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CAN WE TRAVEL THROUGH TIME?

DO PLANTS GET CANCER?

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How To Spot A Pseudoscience

IFLSCIENCE

16



WHERE ON EARTH

NEW ZEALAND'S SEAL CRECHE WATERFALL

For a few months each year, the Ōhau Waterfall in Kaikōura, New Zealand, becomes a seal pup paradise.

10



DEEP DIVE

CAN WE TRAVEL THROUGH TIME?

Stephen Luntz investigates whether time travel is truly possible or strictly science fiction.

4



OUR COVER STORY

HOW TO SPOT A PSEUDOSCIENCE

What's the difference between science and snake oil? Maddy Chapman reveals all.

October 2023

CONTENTS

News Bites | page 2

What's new, what's weird, what's happening?

What On Earth | page 7

Boxing pom-pom crabs

We Have Questions | page 8

Do plants get cancer?

Book Bites | page 14

Marie Skłodowska-Curie's Bone Marrow

Meet The Author | page 15

Medical historian Suzie Edge on *Vital Organs*

Science In Media | page 18

What to watch, read, and listen to this month

Dates To Remember | page 19

What to look out for this month

Dark Vs. Light | page 20

How will you end the issue?

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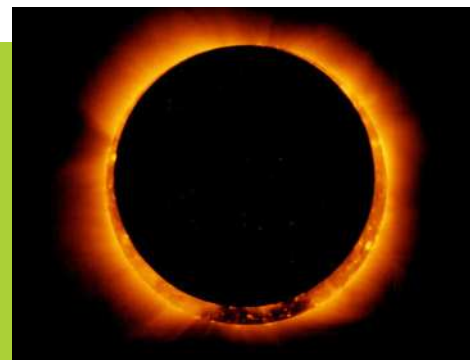
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NEWS BITES




It's CURIOUS Live!

IFLS Science's first free festival of science, CURIOUS Live, is here! Streaming online so accessible to all, CURIOUS Live takes place on October 21 with a full festival line-up of fascinating speakers, interviews, Q&As – and, because it's us, plenty of laughs, some very weird science, and at least one thing that will make you go ewwww. Spanning three festival "stages" – Life, Death, and Creation – hosted by IFLS Science's own The Big Questions podcast hosts, prepare to explore fighting crime with plants, queerness in nature, creating civilizations on other planets, history's deadliest diseases, and more, all for free! Plus, ask your own questions and win exclusive merch. Click [HERE](#) for the full line-up, to book tickets, and for more details. Put it in your diary now!



Ring Of Fire Eclipse

October 14 will see an annular solar eclipse swoop across North, Central, and South America, providing once-in-a-lifetime views. It's nicknamed a "ring of fire" because the lunar disk doesn't completely cover the Sun, leaving a bright circle around the Moon. This happens when the Moon is near its apogee, its furthest point from the Earth, making its appearance in the sky slightly smaller than usual and allowing for portions of the Sun to be visible. For parts of the US, it will be visible for nearly five minutes, and you will need eclipse glasses to view the Sun!



Visiting A Metallic World

NASA's long-anticipated mission to Psyche is launching this month – and this is one exciting destination. Psyche is considered the most expensive known asteroid in the universe due to its unique metal-rich makeup with an estimated value somewhere between \$10,000 quadrillion to \$700 quintillion. Psyche orbits the Sun between Mars and Jupiter and is thought to be the exposed nickel-iron core of an early planet, one of the building blocks of our Solar System. Visiting it could offer insights into the violent events that create terrestrial planets like ours. Set to launch on October 5, the spacecraft won't reach it until 2029, where it will then spend 26 months mapping the asteroid's geology, topography, and gravity, circling ever closer until it gets to just 75 kilometers (46 miles) from the surface. Can studying Psyche reveal some of Earth's own mysteries sounding its core? Check back in with us in *checks watch* six years!

