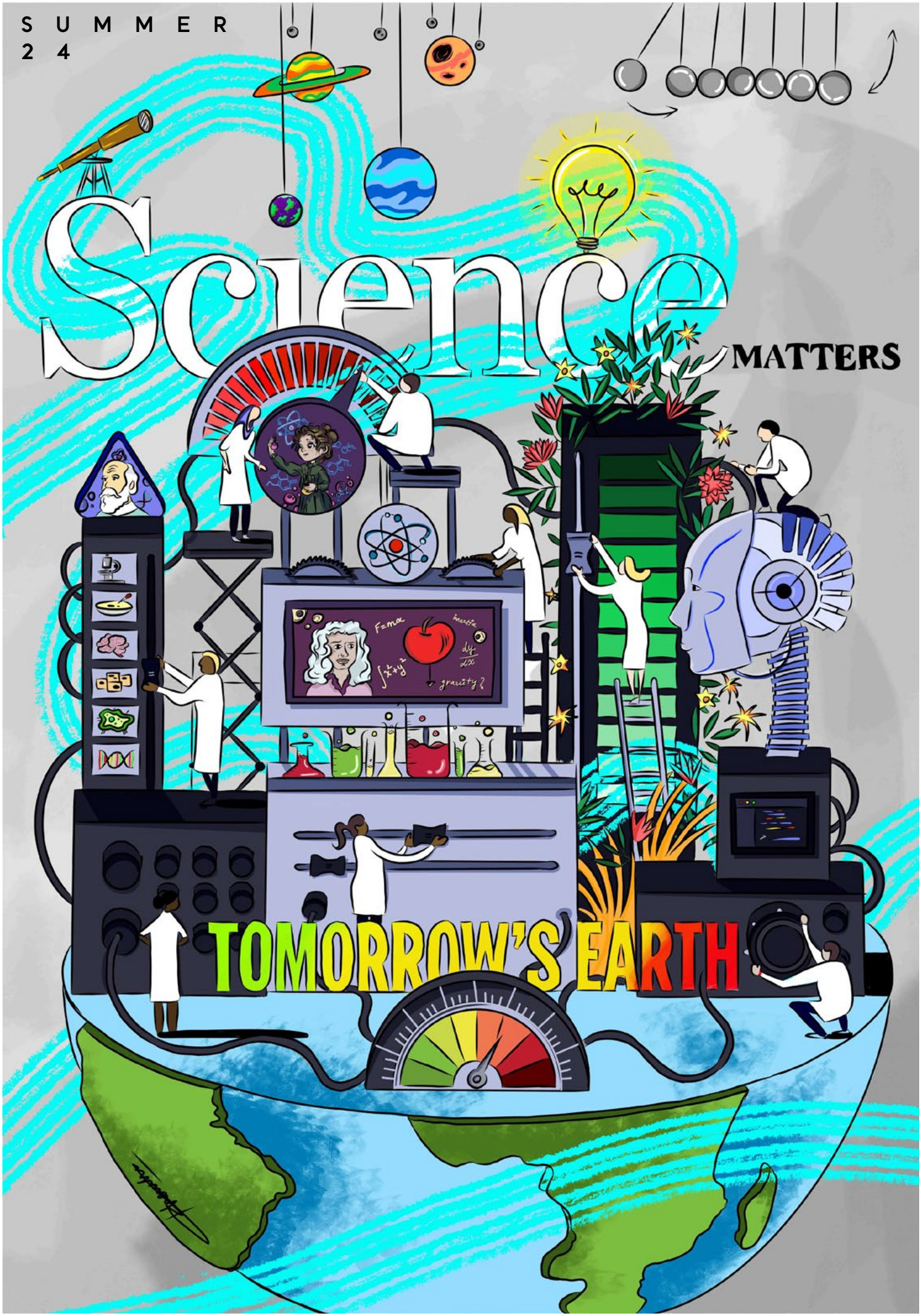


The Abbey Science Department Interviews

Interview with Mrs Beattie about the RSB

Could you tell us about your work in the Royal Society of Biology?

My work involves helping develop policies which inform education, science and public affairs. I am part of a team who talk about the education landscape and the changes we want to make in terms of assessments, what is taught and what is important to students to ensure they become lifelong learners. My main priority is to help draft responses to the Department of Education in terms of teacher recruitment of specialist science teachers, training and retention. During the meetings, we discuss how the Royal Society of Biology are collaborating with other organisations to help solve the challenges in the modern world, for example antimicrobial resistance, food security, new genetic technologies, and ensuring there is an adequate supply of educational staff to ensure a promising pipeline of future biologists.

RSB host many activities including the Bio Attack competition, Biology Challenge and Intermediate Olympia. The good thing about the biology competitions is that it doesn't just test what is in the curriculum, it tests what you've seen on TV, read about, and your love of David Attenborough obviously! So, it is definitely an interesting competition whereby many of our students have an opportunity to showcase their talents.

What has been your most memorable part of teaching at the Abbey?

I think probably running Biology club. We started off not knowing how many students were coming and there were more and more students week after week. I think it had a massive impact on the students who decided to come and it left an impression on me because it showed they clearly enjoyed the club as they went and told other students which has encouraged me to offer more biology activities next year.

The Biology club is run by the 6th formers who design and run biology experiments that younger students can enjoy and to do practicals that are not in the curriculum, because the curriculum is quite rigid and science is not rigid. We want children to realise that science is so much more than just what you learn in school and there is a wealth of opportunities to pursue for their future careers.

I had a card from a student the other day. It read, "thank you so much for doing all the work with Biology Club. I've really loved it, and I've learned so much from it.".

I think you become a teacher because you want to instil that passion for biology into others so to pass on my enthusiasm means the world to me.

What's your favourite topic to teach?

I think my students will probably say microbiology, immunology and viruses. I find it fascinating how something so small, that we can't see, can cause so much damage and harm. I think for me, it's just how something microscopic can be so influential in our lives. And yet, although they have the capacity to cause so much harm to many people, which is what everyone focuses on, they are so important to every organism on the planet. The most amazing part is we're going to exploit the use of viruses to do something

good, for example, delivering medication and gene therapies. For those wondering what I read over the summer holidays- my book of choice was I contain multitudes: the microbes within us and a grander view of life by Ed Yong. Definitely recommended.

What inspired you to pursue a career in teaching in biology?

I always wanted to be a teacher from a very young age. I was a child that would line up my dolls, and I would teach them. My love of biology probably really happened, from the age about 17 onwards. I didn't feel I was necessarily going to be a scientist earlier than that. I chose to read Biological Sciences as biology is the study of everything in the living world. After university, I went to work for Public Health England working on influenza diagnostics and therapeutics, and after four years I went to work in clinical trials at a big pharmaceutical company. I then decided I really wanted to pursue my love of teaching. I wanted to teach, because I love instilling my knowledge into the next generation. I absolutely love seeing my students pursue whatever course they choose, whether it's biology or something else. I aspire to be a teacher who encourages children to do their best and always aim to reach their potential.

What advice would you give to someone considering a career in biology?

I think that you should pursue your passion and if you want to follow a career in biology, you have to remember the things that I didn't think about when I was 16. Firstly, there are so many careers in Biology, if you want to have a look at the A to Z of the RSB website, it will tell you all the careers ranging from a geneticist to a biochemist, to ecology, to working in microbiology, virology….. I could go on! How could you not find something that interests you? For me, I don't understand people who say, "I don't love biology," because there is so much you can do. Secondly, always follow your desires, believe in yourself, really think about what you want to achieve and then know that whatever your dreams, they don't just have to stay as a dream, you can make it a reality.

Dream always, dream often, and dream big.

Hana and Navya

Dr Love interview

When did you first start to really love chemistry?

In school we only had the subject 'Science' up until GCSE where it was divided into separate sciences, and through school I found out that it was the more mathematical based subjects that appeal to me. With things like equations, the process of taking them apart and putting them together is something I really enjoy, because you get to understand exactly how it works. It's certainly for this reason that I do prefer the physical side of chemistry than the organic side, in fact every single time I had to choose a unit at university, I would never choose the organic one, and even if there was a second unit we had to pick as well I'd then pick the inorganic chemistry option. My PhD was a natural extension, I was trying to prepare and characterise polyoligomeric silsesquioxanes, including transition metals within the structure for potential uses as catalysts.

So would you say you're definitely more of a maths person?

Yes for sure, I actually started at university (St Andrews) originally doing chemistry and maths. I continued with both and after year two of studying both, though my maths was at first better, chemistry was my favourite and after a while I cut the maths completely and pursued only chemistry.

What inspired you to pursue a teaching career in chemistry?

One of the things that actually helped me get more into the idea of teaching chemistry was the work I did with the Sutton trust at university. The aim was to make the sciences more accessible and appealing to those who come from backgrounds where they wouldn't have typically been exposed to that kind of encouragement. The university would host days with Sutton trust and the postgraduates would come along and help out. It was designed in a way that kept it interesting, so it wasn't like a homework club, it was more extensions and real world applications of science, like getting iron out of cornflakes (which you can actually do!)

Teaching was my preferred route, partly as I did a placement in industry and found the environment there wasn't for me. I was drawn to teaching because it is about working with and helping people, whereas my experience in industry was more about using the chemistry I'd learned to make discoveries independently. It's the sharing of innovation and helping people which really drew me towards teaching and away from industry where the attitude is completely different.

