THE LAB REPORT

Today's joke

-Why did the plant fail his GCSEs?

The backbone of genetics

Every animal, from the simplest sea creature to humans, relies on tiny conversations happening inside their bodies. These conversations are called cell signalling pathways, it tells cells when to grow, what to become and where to go. They are especially important when an embryo is developing, turning a single cell into a fully formed organism. When these signals go wrong, diseases can appear, which is why scientists are so interested in them.

To uncover how these systems evolved, scientists looked at three very different animals: sea squirts, lampreys, and frogs. Sea squirts are simple creatures without backbones, lampreys are among the earliest animals with backbones, and frogs represent more advanced vertebrates. Comparing them helped researchers spot when important genetic upgrades first appeared in evolution.

Using a powerful method called "long-molecule DNA sequencing", researchers were able to see something no one had seen before. They discovered that lampreys and frogs can produce many different versions of key signalling proteins from a single gene, while sea squirts produce far fewer.

This increase in protein diversity is believed to have helped vertebrates develop greater complexity, allowing for the formation of more specialised tissues and organs, including backbones.

This research not only helps explain how vertebrates evolved but may also be useful in the future for understanding and treating diseases linked to cell signalling.

-Aminah Hossain & Varshini Ganesh

BIOLOGY

Blacktip reef sharks in need of a dentist

We all know that climate change is causing global decay on a wide and long-lasting scale; that many land animals and species are at risk of endangerment and there is a rise in physical impacts such as wildfires in countries that don't naturally experience hot climates. However, what is not often thought about when it comes to the effects of climate change, is our oceans.

In recent years, CO_2 levels within our waters have increased significantly, and as a result we may begin to see the endangerment and loss of blacktip reef sharks. This is because as CO_2 levels rise within the water, the pH levels fall – this results in water being more acidic, which is extremely impactful for sharks that swim with their mouths agape as they hunt for fish.

Afterwards, researchers placed blacktip reef shark's teeth into different pH solutions. The pH solutions represented current oceanic conditions and another with predicted conditions in 2300. Using a scanning electron microscope, they found that teeth exposed to more acidic conditions experienced corrosion of all parts of their teeth, affecting their overall serration. The loss of serration could impact the species overall hunting efficiency. Furthermore, the structural impact is severally degraded by increasing teeth fragility.

-Isabelle Donoghue & Poppy Williams

CHEMISTRY

Physics in Medicine?!?

PHYSICS

Magnetic Resonance Imaging or MRI is based on nuclear magnetic resonance and the quantum property called spin found in certain atomic nuclei, especially hydrogen.
Since the body is mostly water, hydrogen nuclei are abundant and perfect for imaging. In a strong magnetic field, these nuclei align and then absorb energy from radiofrequency pulses. As they return to their original state, they emit signals that are detected and turned into detailed images of soft tissues like the brain, spinal cord and organs, without using harmful radiation.

Computed Tomography or CT uses X-rays, a form of ionising radiation, to create cross-sectional images. X-rays are produced when high-speed electrons hit a metal target. As they pass through the body, denser tissues like bone absorb more X-rays than softer tissues. Detectors measure this and a computer reconstructs it into images.
CT is fast and especially useful for imaging bones, lungs or acute trauma. Both MRI and CT rely on quantum physics and wave-particle duality. X-rays act like photons with quantised energy but also show wave properties. MRI depends on nuclei moving between discrete energy states when excited by radio waves. These technologies show how quantum physics can directly improve medicine.

Medical physics is an exciting career that applies physics to healthcare and shows how medicine is a diverse field, including not only clinical practice but also scientific areas like medical science and advanced diagnostic technology. If you are interested in this area, it is worth reading more about SPECT scans, medical imaging, and how physics helps with diagnosis. Physics is very important to medicine and healthcare. Pretty underrated right?