Heliophysics Big Year

Citizen scientists rejoice, NASA wants your help! Inspired by the birdwatching community's Big Year, it's introducing the Heliophysics Big Year, a year of celebrating solar science from October 2023 to December 2024. Heliophysics is the study of our star and how it interacts with everything in our Solar System. NASA wants everybody to get involved with as many Sun science projects and celebrations as possible, whether it's a gathering for the "ring of fire" eclipse on Oct 14 or an aurora party. There will be plenty of citizen science projects you can get involved in, check out how [here](#).



Wildest Weather Photos

The Weather Photographer of the Year 2023 winners are set to be revealed on October 5 after a public vote. Now in its eighth year, the competition showcases some of Earth's most fascinating weather and climate phenomena, from Omega sunsets and strange mirages like **Brocken specters** to weird rare clouds, including gorgeous "mother-of-pearl" stratospheric clouds or this lenticular cloud above a volcano snapped by Francisco Negroni in Chile, one of the shortlisted finalists for this year's competition. To see all the winning images visit [here](#).



Life On Our Planet

Got a prehistoric creature-sized hole in your viewing schedule? Netflix has you covered with its new eight-part series *Life on Our Planet*, hitting screens on October 25. Following nearly 4 billion years of life on Earth, the show chronicles the rise and fall of millions of species via the cataclysmic events that both ended lives and allowed for new species to burst forth: the five big extinction events. Using the latest technology and science to bring long-gone creatures – from dinosaurs to mammoths and saber-tooth cats – back to life, to quote another famous prehistoric blockbuster, they "spared no expense". Steven Spielberg's Amblin Television is even one of the creators.

WHAT'S UP?



Fat Bear Week

We're Gonna Get Chunky

Name: Fat Bear Week

Appearance: Chonky

Location: Katmai National Park, USA

annual winter hibernation. Putting on weight before then can help them to survive.

Fat Bear Week?

It's Katmai National Park's annual tournament to see which of their local ursine residents has put on the most weight in preparation for winter.

Should we be calling out the bears for being fat?

Yes, that's the aim of the game. In fact, it's a celebration – there's no fat-shaming in this competition. The winner is considered a king or queen amongst bears.

How is the winner decided?

In true *America's Got Talent* fashion, it's down to a public vote. Bears are pitted against each other, with voters picking which bear they believe has put on the most weight. Of course, the winner might not actually be the heaviest, but where would be the fun in that?

Why do they need to get so fat?

Bears can lose up to a third of their body weight during their

What kind of diet plan are they on?

Salmon – and a lot of it. During the annual salmon run, around 3 million fish pass through Katmai's waters, giving the carnivorous competitors ample opportunity for snacks. They can put on around 1.8 kilograms (4 pounds) in a single day during the summer months.

Who is the bear to beat?

747, appropriately nicknamed Bear Force One, is the two-time-winning reigning champion. However, his crown could be threatened by the oldest bear in the park, Otis. Having won a whopping four times in the last nine years, he may be looking to reclaim his title.

When is Fat Bear Week 2023?

This year's competition takes place October 4-10. Choose your champion and get voting [here](#).

OUR COVER STORY



HOW TO SPOT A PSEUDOSCIENCE

The line between science and pseudoscience can be pretty blurry, here's how to know when you're being had.

Image Credit: Imran Chowhury

By Maddy Chapman

We exist in an increasingly online world that bombards us with information at every opportunity. A simple scroll on our favorite websites, news outlets, and social media platforms can bring a torrent of (sometimes questionable) content down on our heads, and it can be a nightmare to decipher the fact from the fiction – especially when it comes to science.

It's no wonder, therefore, that we find ourselves asking more and more often: Is this science or is it snake oil? And, more importantly, how can we tell?

This distinction, also known as the demarcation problem, is "key to most of the fundamental problems in the philosophy of science," according to Karl Popper, one of the 20th century's most influential philosophers.