The desire to teach came pretty naturally to me after coming to appreciate the aspect of knowledge and the importance of passing it on. Some people will really have their heart set on becoming a teacher, but others, like myself, really end up just finding their way towards it and seeing it contains those aspects of chemistry I really loved.

How long have you been at the Abbey and what do you enjoy most about working here?

I started working here in 2005, so I'm now into my 20th year at the Abbey. I most enjoy the variety that the job entails, the students certainly make sure of that by showing an interest and asking plenty of thoughtful questions.

What are your favourite kinds of experiments?

Personally I really enjoy the calculations based experiments where you have to go into the practical knowing very little about what you are dealing with, and a step by step process is required to figure it out. I remember I used to do an analysis task for my students (which I can't actually do anymore) which involved bringing a dozen unlabelled bottles and they had to use analysis techniques to figure out what they were, most of them actually got it right!

On the other end of the spectrum, some experiments that I really enjoy could be the reason I am considered a secret pyromaniac. Oddly enough I wasn't a fan of fiery experiments in the lab in sixth form, and it only really came about at university, but I enjoy those kinds of practical experiments because they're usually the more out there experiments you can't necessarily do every day in the lab.

What advice would you give to someone considering a career in chemistry?

I would say the main thing to do is focus in your chemistry lessons (seriously!), read around the subject as well (such as popular science books, magazines such as Chemistry World) to really make sure you're enriching and developing your interest in the subject. An important thing to recognise in chemistry is that it is much more often more about the "why" something's happening, rather than just the final answer, as it allows you to really get a key understanding of how the chemistry works. Even in chemistry there are many more different specialisms than the inorganic, organic, physical split, there is lots to discover beyond the exam specifications!

Abbey Alumna

Julie Bushrod

Alexandra Atack – 2006 leaver

Associate Professor in Biomechanics at St Mary's University, Twickenham

I was a student at The Abbey from Reception to Upper Sixth, leaving in 2006 to study Sport and Exercise Science at University of Bath. Throughout my time at school, sport was my passion - I represented The Abbey in everything from biathlon to cricket, waterpolo to hockey, but was also always fascinated by science, IT and Maths. My university course enabled me to combine my interests, studying how science and technology can be used to improve sports performance and reduce injury risk.

I went on to complete a PhD investigating The Biomechanics of Rugby Place Kicking (one sport I had never played!), working alongside players and coaches at England Rugby to perform detailed analyses of kicking technique to understand what determines success and, subsequently, the effect on match outcomes. Since then, I have combined lecturing BSc and MSc students at St Mary's University with undertaking numerous research projects. Over the last two years, I have worked with The Royal Ballet to understand how the mechanical requirements of ballet influence the injuries dancers sustain, collaborated with a wearable sports tech company to validate in-shoe sensors measuring power production during running and leg asymmetries in athletic movements and most recently partnered with Surrey County Cricket Club to enhance their on-field performance. These types of projects are the most exciting part of my job as they allow me to apply scientific principles to real-world sporting activities affecting both athlete and coaching practice, not to mention the global travel to present at international conferences.

As a lecturer, I see students who study Sport and Exercise Science because they love to watch sport, but that is not enough. Those that go on to work in the sector have a desire to explore further why athletes win and how injuries are sustained. However, most importantly, they seek out additional opportunities to gain experience and this sets them apart. Some complete organised work placements (such as the year-long position I held within a research group, as part of my Undergraduate degree) others through volunteering with local organisations, but all gain invaluable insight which sets them apart. Sport and Exercise Science is a dynamic field to work in and technological developments mean it is only going to keep developing!

Elizabeth Bennett, PhD, MBE – 1974 leaver

Vice President, Species Conservation, Wildlife Conservation Society

I left the Abbey in 1974, after studying biology, chemistry and physics at 'A' Level. Our biology teacher, Mrs Gilman, supported me in my degree choice of zoology, and guided me towards Nottingham University, her alma mater. Part way through the degree, I realised that many of the species that fascinated me were threatened, and that the only career for me was conservation. It was not the broad field of today; the only way in then was through a fieldwork-based PhD. Primates were my passion, so I wrote to all universities with possible options. The only realistic one was Cambridge, to study leaf-eating monkeys in Malaysia. Two years of following monkeys around for long days in swampy rainforest gave me passion both for the work, and for Malaysia. So after completing my PhD, I went back to Malaysia, this time to Sarawak in Borneo, to do the first ever detailed study of the endangered and bizarre proboscis monkey. I stayed in Sarawak working for the Wildlife Conservation Society (WCS) for the next 18 years, including three years studying hunting patterns of different indigenous communities across northern Borneo, then working with the government and other colleagues to incorporate research on why wildlife was declining into Sarawak's wildlife policies and laws.

The next few years working for WCS included establishing programmes to manage wildlife trade in China, Vietnam and Central Africa before I moved into my current role, based at WCS headquarters in New York, overseeing our species conservation programs around the world. Over the years of a terrific career, I've learned that success isn't achieved by individuals but by teams, bringing different perspectives and skills while also building lifelong friendships.

When we leave school, none of us know where life will lead us. I've never known for more than about three years in advance what I'll be doing or even where in the world I'll be living. But the vision of wanting to save wildlife has always been there. My advice is to follow your passions about what you hope to do, in whatever field, don't be deterred by possible hitches along the way, and you will get there. Maybe not in the way you can envisage now, but that's all part of the adventure!

Crest Awards

Have you ever wanted to look at how rockets work, build your own robot or make your own toothpaste? The Crest Award is an excellent extracurricular opportunity for students who are interested in science, technology, engineering or maths to have a chance at planning and running your own project. This project can be selected and then planned based on your own interests from a list of projects across all STEM disciplines. It is student led with assistance from teachers and lab technicians. It is an amazing opportunity to get to study something outside of lessons in a fun and accessible way, concluding in a written report of your findings.

There are three different levels to the Crest award: Bronze, Silver and Gold. Bronze is a great opportunity for students in LIV or UIV, who would like an extension to their usual learning, to do a project over the course of 10 hours. Silver is a 30 hour project suitable for students in LV and Gold is a 70 hour project for those in sixth form and includes sourcing an external mentor and exploring a topic in depth, then producing a report.

These projects are really interesting, rewarding and a brilliant opportunity to gain an insight into scientific research, broader scientific careers and to gain knowledge about something you are really interested in. If you are considering doing a scientific career or just really enjoy science, this is a wonderful taster to see what you enjoy and to give you the opportunity to use critical thinking skills, to learn and then reflect, which is key for any future career. Please go to see Dr Gilroy-Hirst for more information.

I did a CREST project titled *Fire Investigation Practices: Alternative Materials for the Manufacture of Evidence Containers to Prevent Loss and Contamination of Evidence*, in the summer of 2020 when A levels were cancelled, and in many ways it more closely aligned with the skills I would need at university than taking exams. Because of Covid my project was entirely literature based; had I had the opportunity to test my research in the lab, the experience may have been even more valuable – a large proportion of my masters research (also related to materials functionality - *Investigating the structure-property relationship in layered ternary chalcogenide solid solutions*) is using literature to design my own experiments. The depth a CREST project allows you to go into is something which will likely not be repeated until the final year of university and gives a good insight into what research will be like, and whether it is something you may be interested in in the future.

CREST enabled me to use my own self-directed research skills, in identifying and refining a workable research topic, it required a literature review (a staple skill in any science degree), I had to reach out to academics specialising in my chosen field to act as a mentor, it encouraged a one to one tutorial style relationship with my mentor in school. This supports the skills that underpin my degree. Being able to discuss my work with academics is essential, in the first three years of my degree, twice weekly lab reports are signed off through a short viva and small group tutorials also involve in depth discussion with specialists in the field. Perhaps most importantly it, gave me a really good base in academic science writing skills over an extended report- chemistry degrees do require a surprising amount of essay and lab report writing, culminating in a thesis. It also gave me the rare opportunity to explore where my particular areas of interest and expertise may lie. In fact, 4 years later, my CREST project is directly relevant to the job I will start once graduating, and is what reinforced my initial interest in materials science, and was hugely helpful in the interview process.I would not be surprised if it helped me secure the job

Is a CREST project hard work? - yes it is, daunting,? - yes it is, because it's unlike anything you have done before. Is it worth it? Absolutely, because the skills and - you learn will give you a great skill base for your studies at University - and you may just hit on something that may direct your future.

Ella Greenwood

Microbiology

Eden

There are 100 trillion microbes in your gut. That's about 85g of bacteria living in you! Pretty impressive seeing as one bacteria weighs 0.000000000001 grams. But why are they there? It may sound scary, to have all these microbes living in you when we usually think that microbes equals bad, but the truth is that these microbes do more for us than we could have ever imagined. The reality is that the gut microbiome is a network of microbes that live in your gut which help your body function properly, and affect all sorts of processes in your body, that without, your body certainly wouldn't work as efficiently as it does today. These microorganisms have a significant impact on our digestion, mood, metabolism, immunity and general brain function, and a malfunctioning microbiome can cause a wide range of problems that can impact all of these processes. It is important for us to learn more about it and ensure that we allow ourselves to maintain this ecosystem to preserve our health and ensure that we don't have to experience these negative effects that not taking care of your gut health comes from.