-Nkemdirim Uliem & Sara Sehgal

The Birthday Paradox

MATHEMATICS

Imagine a classroom with 23 students. What are the chances that at least two of them share the same birthday? Most people guess the probability is low, perhaps 10% or less. In fact, it's just over 50%. This surprising result is known as the birthday paradox, and it highlights how different reality is compared to human intuition

The paradox comes from how we instinctively frame the problem. People often think of the chances that someone shares their birthday, that probability is indeed small, but that's not the question being asked. The real question is: "What's the chance that any pair of people share a birthday?" As soon as you think in terms of pairs, everything changes.

In a group of 23 people, there are:
$(23 \times 22)/2 = 253$ different pairs of people. Each pair is a chance for a shared birthday. While the probability for any single pair is low, the overall number of comparisons makes a match likely. As more people are added, the probability of all birthdays being different falls rapidly.

This result assumes birthdays are evenly distributed across 365 days and ignores leap years. Even though in real world data this isn't the case, the effect is still the same, in the way that the conclusion remains true.

The birthday paradox matters far beyond this. Similar reasoning appears in genetics, cybersecurity and data science. In cryptography, for example, the "birthday attack" exploits this exact principle to break poorly designed security systems.

Whilst human intuition predicts that the chance of sharing a birthday is very low, this mathematical paradox suggests otherwise, producing an unexpected but statistically accurate conclusion.

-Louisa O'Neill & Juanita Jabson

Did you know?
The most common birthdays are September 9th and September 16th-26th, occurring roughly 9 months after the Holiday Season

SPACE FACT

A day on Venus is longer than its year, and it rains diamonds on Jupiter and Saturn.

CAREERS

Future Careers Advice: Dentistry

For those looking to pursue a career in dentistry, I would recommend taking Chemistry, Biology and another science-based subject such as Maths or Physics.
It takes around 5-6 years to complete dental school. For some relevant degrees, there are accelerated graduate entry paths which take around 4 years to complete instead.
Orthodontists require a further 2 years of experience after graduating but a regular dentist only requires a year of foundation training.

As a foundation dentist in your first year out of university, you can expect a salary between £38,500 and £42,400, while you complete your supervised training. Once you become a general associate dentist, your earnings typically rise to between £50,000 and £90,000, depending on how many NHS patients you see.
If you choose to focus on Private dentistry, where you can set your own fees for cosmetic and elective treatments, your income often jumps to between £80,000 and over £140,000. Highly experienced NHS consultants or specialists (like oral surgeons) generally earn between £100,000 and £150,000. At the top end of the scale, practice owners who manage their own clinics and staff can earn anywhere from £150,000 to over £250,000 per year.

And hey, maybe one day you'll be looking after Blacktip Reef Sharks!

-Kinus Krishnamoorthy

Revision tips

Effective GCSE revision for Science and Maths should prioritise active, exam-focused methods over passive revision.
Past papers are the most important form of revision and are far more effective than rereading notes or watching videos. Completing them under timed, exam-conditions helps mimic the real exam and is the best preparation possible. Use Physics & Maths Tutor for past papers and topic questions and review mistakes carefully using mark schemes. Examiner reports are also useful for seeing exactly what exam boards are looking for, though they are not always completely precise and should be used alongside mark schemes.
For maths, complete Corbett Maths 5-a-Day daily, and for science, use blurting, active recall, and spaced repetition to memorise large amounts of content. Regular essay and extended-answer practice improves structure, timing and use of key vocabulary, which can also be strengthened through reading.
CGP science guides are ideal for clear explanations and concise summaries, and checking your exam board's specification is essential because if you follow the specification closely, you cannot miss any examinable content.
Finally, avoid relying on AI tools or solution banks as a crutch and attempt questions independently first, using support only to check and refine your understanding.

-Obinna Uliem

Today's joke
-Textbooks... he never botany!

Thanks for reading!
If you have any questions or articles for future issues, please email us at TheLabReport@ccgrammarschool. co. uk

That's all from us , see you in our next issue !

-Isabelle Donoghue, Poppy Williams, Juanita Jabson, Varshini Ganesh, Aminah Hossain, Nkemdirim Uliem, Sara Sehgal, Obinna Uliem, Lousia O'Neill, Kinus Krishnamoorthy, Injila Bilal, Joseph Hobley

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