Despite its importance, it's not always easy to know what's science and what's not. Fortunately, there are some tell-tale signs that may help in navigating the maze of misinformation out there – here's how to spot a pseudoscience in the wild.

Pseudoscience: a history

Pseudoscience is a system of thought or a theory that is erroneously regarded as scientific despite not being rooted in science. Pseudoscientific ideas predate the scientific era, and in some cases are ancient – the practice of astrology can be traced back to the 3rd millennium BCE, for example.

Things really got going in the 19th century, which saw a burgeoning of pseudoscientific ideas. Practices such as phrenology – the idea that bumps on the skull can reveal aspects of our personalities – spirituality, and **telepathy** became popular, and proponents of them often published their beliefs in books and magazines, presented as "research".

The dawn of the Space Age in 1957 saw things take an extraterrestrial turn, with

ancient astronaut theories taking off. However, by the end of the 20th century, skepticism had begun to grow and various societies aiming to counter pseudoscience popped up, including the Center for Inquiry (1991) and Skeptics Society (1992).

Famous examples

Today, belief in pseudoscientific theories is still rife – you only need spend five minutes on TikTok for evidence of that.

Popular examples include the previously mentioned astrology – the concept that the movements of celestial bodies somehow influence our daily lives – which has reams of fans despite evidence **it isn't real**; **numerology** – the belief that the numerical values of our birth and name can reveal deep truths about us; and the handwriting-based personality practice called **graphology**.

You might also be familiar with homeopathy, cryptozoology (seriously, **where is Nessie?**), **pseudoarchaeology** (looking at you, **Atlantis**) acupuncture, and aromatherapy, which are all largely considered to be pseudoscience. And that's naming just a few.

But what separates these ideas apart from legitimate science?

Science vs. pseudoscience

A quick Google will tell you that science is "the systematic study of the structure and behaviour of the physical and natural world through observation, experimentation, and the testing of theories against the evidence obtained" – which is a lot of words to essentially say that science adheres to the *scientific method*.

This begins with a question, which is developed into a hypothesis and tested in a series of experiments, the results of which can be used to draw new conclusions. Ultimately, the process enables us to generate knowledge, make predictions, and advance our understanding.

A pseudoscience, on the other hand, may present itself as scientific, but is in fact incompatible with this method. It

***EVEN WITH THESE INTRINSIC DIFFERENCES,
IT'S NOT ALWAYS CLEAR WHERE
PSEUDOSCIENCE ENDS AND SCIENCE
BEGINS: ALCHEMY PAVED THE WAY FOR
THE SCIENCE
OF CHEMISTRY, AFTER ALL.***

often starts with a conclusion and works backwards to find the evidence to "prove" it.

A crucial tenet of "science" is that it builds on previous knowledge, using what has come before, alongside new evidence, to support or refute a theory. Because of this, it is highly adaptable and can change in light of new information.

For example, a widely accepted scientific theory, like Einstein's relativity, may be the best current explanation that we have for something, but only until a better one comes along.

"Anything that is truly scientific is going to allow for that kind of refinement and even that kind of rejection," Rachel Ankeny, a professor of philosophy of science at the University of Adelaide, told **IFLScience**.

However, pseudoscience, which has likely not been subjected to such scrutiny and stringent testing, tends to be much less malleable.

"For something to be a scientific fact, typically, they have to be a finding that has resulted from careful attention to building empirical evidence. [...] In different fields, these are going to be different but it often involves observations, testing, and measuring through experimentations," Ankeny added.

The same cannot be said of pseudoscience, which instead of repeatedly carrying out rigorous testing relies on claims of "ancient methods" used for "thousands of years" or cherry-picks its evidence from real

existing data, sometimes just one small study, not widely evaluating any further or updated findings and often taking those findings out of context to fit a foregone conclusion.

Even with these intrinsic differences, it's not always clear where pseudoscience ends and science begins. And sometimes it can seem like the fields themselves are confused; the pseudoscience of alchemy paved the way for the science of chemistry, after all.