The gastrointestinal microbiome develops in the womb, even though it was previously thought to have been sterile. This formation of bacteria occurs via the transfer of bacteria through the placenta, or when amniotic fluid is ingested by the foetus. This means that some of our gut microbiomes with certain species being directly inherited from the mother. These inherited strains of bacteria were also found to be more likely to persist in the infants gut than non maternal strains, so strains that were picked up early on may not have been as successful to survive in the environment of the gut than those that were not passed on. The gut bacteria of an infant develops as it grows, and is typically fully functional at three years old, where it will by then be full of all the gut bacteria we need to keep us healthy, but this can change overtime due to factors such as environment and diet. So how exactly does it supposedly keep us happy and healthy?

We depend on our gut microbiome a lot, for things ranging from producing short chain fatty acids (SCFAs), which are important metabolites which are an excellent energy source and have efficient anti-inflammatory properties, to protecting us from pathogenic bacteria. A good example of the way humans depend on our gut microbiome to keep us healthy by protecting us is the way gut bacteria influences immune function. A healthy gut bacteria is key for immune function as they produce a range of substances that aids pathogen control, ensuring there aren't too many pathogenic bacteria in our gut, increasing our defences against harmful bacteria. Organisms like lactic acid bacteria are powerful probiotics and are able to produce peptides called bacteriocins that inhibit the growth of bacteria that are closely related to them and kill those target cells (the pathogens).

Due to the fact that the bacteriocins target closely affected bacteria, they are typically produced by weak bacterial strains that are non pathogenic, which can be found in many probiotic foods (bad news for any yoghurt haters out there)

Humans need vitamin B to allow proper digestion, nerve function, eyesight, cell health and more. However, we cannot produce it ourselves, and rely on consumption of vitamin B from food and production of it from bacteria in our gut like biotin, riboflavin, and thiamin. Now, it may not seem very beneficial that our gut bacteria produce vitamin B. as the main site of absorption is the small intestine. However, many bacteria are able to produce it and other bacteria need it for metabolic processes. This ensures a healthier gut biome because it allows other bacteria to be healthy enough to grow and carry out their jobs, and maintain a diverse but healthy gut bacteria. The vitamin b does actually get absorbed through the large intestine, meaning it allows the cells in your body to also carry out metabolic processes, such as the glycolysis of carbohydrates to aid in energy production.

While we might not want to admit it sometimes, our parents really do know best and unfortunately, they are definitely backed up by science on this one. All those lectures on "don't eat junk food" or "an apple a day" might need some more attention, as it's been found that as a result of the close links between your brain and your gut, the food you eat may be affecting you more than you think. The gut and the brain are connected directly through the vagus nerve, a nerve that can actually be activated by bacteria, or the many psychoactive compounds that the gut bacteria produce. In the small and large intestines, we have signalling cells called enteroendocrine cells, which synapse with nerves including the vagus nerve, alerting it to things it senses in the gut, like information about contents of the gut, and energy status, influencing our mood. They also secrete a variety of hormones into our blood, which signal things to the brain like telling us when we are full and regulating our metabolism by stimulating insulin release.

Another example of the gut influencing our brain is the way the gut enables us to produce serotonin. The gut provides about 95 % of serotonin produced to the body, but how? One instance of this is the metabolization of tryptophan, an amino acid that can be found in animal products, nuts and seeds, and legumes. Tryptophan metabolism is important as we have bacteria in our gut such as Escherichia coli, Clostridium sp., and Bacteroides sp that is able to convert it into important hormones, such as serotonin, melatonin and indole. Serotonin is an important hormone which promotes anxiety regulation and feelings of happiness. Melatonin is an important circadian rhythm regulatory compound and Indoles are protective to the lining of the gut, and are beneficial for the health of the gut bacteria themselves. In some research it is suggested that Indoles are powerful neuroprotectants, suggesting an ability to prevent or treat nerve damage. It is remarkable how just one amino acid can be converted by our gut bacteria into such helpful organisms, and there are many more examples of this. Now see why your gut health is so important? Without it you would be miserable! So how can we take care of these magical bacteria that do so much for us?

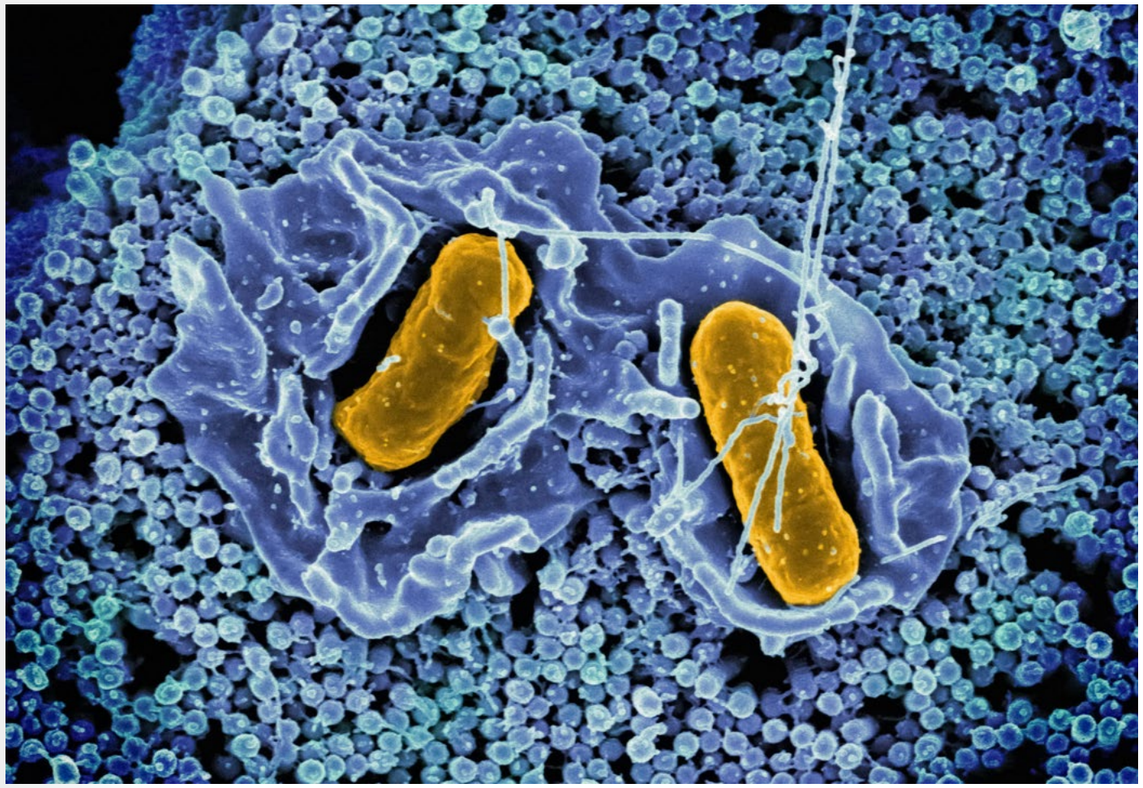
A very significant part of keeping our Gut Microbiome healthy is to ensure we keep a good diet, with enough probiotic foods that allow us to give the bacteria in our gut vitamins that keep them healthy and properly functional. There are many supplements that are marketed towards keeping your Gut Microbiome healthy, but they are not typically recommended by doctors, especially not when that person has a compromised immune system. Keeping a healthy diet is much more beneficial to your health. Recommended foods are things such as high fibre foods, which can only be broken down in the colon into SCFAs. There are foods which can be very detrimental to the human gut microbiome, such as highly processed foods, like your regular fast food. These foods typically lack sufficient fibre levels, which are important to maintain as it means that levels of bacteroidetes decrease, reducing the amount of SCFAs getting digested. This lack of fibre consumption leads to a decrease in SCFA fermentation means the pH of the colon increases, allowing some pathogenic bacteria to multiply more because the pH is closer to their optimum and it isn't low enough to suppress their multiplication.

Another potential problem that can damage your gut microbiome is the use of antibiotics, especially broad spectrum antibiotics. Your gut is made up of trillions of organisms, including many bacteria, and when using antibiotics to treat forms of infections, these can be dangerous to the biodiversity and health of the bacteria in your gut. Broad spectrum antibiotics are antibiotics used that can affect a wide variety of bacteria, e.g. penicillin which causes the bursting of the pathogen cell walls to kill them. These are problematic as they can cause something called dysbiosis, where the mass death of pathogenic (and beneficial) bacteria can lead to an opening in the food chain in the microbiome for a pathogenic bacteria to proliferate and grow at a rate which causes an infection very quickly. Due to the lack of a beneficial immune system supporting bacteria, these are more difficult to wipe out and need further treatment, which can lead to a difficult journey in order to restore your gut health.

Now this all sounds very negative, as we all enjoy the occasional McDonalds, and you can't help it if you need to go on antibiotic treatment. So what can we do in order to ensure that we can keep our gut health on the right track? By eating a diverse and nutrient rich diet, we can ensure that our gut bacteria receive many different kinds of essential fibres and proteins to allow them to synthesise the highly beneficial SCFAs and things like the essential neurotransmitters such as serotonin and melatonin. These food support the growth of beneficial bacteria and promote a healthier more diverse microbiome in the gut that can metabolise these molecules more efficiently and promote a healthier immune system

We can also introduce probiotic foods into our diet, which are things like live cultures of bacteria in safely fermented foods, full of bacteria that is beneficial to our gut, and allows greater biodiversity. Things like yoghurt which contain lactic acid which promote lactic acid bacteria that help increase the bacteriocins produced to help build up the immune system by eliminating bad bacteria by inhibiting their growth or damaging their membranes to cause leakage and death of the pathogen.