So how can you work out what to take seriously when the waters are so diluted? (Yes, that was a homeopathy joke.)

How to spot a pseudoscience

The first thing to ask yourself is "Where has this come from?" Experts are experts for a reason, and if they're touting something then it's likely to be more valid than if, say, you heard it from your mom's friend's neighbor. Always question a big claim's sources.

GWYNETH PALTROW'S GOOP, WHICH SELLS MANY UNSCIENTIFIC "WELLNESS" ITEMS, FROM HEALING CRYSTALS TO ENERGY REBALANCING STICKERS, HAS AN ESTIMATED ANNUAL REVENUE OF \$18-60 MILLION.

The next thing you might want to consider is "Why?"; what is the purpose of this theory, and what could someone gain from it? Science generally strives for discoveries to open up new avenues of research, advance knowledge, and perhaps influence current policies or worldviews. Its purpose tends to be more altruistic than pseudoscience, which may be pushing an agenda – perhaps someone stands to benefit financially or

in some other way by pushing this idea. Gwyneth Paltrow's Goop, for example, which sells many unscientific "wellness" items, from **healing crystals** to **energy rebalancing stickers**, has an estimated annual revenue of between \$18-60 million.

If in doubt, you can always turn to The Research. As we've established, science is supported by a broad body of evidence that has stood up to peer review and the scrutiny of scientific peers. Robust evidence is more likely to suggest something is science, whereas limited, flimsy, or cherry-picked data hints otherwise.

If we're talking science, this evidence is likely to have changed over time, so you should look out for an evolution of ideas. If the principles are more or less unchanged since a concept was first introduced, or no new research has been conducted, you could have a pseudoscience on your hands.

In a similar vein, you could consider how a theory responds to challenges. If it, or its supporters, ignore or refuse to accept contradictory evidence, it may not be legitimate. Science, on the other hand, embraces challenges.

Last but not least, let's return to our old friend Karl Popper. His theory of falsification posits that for a theory to be considered scientific, it must be able to be tested and conceivably proven false. However, many pseudoscientific claims cannot be tested and so cannot be proven or, crucially, disproven. Where pseudoscience shies away from falsification, science seeks it, something that can be useful to contemplate when looking to uncover a pseudoscience.

Armed with these top tips, you can not only satisfy your skepticism but, according to Popper, you can solve most of the problems in the philosophy of science. We bet that wasn't in your horoscope for today. •

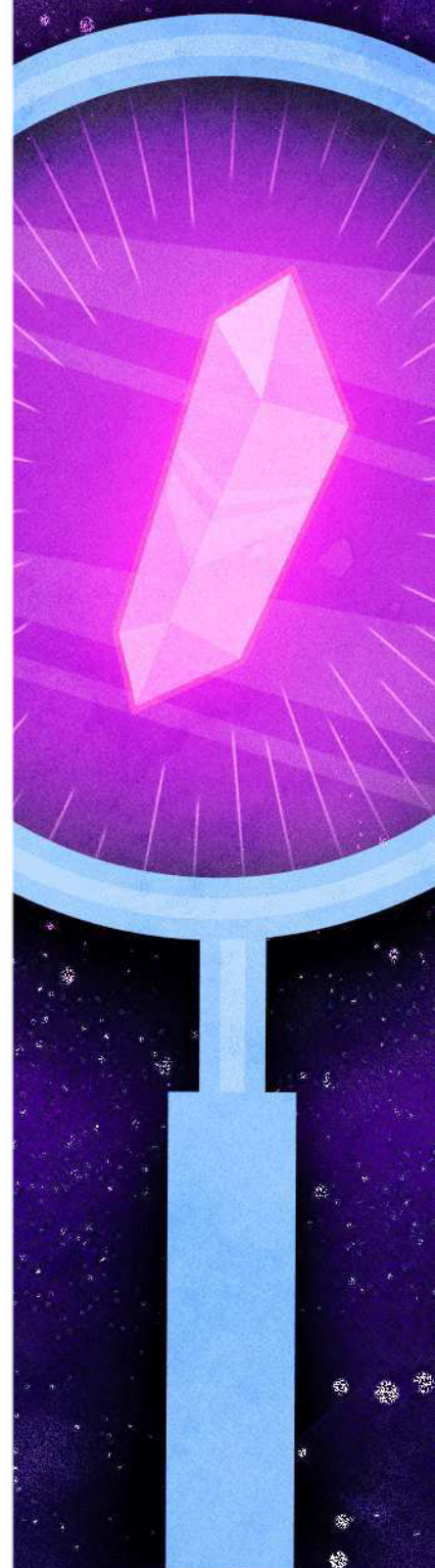




Image Credit: littlesam/Shutterstock.com

BOXING POM-POM CRABS

Boxing and cheerleading collide in the case of the pom-pom crab (*Lybia edmondsoni*). Also known as the boxing crab, it has evolved to use the stinging power of anemones to its advantage by holding the venomous species *Triactis producta* in each claw. The defense mechanism increases feeding opportunities for the anemone as it's waved through the water, but there's a price. If the crab loses an anemone, it can rip the remaining one in half as a thrifty way of regaining a second pom-pom. Savage, but effective.