Another way we can improve our gut bacteria is by reducing stress. Stress affects our gut bacteria as when the body is under stress it releases hormones like adrenaline and cortisol, both of which affect blood flow to digestive organs and enzyme secretion. This causes poor function of the digestive system, which increases gut permeability allowing pathogens to trigger inflammation in the gut lining. To reduce our stress and maintain a healthy gut microbiome, we can use techniques such as deep breathing and yoga as well as doing exercise which is known to be good for reducing stress levels. These very small things, though they seem insignificant can have major benefits for people's gut health, physical health and mental wellbeing; and it all begins with the trillions of microbes you may not even have known were there!



What's On at The Abbey

Biology and ESS field trip

Lower VI IB Biology and ESS students spent a day at Amersham Field Studies Centre where they covered key material for their courses and started preparing for the coursework.

The IB Biology and ESS students travelled to Amersham Field Studies Centre to complete key content and prepare for their individual coursework projects. The weather was perfect for ecology work, and we were able to spent time comparing the diversity of species found in different types of woodland. We enjoyed hearing about the dangers of foxgloves, but also tasting some edible plants, under careful supervision of course. We were able to put the theory we had learnt in the classroom into practice, and captured lots of woodlice to do the 'mark, release, recapture' technique. In the morning, we were not convinced we would all be able to find an individual project, but we were amazed that by the time we left, we had all decided on our final idea and looked forward to collecting the data next week.

Schools analyst competition

On 6 June, we hosted a regional heat of the Schools' Analyst Competition in the chemistry department for LVI Chemistry students. Two teams from Maiden Erlegh joined two teams of Abbey Students, and the students worked on the analytical chemistry competition for the day. The competition had three parts, each requiring some really challenging unit conversions, including determining the amount of ascorbic acid in supermarket tablets. It is a national competition, and we'll find out the results in a few weeks.

"It was a pleasure for the six of us to join the Royal Society of Chemistry school's analyst competition. Throughout the day, we performed many titration trials to determine the vitamin C concentration in a tablet. We developed TLC plates, a new interesting technique, to investigate the colour dye of sweets. Spending a day in the lab was such a fun experience, and we felt like being real scientists!"

Dorcas LVI

PARTICLE PHYSICS MASTERCLASS

On Wednesday 13 March, a group of Lower VI physics students went to the Rutherford Appleton Laboratory to tour the ISIS neutron and muon source as a part of a particle physics masterclass. We started the day off with a series of detailed lectures that introduced us to the fundamentals of particle physics while also gaining an in-depth understanding of how accelerators work. We were also incredibly privileged to learn about the revolutionary research being conducted at the large hadron collider in CERN.

During the afternoon, we toured the ISIS facility where we got to see the practical uses of the accelerator and its facilities. One of these uses was the ChipIr that is dedicated to seeing how microelectronic devices respond to the impact of neutrons. This problem is a major concern for the electronics industry and it was super interesting to see how research done at the facility is applied to real world scenarios. At the end of the tour we had a brief pop quiz where we learnt some fun facts. Did you know that for over the 40 years of running the synchrotron, the facilities had used 1 teaspoon worth of neutrons?

We also had the opportunity to act as a particle physicist programmer by using Python and data from the CERN to plot graphs to identify particles.

All round it was an amazing experience and Navya was also able to find a self driving bus that shared her name!

Navya and Prachi

CHEMISTRY RACE SATURDAY 10TH FEB

Four of our sixth form students attended the Chemistry Race at Oxford University. The event took place in the Inorganic Teaching lab and the students heard about the amazing work currently being done at Oxford, as well as some historic work by the great Dorothy Hodgkin. It was the first time we have entered the event, and it was quite interesting to see how some teams had huge bags of undergraduate level textbooks with them! We were sitting about middle table at the end of the event, out of about 40 schools, and a great time was had by all!

Dr Maclennan

It has been a pleasure for the four of us to join the Chemistry Race this year. We tried our best to answer some challenging but interesting questions. I have discovered more about different aspects of Chemistry such as how Lithium batteries work and the concentration of Potassium in a banana. The event was really fun and has made me enjoy doing Chemistry more than I ever did before.

Dorcas LVI

Jo Trott Memorial Lecture - Professor Russell Foster

For our prestigious Jo Trott Memorial Lecture this year, we were fortunate enough to hear Professor Russel

Foster speak passionately about Sleep and Circadian Rhythms. A man with many titles and a personal connection to the Abbey shared his expertise, having been researching for almost four decades!

"What an amazing talk! Sleep is so fundamental to our health and learning more about the biological body clock was fascinating. It's remarkable to hear about recent and upcoming developments within the field and how dynamic it is! It's crucial to consider the transnational nature of collaboration in science. Whilst the adage goes - too many cooks spoil the broth - perhaps that doesn't apply to research as different perspectives are essential for innovation and creativity. "- *Aarini*.

"As someone with an interest in neurobiology I found this talk particularly insightful. Professor Foster's talk debunked a sea of misinformation such as how adults and teenagers have their peaks in cognitive information processing at a different time of the day and how melatonin isn't actually a sleep hormone but it is a hormone in the brain which produces the response to darkness!" - *Ayzah*

"Following the insightful talk from Professor Russel Foster on sleep and the circadian system, I must say it has definitely sparked my curiosity to research more. The topic of biological rhythms is fascinating to me, especially since we are beginning to learn about this topic in Psychology. I enjoyed the level of detail Professor Foster went into when explaining different scenarios. For example, he explained the biology of how driving in the early morning is as dangerous as driving under the influence." - *Mahi*

How does AI learn?

Avani, Lower VI

Today Artificial Intelligence helps doctors diagnose patients, pilots fly commercial aircrafts, and city planners predict traffic. But no matter what these AIs are doing, the computer scientists who designed them likely don't know how they are doing it.

Yep, that's right…. the people who created these super smart all-knowing systems have absolutely no idea how they became super smart.

And that's because Artificial Intelligence, in essence, is self-taught, all it does is take a simple set of instructions applies them to very, very, very large seta of data and starts creating patterns and sets and strategies out of them.

But how does AI create those patterns?

Well, there are many ways to build these self-teaching programs. But they all rely on three basic types of machine learning (machine learning is just a fancy way of saying the robot is studying):

Unsupervised Learning

Supervised Learning

Reinforced learning

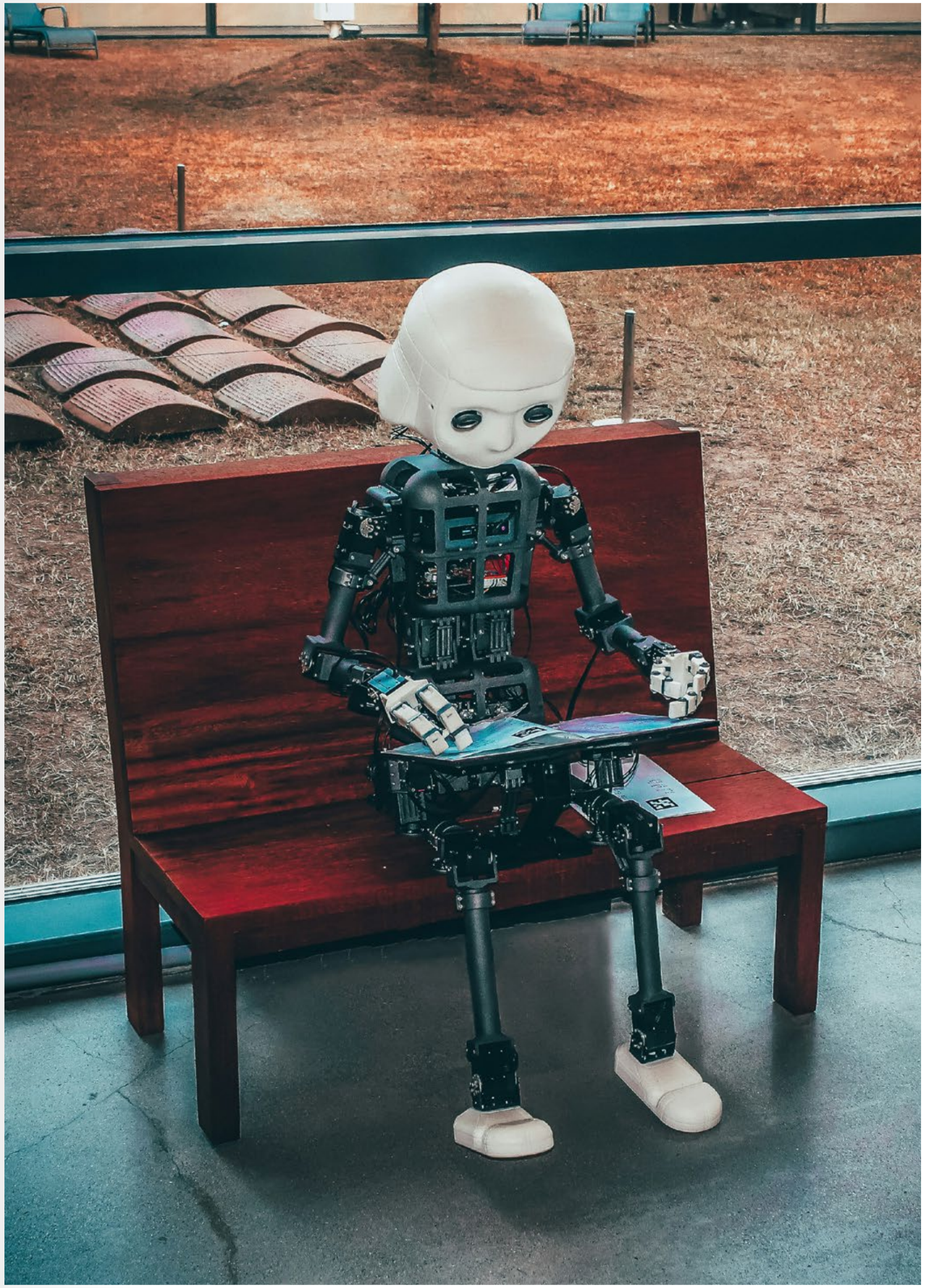
To see this in action let's use something that at least machines don't have, yet our **IMAGINATION**.