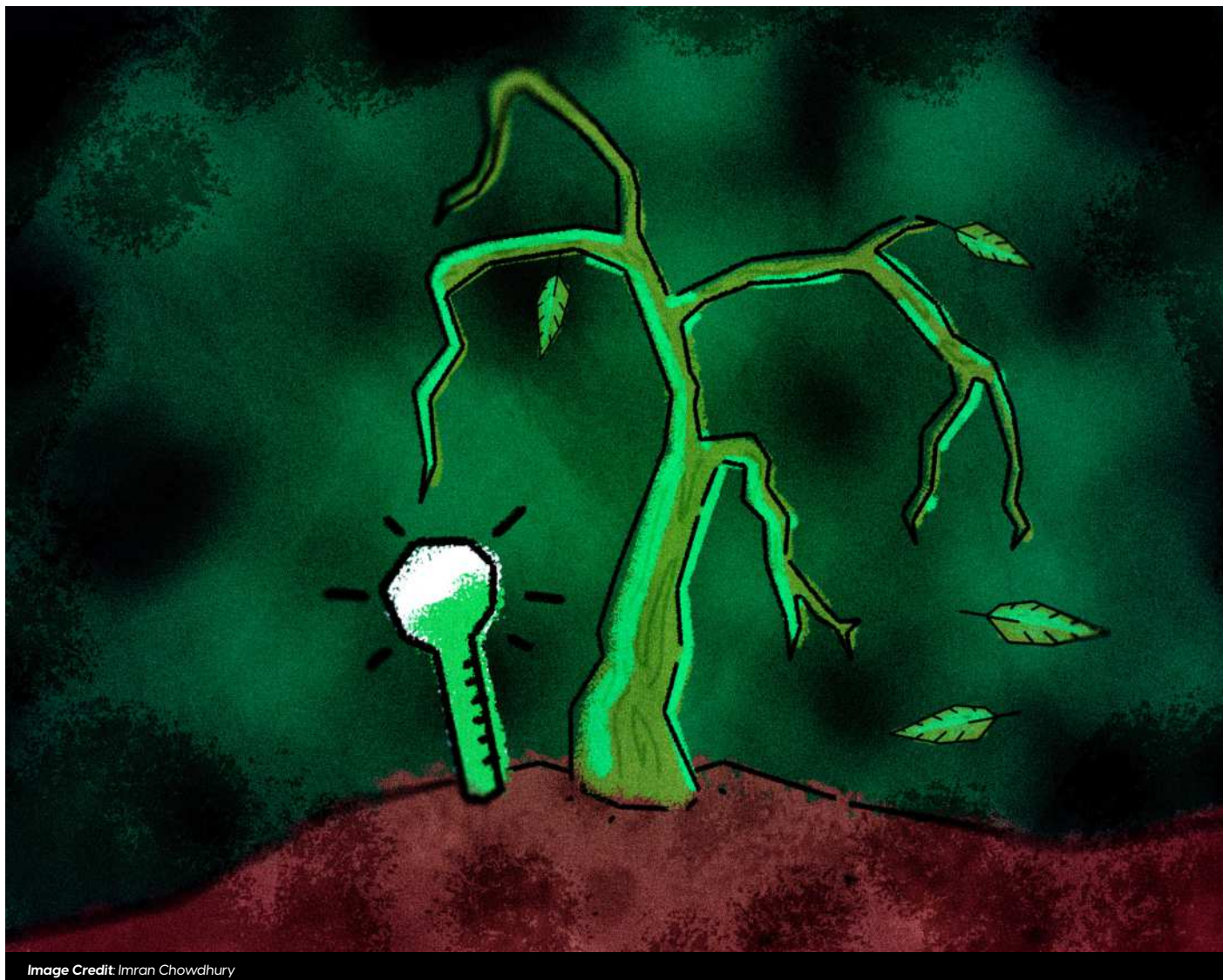


Image Credit: Imran Chowdhury

DO PLANTS GET CANCER?

AND IS THERE SUCH A THING AS PLANT MEDICINE?

By Rachael Funnell

A 5,000-year-old bristlecone pine stands in the White Mountains of California, making it the oldest non-cloned living organism on Earth. We know the extremes of longevity can get messy in the context of animal cancers, but what about botanical species? Do plants get cancer?

Louise Gathercole is the Coordinator for the **Centre for Forest Protection** (CFP), UK, a new center led by Forest Research and Royal Botanic Gardens Kew, which carries out innovative research into protecting trees and woodlands from future threats. She is also a part-time PhD student researching oak trees. We caught up with her to find out if, and how, plants get sick.

Do plants get sick?

LG: Plants do get sick, and it can have a big impact on things like our food supply. For example, the Irish Potato Famine happened because the plants got sick. With trees, we have had problems with fungi like Dutch elm disease and ash dieback, which have a big impact on our landscape.

What about cancer?

LG: With plants, there are lots of things that cause their cells to grow uncontrollably, and in a way that's not normal for the plant. Usually, these are caused by something else. So, it might be bacteria infecting the cells and subsequently the DNA. You also get viroids, viruses, and fungal infections, and in some cases, we don't know what's causing the cell growth.

Then there are also galls caused by gall wasps, a lot of which grow on oak trees. The wasps lay an egg in a leaf or acorn bud and when they hatch, they secrete chemicals that cause the cells of a leaf or an acorn to grow abnormally. That creates this space that's safe for the gall wasps' larvae to develop in. This doesn't really harm the tree.

One of our science leads, Lisa Ward, who is Head of Pathology at Forest Research sent me some examples of plant diseases that cause massive cell proliferation in a cancer-like way. There's crown gall that transfers bacteria into a plant's genome, altering levels of plant hormones which leads to irregular cell division, causing tumours to grow. Also, black knot fungus releases chemicals that make the tree grow extra plant cells that are unusually large, resulting in swollen, woody galls. But there are many more.

How do these growths differ from animal cancer?

LG: You don't get secondary cancer because the cells don't move around the body. So, the cancer can't affect the different parts of the plant. But the way these growths can spread is the pathogen itself can move. So, a bacteria might infect cells in one area, but if the bacteria then multiplies and replicates, it can move somewhere else, or get carried somewhere else by another organism.

The other thing is that, for the most part with plants, it's not spontaneous. It's often triggered by a bacterium or fungus, while animal cancers are more typically a spontaneous breakdown in DNA replication

or a breakdown in the body system that deals with out-of-control cells. Of course, there are exceptions like cervical cancers and human papillomavirus, so there are some similarities there.