Imagine researchers are trying to pull information from a medical data set containing thousands of patient profiles.

First up, **UNSUPERVISED LEARNING**. This approach would be ideal for analyzing profiles to find general similarities and patterns. Maybe certain patients have similar disease presentations or perhaps treatments produce specific side effects. This broad pattern seeking approach can be used to identify similarities between patient profiles and emerging patterns, all without any human guidance.

But let's imagine doctors are looking for something more… specific. These physicians want to create and algorithms for diagnosing a particular condition (yes, a computer can be taught to do this). They begin by collecting two data sets- medical images and test results from both healthy patients and those diagnosed with the condition, this data is then inputted into the program designed to identify features shared by sick patients, but not healthy patients. Based on how frequently it sees certain features the program will assign values to those features diagnostic significance generating an algorithm for future patients. However, unlike unsupervised learning doctors and computer scientists have an active role in what happens next, Doctors will make the final diagnosis and check the algorithm prediction. Then computer scientists can then use the new uploaded databases to adjust the program's parameters and improve its accuracy (you can probably see why it's important, I mean someone's life could be at stake here) This hand on approach is called **SUPERVISED LEARNING**.

Now, let's say that those doctors wanted to design an algorithm to recommend treatment plans. Since these treatment plans will be implemented in stages and they may change on each individual's response to the treatment, the doctors decide to use **REINFORCEMENT LEARNING**. This program uses an iterative approach to gather feedback about which medication, dosages and treatments are most effective. Then it compares that data against each patient's profile to create a unique, optimal treatment plan. As the treatments progress and the program receives more feedback it can constantly update the plan for each patient.



Royal College of Science Union Science Challenge

Imperial College's Faculty of Natural Sciences runs an annual Science Challenge, which is open to students in years 10-13 across the country. Lord Robert Winston is the ambassador of the competition and he judges the overall winner each year.

This year, Nishka (LVI) entered the competition, and was shortlisted for the Space Exploration question . She was invited to the awards ceremony during summer term which will take place at Imperial College's Kensington Campus.

WHAT'S NEXT?

SPACEX 'S MARTIAN TRIUMPH

Achievement led to Concerns

Two years ago, SpaceX, led by Elon Musk, made history by reaching the surface of the Red Planet. This monumental event has been hailed as one of humanity's greatest achievements, marking a significant milestone in our journey to explore beyond our home planet. The immediate reactions were overwhelmingly positive, with people worldwide marvelling at the possibilities this achievement unlocks for future innovators, scientists, and explorers.

However, alongside the success, concerns have emerged. NASA, once the leading company in the space industry, is now overshadowed by private companies led by individuals.

Questions arise about how these companies have surpassed established national institutions and what this means for the future.

Are they prepared to use their newfound freedom to benefit humanity, or are they driven solely by profit motives?

The arrival of humans on Mars sparks worries about not just the Martian environment, but also how it affects us on Earth.

Over the past decade, scientists and environmentalists worldwide have tirelessly tackled climate change and carbon emissions.

Is space travel undoing the progress we've made in preserving our atmosphere?

Are we facing a reset button on our efforts to protect our planet?

Furthermore, ethical dilemmas arise. Society requires clear guidelines regarding Mars control and habitation.
Can just anyone travel there?

Despite claims that the mission to Mars revolves around safeguarding humanity from threats, determining who gets to go poses a significant challenge.

It's a contentious issue, and we must strive to make equitable decisions that prioritise the well-being of all involved, while maintaining order and stability.

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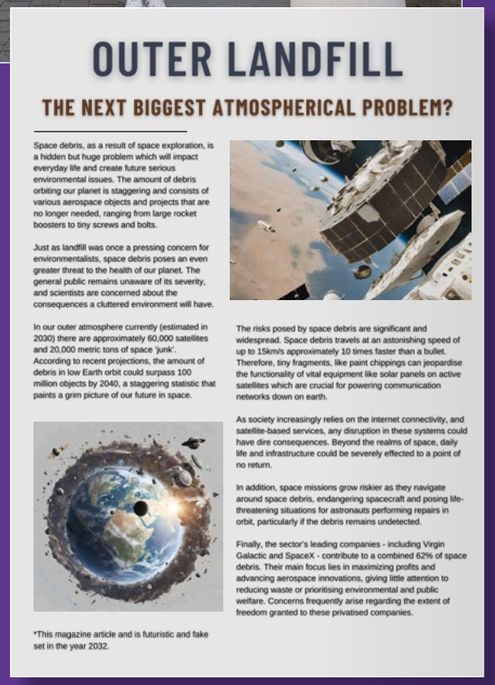


OUTER LANDFILL

THE NEXT BIGGEST ATMOSPHERICAL PROBLEM?

Space debris, as a result of space exploration, is a hidden but huge problem which will impact everyday life and create future serious environmental issues. The amount of debris orbiting our planet is staggering and consists of various aerospace objects and projects that are no longer needed, ranging from large rocket boosters to tiny screws and bolts.

Just as landfill was once a pressing concern for environmentalists, space debris poses an even greater threat to the health of our planet. The general public remains unaware of its severity, and scientists are concerned about the consequences a cluttered environment will have.

In our outer atmosphere currently (estimated in 2030) there are approximately 60,000 satellites and 20,000 metric tons of space 'junk'. According to recent projections, the amount of debris in low Earth orbit could surpass 100 million objects by 2040, a staggering statistic that paints a grim picture of our future in space.

The risks posed by space debris are significant and widespread. Space debris travels at an astonishing speed of up to 15km/s approximately 10 times faster than a bullet. Therefore, tiny fragments, like paint chippings can jeopardise the functionality of vital equipment like solar panels on active satellites which are crucial for powering communication networks down on earth.

As society increasingly relies on the internet connectivity, and satellite-based services, any disruption in these systems could have dire consequences. Beyond the realms of space, daily life and infrastructure could be severely effected to a point of no return.

In addition, space missions grow riskier as they navigate around space debris, endangering spacecraft and posing life-threatening situations for astronauts performing repairs in orbit, particularly if the debris remains undetected.

Finally, the sector's leading companies - including Virgin Galactic and SpaceX - contribute to a combined 62% of space debris. Their main focus lies in maximizing profits and advancing aerospace innovations, giving little attention to reducing waste or prioritising environmental and public welfare. Concerns frequently arise regarding the extent of freedom granted to these privatised companies.

*This magazine article and is futuristic and fake set in the year 2032.

The Periodic Table

A brief history of the periodic table

In 1869, Russian Scientist Dimitri Mendeleev created the framework for the modern periodic table. Mendeleev arranged the elements according to their atomic mass and predicted that there would be more elements discovered so left gaps for them in his model of the periodic table.

The Periodic Table

The periodic table of elements currently used by the International Union of Pure and Applied Chemistry (IUPAC) features rows to represent the seven periods and columns to show the 18 groups of elements. While the current model of the periodic table works well and has been working well for many years, this does not mean that it is a perfect model. In fact, some issues do exist with the current model of the periodic table that we are used to seeing. By creating an alternative model of the periodic table, I hope to address some of these issues. Aside from this, I also want to demonstrate that just because something works well enough and has been in place for years, it doesn't mean that we shouldn't constantly be seeking to improve it.

KEY:

S block (Group 1 & 2)

D block (Groups 3-12, excluding f block elements in these groups)

P block (Groups 13-18)

F block (Lanthanides and Actinides)

P2-P7 = Periods 2 - 7

Period 1 (Hydrogen and Helium)

My Model of the Periodic Table

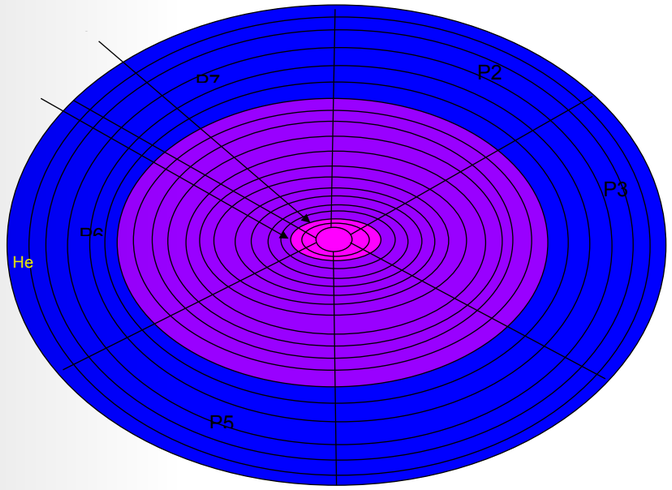
The model of the periodic table that I have developed features a circle divided into 18 segments to separate it into the 18 groups. I have then further divided this circle into 6 sections to separate it into 6 periods and highlighted Hydrogen and Helium as belonging to the first period. It also features a separate circle for the f block elements also divided into segments to represent the 14 groups that the f block elements consist of and two sections for the two periods that the f block encompasses.

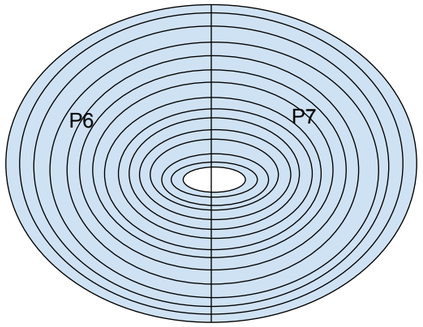
One of the first things I sought to address in my model of the periodic table was the grouping of Hydrogen with the group 1 alkali metals. Hydrogen is not a metal and yet is placed on top of the group 1 alkali metals in the IUPAC periodic table of elements. My desire to remove Hydrogen from the group 1 alkali metals led to me deciding to use a circle divided into segments for my model of the periodic table rather than rows of elements. This would allow me to create a completely separate segment for Hydrogen and to separate it from the Group 1 metals without separating from the s block elements.

The second thing I knew I wanted to address was the f block elements. While I had thought of adding the f block elements into the main body of my model, I decided to keep them as a separate entity for easy organisation into blocks. However, I did want to remedy the grouping of Lutetium (Lu) and Lawrendum (Lr) with the f block elements. Lu and Lr should, in my opinion, be placed in the d block with the Group 3 elements Scandium and Yttrium. Lu and Lr can be classified as transition metals so I therefore believe that they should be grouped with the transition metals in the d block.

Hydrogen, Lutetium and Lawrendum are all labelled on my model to highlight the adaptation I have made to the current model of the periodic table with their placement.

Kayla Osei, Lower VI





The Reality Matrix

Avani, Lower VI

You've probably heard of snapchat , you've probably used it too.

But have you ever wondered about what would happen if this idea was taken to the next level, to a level where you could interact with people in real time in your own avatar in any city of any country of any planet of any universe, real or imaginary?

Well facebook did, and if you have been up on the current news you know that facebook has changed its name to meta, and is planning on launching a METAVERSE.

I don't think enough people are talking about this, because the metaverse is going to change my life and it is going to change your life.

So, we need to understand - What it is?

Why is there so much hype about this?

Why it has the power to bend and break society as we know it?

A LIVING, SHARED, EVERLASTING UNIVERSE

The concept of the Metaverse is this - Throughout history we have continuously been moving towards mediums that are more and more engaging and hands - on, we have gone from text to photo to video to sharing those photos and videos and the Metaverse is what comes next.

It is basically an internet that you are not just looking at through a screen but one that you are actually inside of. Take anything you could think of doing right now - Shopping, chatting with your friends or even meditating to ASMR videos on Youtube, now imagine that at the snap of your fingers you could be doing that exact thing in a way that feels "real" with people who feel as if they are sitting right next to you, in whatever place you want them to be, even if you just made it up.

This is what the Metaverse plans on achieving through a combination of Augmented Reality and Virtual reality. And if I have not made it abundantly clear by now, this is pretty cool and there are some undeniable positives.

Just to get the obvious out of the way, the Metaverse will allow you to live out your dreams and fantasies. In one single evening you could be slaying demons in hand to hand combat, playing a quiet game of chess in a little cafe on the streets of Paris and even go surfing in the tropics off the coast of the Bahamas. All this with incredible realism, but at the same time with the reassurance that you are safe in your own home.

On a similar note there is also a comfort to the idea that you will be able to express yourself however you want to, you know how right now you have profile pictures for all your social media accounts, the image that represents you to other people. Well in the Metaverse you won't just have an image you will have an entire avatar, a fully three dimensional living depiction of you, but you however you want you to be. Did you ever wish you were 5 inches taller now you can be, you ever wish you had rainbow colored hair, with the metaverse, you can.

But it is not just transformations that will speed up massively, it is also learning. You know how today we look at libraries as really old fashioned, because why would try and find out information from a book when you can just google it, well the Metaverse is going to make to seem like "googling it" is just a relic of the past as well. You will be able learn about things just by touching them, or even looking at and to be able obtain information in a more visual, interactive and even fun way than we have ever seen before, you will be able to travel not just any place but to any time, the industrial revolution, world war II, even the dinosaurs, talk about an awesome history class.

These are definitely some of the obvious benefits of the metaverse,

"Experiences, Expression and Knowledge"

but there is an unexpected bonus that comes with it. Like the environment, you see producing "real" products is really inefficient, the production of just one car for example can lead to up-to 20 tonnes of carbon-di-oxide emission, the production of a virtual one?

0.00000000000000000000001, i think you know where i am going with this. Just a drastic change in the amount of CO_2 emitted in the making of one car.

Now imagine this with airplanes, ships, bikes, in-fact any article you can think of just imagine the positive impact it will have on the environment, when it comes to actually using it.

But, at the same time this idea is also quite scary.

There are 3 key things we need to be extremely mindful of.

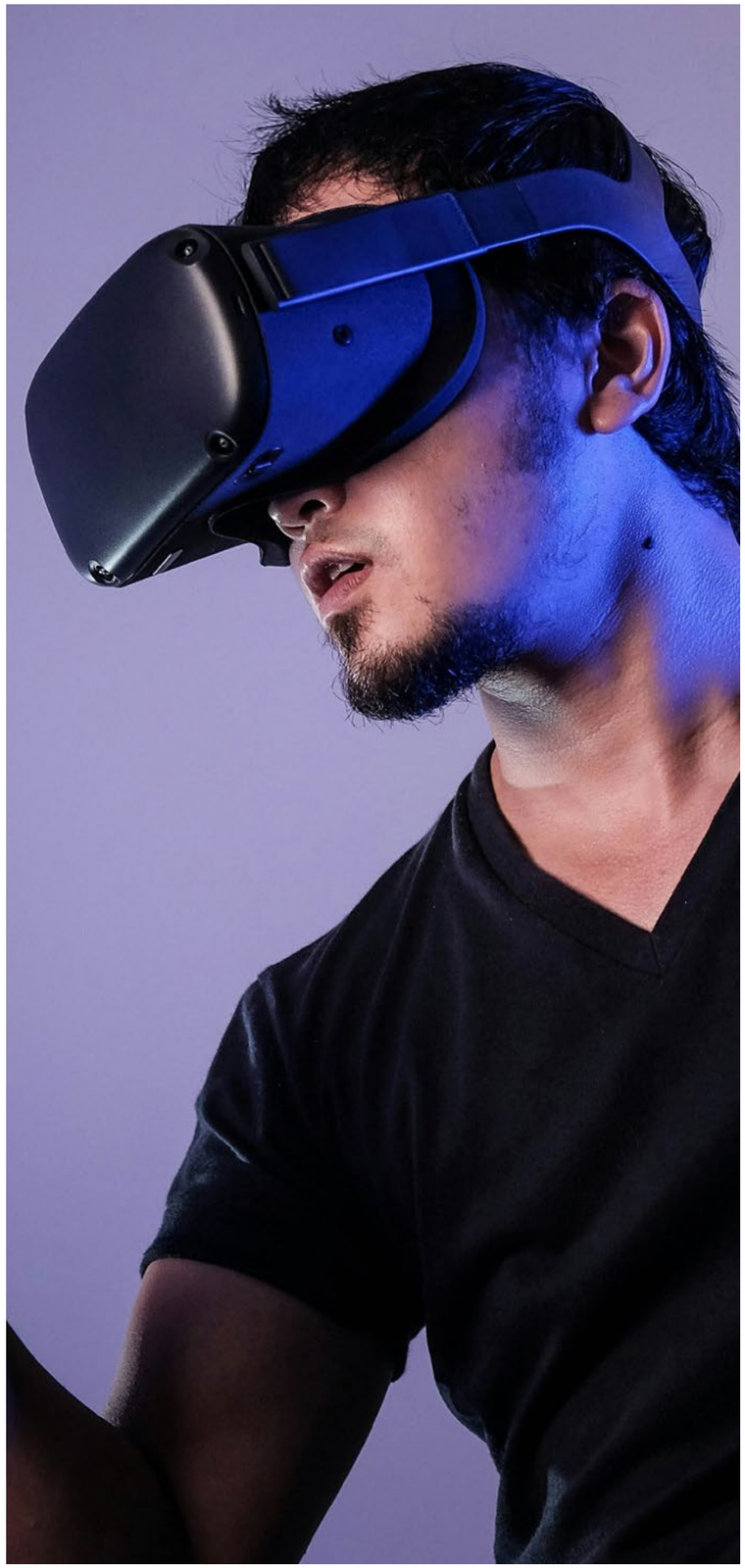
The first one being data, let us be honest facebook has a pretty rocky relationship with how it handled user data and privacy in the past, and remember that took place when we were still somewhat separate from our digital selves, but in the case we become our digital selves, where our profiles are not just the few vacation photos we choose to share, it is everything we do in this metaverse, we are going to need to put an extreme amount of trust in a company, that does not exactly reveal how they are using this information in the first place. We are talking about data collection on the level of measuring your brain activity, that is the kind of information you wouldn't share with your own family.

On a similar note, comes the moderation of this platform, facebook or now meta already has entire warehouses filled with people, who are going through billions of posts and scanning what are the absolute worst things people are posting - hate speech, racism, exploitation - and just making sure that as much as possible this stops from spreading. But trying to police written text which can be very easily scanned for a few key words and doing this in something as complex and as open as the metaverse are two entirely different worlds, because they are going to have to do this in a way that is incredibly invasive, they are going to have to be watching exactly what tattoos peoples avatars' have, what the writing on their clothing is saying, hearing in on every conversation even extremely private ones, every action will have to be monitored if they do not want it turn into chaos.

But what I feel is the scariest problem of all is that, we are talking about how companies will be able to create virtual experiences that feel indistinguishable from real ones right? I mean on one hand this is a miracle but is it not a bit alarming as well? we are already being shown predominantly the content we agree with and the content we want to see, but if you take that concept into the realm of the metaverse, we could completely lose touch with reality, the power to curate not just your news feed, but your entire world, now means that; if you hate seeing homeless people well your metaverse can pretend they do not exist; if you only loved one tech brand and hated all the others, in your metaverse that is all you would need to see. You won't even know if what someone is saying to you is actually what the person behind that avatar is saying or if it is just what meta wants you to hear because it will keep you on the platform for the longest.

And when you finally take off your headphones at the end of the day, you are going to realise that the world you just spent your entire day is not real, and the real world will start to seem like a nightmare to be in, and this will not encourage you to go sleep energised for the next day, all it will do is force you to pop your headset back on and spend even more time in this "perfect" world you have fabricated.

Well that is all you need to know about the metaverse - The good, the great, the bad and the straight up scary.



The Pros and Cons of MDMA

Grace, Lower V

For decades psychedelic drugs have captured our curiosity and imagination, offering pathways to altered states of consciousness and potential therapeutic breakthroughs. Amongst these compounds, it's arguable that MDMA (3,4-methylenedioxymethamphetamine) has gathered significant attention due to its distinctive side effects on perception, emotion, and thinking. While MDMA presents a variety of benefits and drawbacks, it's essential to delve deeper into its pros and cons to better understand its potential impact on individuals and our society.

In the US, the UK, and most parts of Europe MDMA is a forbidden substance but in Australia, it was made legal to prescribe MDMA and psilocybin (another psychedelic) to patients suffering from PTSD as of early 2023. There was a great controversy surrounding this decision as many people were quick to suggest that this was rushed and would cause more harm than good. However, recent scientific studies have shown that these substances could hold promise in treating mental health disorders including depression, anxiety, and PTSD when administered under controlled conditions. These drugs' ability to foster contemplation/introspection, diminish fear response and enhance communication could revolutionize psychotherapy for the better. In 2021 Daniel Carcillo interviewed with Forbes where he talked about taking MDMA to help recover from his trauma-induced brain injury caused by his ice-hockey career. Before taking the drug, he was losing speech and experienced fuzzy memories, but after participating in the MDMA trial, he went back to his pre-injury capacity as the drug was able to correct his trauma injury.

Furthermore, MDMA doesn't only have medical potential, but it is shown to enhance positive personal emotions and is renowned for fostering profound feelings of empathy, compassion, and social skills/interpersonal connection. When administered in controlled settings, the substance can help individuals break down emotional barriers and connect deeper with themselves and others, providing a valuable path for healing relationships. Alongside improving empathy and connection many users report experiencing heightened self-awareness and a sense of personal growth during MDMA experiences. This altered state of consciousness can greatly aid introspection, allowing people to open up and confront pent-up emotions and traumas. In addition to this, the dissolving of psychological defenses and inhibitions induced by MDMA is associated with increased creativity and innovation. Artists and philosophers have reported accessing new perspectives and inspirations during their inebriation with notable examples being Kanye West, Jay-Z, Tommy Lee, and Eminem.

Despite its potential benefits, MDMA poses significant health risks, especially in uncontrolled settings. Users may experience dehydration, overheating, and cardiovascular complications. Excessive consumption can lead to serotonin syndrome, a potentially life-threatening condition characterized by dangerously high levels of serotonin in the brain. This can cause shivering, agitation, nausea, and diarrhoea at a mild level and can range to severer symptoms such as hallucinations, high fevers, muscle rigidity, and seizures. Severe serotonin syndrome can be fatal if left untreated and has a fatality rate of 12%. As well as serotonin syndrome, long-term and heavy MDMA usage may disrupt the brain's serotonin system which could result in mood disorders, cognitive impairment, and memory loss. Whilst MDMA isn't considered to be a highly addictive drug, it can still lead to psychological dependence and like many other addictive drugs, users develop cravings and reliances on the drug to experience emotional highs. These potential neurological effects raise concerns about the substance's overall safety.

Also, MDMA's classification as a controlled substance in many jurisdictions has fueled a dangerous and thriving black market. The illegal production and distribution of MDMA raises concerns about the purity and safety of the substance, as well as the potential for criminal involvement. Many times street vendors get the drugs laced with other harmful substances, and finding pure MDMA is very rare. However, on the other hand, sometimes MDMA becomes available in highly concentrated doses, which often results in the user suffering an overdose. Due to the illicit nature of the substances, they are often found in clubs and parties where teenagers are often the main consumers. In recent years ecstasy (a form of MDMA) has been labelled 'too child-friendly from an access point of view as deaths have risen to record levels. There were reported deaths of teens taking ecstasy tablets at festivals and then overheating and seizing before they were able to get the medical help they required.

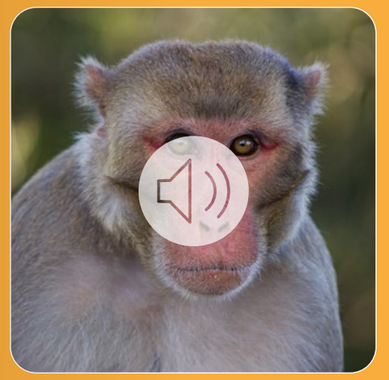
In conclusion, MDMA embodies the paradox of psychedelic drugs- a duality of potential benefits and risks that must be carefully navigated. Its capacity for medical breakthroughs and personal improvement is juxtaposed with its potential health and legal implications. Ultimately, the journey of psychedelic exploration, highlighted by MDMA, requires a balanced approach that considers both its positives and negatives. By acknowledging and understanding the complexities of psychedelics, society can better navigate the evolving landscape of psychedelic drugs in a way that maximizes benefits whilst minimizing harm.

Citizen Science as part of the Collaborative Sciences Project

As part of the IB students complete a Collaborative Science Project (CSP) and this year we decided to get involved with some citizen science. There are many online projects that you can work on, and you are making a really important contribution to real-world science. Each group of students selected a project of their choice, and each group made a podcast discussing their experiences.

You can participate in many citizen science projects online too

https://www.zooniverse.org/



Group 1: Monkey health explorer

Grace Butler, Alexia Bormann, Carys Westcott

Group 24

Lucy, Sophie, Nitya, Cara

Group 3

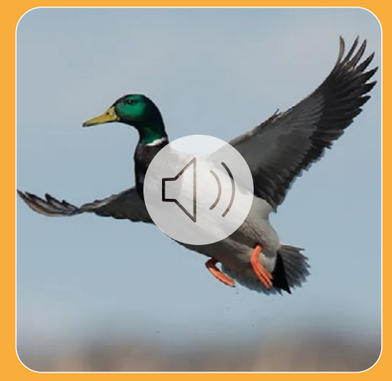
Kayla, Ashna, Izzy

Group 4

Dilara, Meredith and Bella!

Group 5

Harriet, Sophie and Hope



Group 6

Laura, Matilda, Isla, Helen

Time Competition

The theme of British Science week 2024 was Time. We invited all students to enter our annual Science writing competition and write an article based on this theme. We had lots of superb entries which are included here, and congratulations to the winner this year - Emily for her superb article on Hydrogen; Past, Present and Future.

runner-up

Every second counts - Laasya, Lower VI

Time dictates our daily routines, from the alarm that wakes us bright and early to the 2 minutes dedicated to brushing our teeth. Its role extends far beyond daily schedules, critically influencing the field of surgery where meticulous timing often means the difference between life and death. This essay will highlight the pivotal role time management has played in the evolution of surgical techniques while considering how ongoing advancements will continue to be bound by the ticking clock.

In the past, surgeries were often a race against time. Speed was crucial for procedures such as amputations to minimise blood loss and pain to the patient. Time was seen as an obstacle and the only solution was for the doctor to work quicker. However, this gave way to huge blunders and increased likelihood of death. People then realised that time was their limiting factor and a solution must be found to increase their time to operate. The development of the tourniquet by Jean-Louis Petit in the 17th century marked a revolutionary moment since surgeons now could stem blood flow and prolong the window for the procedure. This subsequently increased the frequency and success rates of amputations. As a result, this tool became a turning point, leading to a more methodical approach to surgical timekeeping.

Time has become the foundation for the future of operating with the new development of robot-assisted surgeries. This is where the surgeon sees the operative field through a video monitor and manually controls robotic arms to replicate the movements of a surgeon's hands. They can repeat the same action many times without getting tired, making them a reliable assistant during surgery. These robots can reduce the duration of a surgery using their small precise movements and therefore reduce the risk of infections from less exposure to the external operating theatre. A study published in JAMA found robotic surgery reduced the chance of readmission by half (52 per cent), and revealed a "striking" four-fold (77 per cent) reduction in prevalence of blood clots. This ultimately has been thought to produce faster recovery times.

While robotic-assisted surgery has many benefits, there are also potential drawbacks that must be considered. These range from whether the cost of maintaining the machine outweighs the promise of faster recovery for the patient, or the risk of a malfunction, which would require a repair of the robot, increasing the operating time. These challenges don't necessarily outweigh the promise of a faster recovery for patients, but they are fundamental factors for healthcare providers to consider.

In conclusion, the evolution of surgery is a testament to humanity's relentless pursuit to optimise time for the betterment of health. From the frantic, high-stakes operations of the past to the current era of precise, robot-assisted surgeries, we have continually strived for methods that provide surgeons with the time necessary to perform at their best. The development of surgical tools and robotic technologies highlights a shift towards reducing risks and improving patient outcomes. While the use of robotic assistance in the operating room presents new challenges such as cost and technical reliability, it also offers a glimpse into a future where surgical precision and efficiency can significantly extend the quality and duration of patient lives. Embracing these innovations with careful consideration and ongoing improvement will set the clock for a new age of surgical excellence.

highly commended

Scan the QR code to read these entries

Adapt or die trying - Meredith, Lower VI

Einstein's theory of relativity - Silvie, Lower V

Biomed over time - Laura, Lower VI

Evolution - Holly, Lower V

winner

Hydrogen: The past, present and future

- Emily, Upper VI

Hydrogen is the most abundant element in the universe, the first element on the periodic table and the fuel of stars. Consisting of just one proton and one electron, how could the simplest element help to solve our climate and resource crisis?

In order to look into the future of hydrogen, it is important to look at its present. In industry, the most common uses of hydrogen include refining petroleum, treating metals and producing fertiliser. All these uses require hydrogen in its pure form, in much greater quantities than is found in the atmosphere. This poses the question, how do we isolate hydrogen?

Currently 95% of hydrogen production is generated from fossil fuels. The most common production route producing 'blue' hydrogen by methane steam reformation, using high-temperature steam to produce hydrogen from a methane source such as natural gas. Due to its endothermic nature, this process requires high heat input and produces greenhouse gases. In the future, other production routes should be further explored in order to lessen the impact on the environment. Another form of hydrogen is 'green' hydrogen which is produced by the electrolysis of water. This is highly efficient, producing no carbon dioxide however does require a large amount of water and electricity, often produced by the combustion of hydrocarbons. This process can be made more sustainable by using electricity generated from renewable sources. A further option is using microbes to digest biomass anaerobically. A process that can convert straw and sewage into hydrogen and is already used to make methane. Other less common and more experimental methods include: photofermentation using organic acids, microbial electrolysis and separating hydrocarbons using microwaves.

Hydrogen by itself is actually extremely useful. As a fuel, hydrogen is energy dense and zero carbon, already used in fuel cells to power vehicles, posing a more sustainable solution than current, mostly fossil fuel powered, transportation. However, to be transported in its liquid state, pure hydrogen requires high pressure and extreme temperatures of around -250°C (requiring more energy input than potential output) as well as being extremely flammable. A solution to this could be using ammonia as a hydrogen carrier which can be cracked and purified to reproduce hydrogen. By comparison, ammonia can be easily stored in bulk at moderate temperatures and pressures and already has an existing distribution network due to its use in fertilisers.

As previously mentioned, a current use of hydrogen in industry is to produce fertilisers through the production of ammonia by the Haber Bosch process ($N_2 + 3H_2 \rightleftharpoons 2NH_3$). Invented in 1909 by German chemist Fritz Haber, it changed nitrates (used to make fertilisers)

Fritz Haber

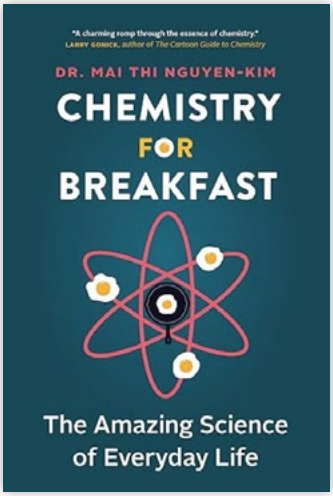
from a scarce resource to an unlimited one. Since its invention, due to the increased production of fertilisers, the population of undernourished people on a global scale has fallen from 65% to just 10%, a significant positive impact of hydrogen use in industry. However the production of ammonia has its downsides. Due to the large amounts of electricity and pure hydrogen required to fix atmospheric nitrogen, the Haber Bosch process is responsible for around 2% of all carbon emissions. In the present and the future, using electricity generated from renewable sources as well as low carbon hydrogen could greatly reduce global carbon emissions.

In addition, another use of ammonia that benefits the environment is through the production of monoethanolamine (MEA), a compound with potential to be used in carbon capture. When looking at carbon capture solutions, the energy consumption and direct and indirect CO_2 emissions of the process have to be considered globally in order to develop an approach which does not result in an increase in CO_2 production. Taking into account factors such as: what chemicals are required to produce it, transportation logistics and emissions, byproducts produced and how they are disposed of. MEA specifically is produced by the reaction of ammonia and ethylene oxide. Potential issues include: carbon emissions through the production of ammonia, emission of amines and the toxicity of ethylene oxide (to humans and the environment through eutrophication). This is an example of how carbon capture solutions and sequestration is a complex challenge which requires understanding of the effects on the environment, economy and supply chains of any process that is utilised. If a single process is implemented on a global scale, any potential side effects are magnified and could cause more harm than good.

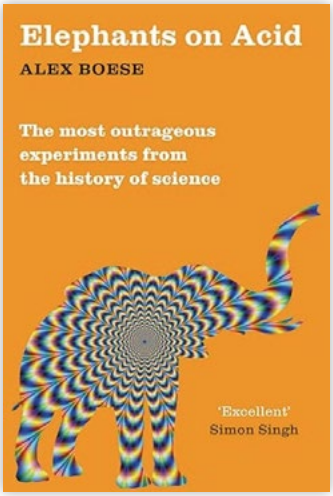
Hydrogen is an infinitely useful element that has had major contributions towards past scientific breakthroughs and continues to impact our everyday lives through its use in industry. It continues to aid the solutions to global problems such as famine and could have the solution to more current problems such as global warming - potentially through uses in the production of carbon capture solutions and in industry through low carbon hydrogen production. It is the simplest element that may have the biggest impact on our future.

Science Book Recommendations

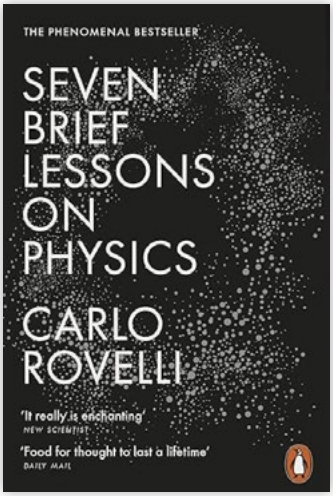
If you enjoyed the Jo Trott lecture, you should read the book written by Professor Russel Foster. I would recommend this book for sixth form students, especially those interested in Biology and psychology.



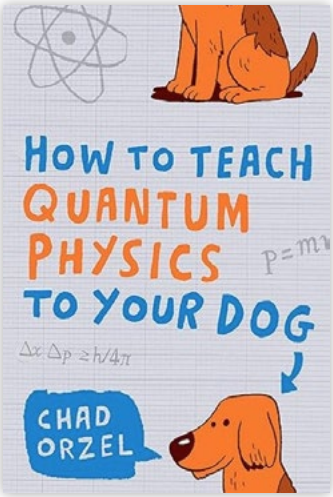
Popular science book on my reading list for this summer. In June 2020 the author, Mai Thi Nguyen-Kim was elected to the senate of the Max Planck Society. She is a chemist known most widely for science communication and has a popular youtube channel called the Secret Life of Scientists. The channel is in german so I was sadly unable to understand it!

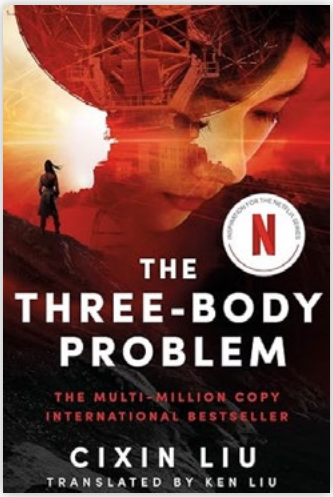


This book is not for the faint hearted and is also not suitable for younger readers, sixth form and above only. Essentially a collection of short stories detailing some unbelievable experiments, including tales of conning wine connoisseurs with the use of food colouring or packaging.

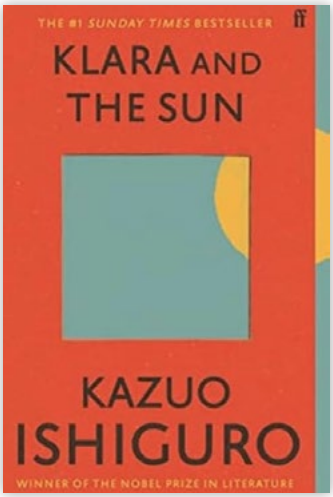


As a chemist who would really like to learn more physics, this book is amazing. Easy to see why it has been published in so many different languages. You will better understand some important fundamental physics after reading.





Both of these books are recommendations students have made to me in the past. *How to teach quantum physics to your dog* was recommended to me by a younger student some years ago; she loved it. I was working with students in China (online during Covid) and we were discussing evolution and space travel. They all recommended the *Three Body Problem*; it's now a netflix show too, but I need to finish the book before I watch it!



If you love reading fiction then here's another Ishiguro recommendation (last year's was *Klara and the sun*). Both are science fiction and as a scientist who doesn't have time to read fiction that often, I finished both of these books in a matter of days.

The Abbey