Do we have plant medicines?

LG: If you think about agriculture and gardening, there is the use of pesticides and fungicides to protect plants. Then there's biocontrol, where you might have an invasive insect that could be controlled by introducing more of its natural predators.

That's quite a big area of research now, using biocontrol for potential future threats such as pests and disease, but obviously, you have to do a lot of work to make sure that the predator you're releasing doesn't affect other species. People are also looking into whether you can put together a cocktail of bacteria that might out-compete a bacterium that's causing problems. Improving the natural environmental conditions, such as soil, can also help as environmental factors can affect a plant's susceptibility to disease. So, there are lots of things that aren't quite medicines, but that can actually help to deal with whatever is causing the illness.

What are you looking into at the CFP?

LG: We are researching possible future invasive threats to trees, and also how to make our trees more resilient. We do a lot of genomics research at the CFP at Kew, using methods previously developed for human health or agriculture.

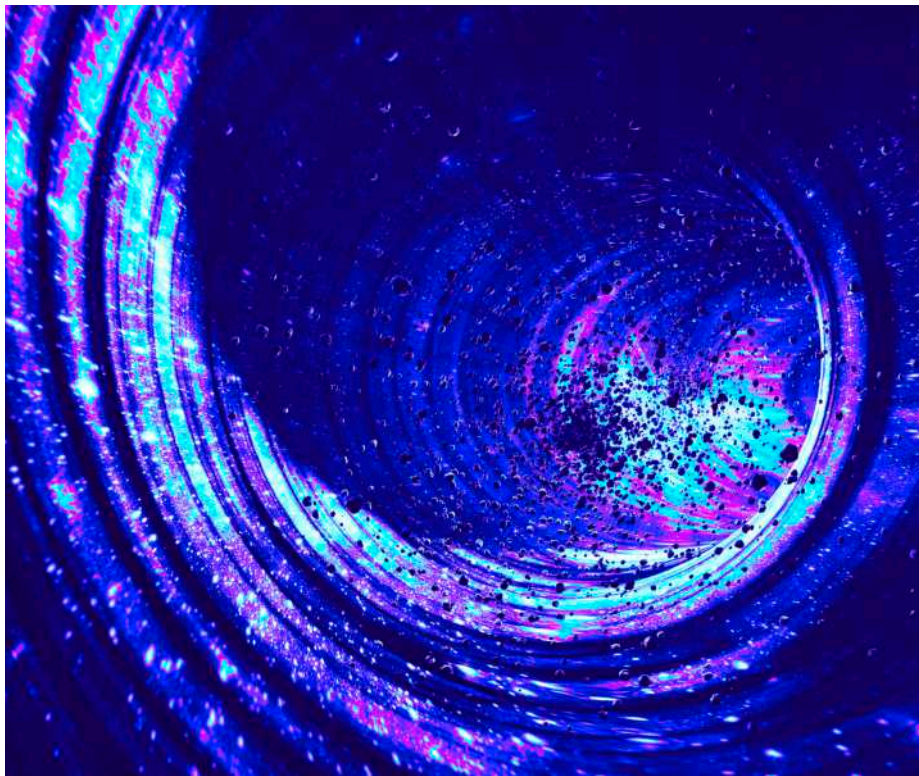
One method is to compare the genomes of sick trees with the trees that seem to be resistant to a pest or disease. If you get more of one version of a gene in the resistant group, that version might be helping the tree to resist the disease. In reality, it is much more complicated than just one gene, but if we can identify the mix of variants, or the genotypes, that lead to a healthier outcome, we can start looking at planting more resistant trees in the future. ●

Image Credit: Robert L. Anderson, USDA Forest Service, Bugwood.org

SCIENCE FACT OR FICTION:

CAN WE TRAVEL THROUGH TIME?

Paradoxes may well make time travel impossible, but an unbreachable physical obstacle is yet to be found, finds Stephen Luntz.



H.G. Wells set off an obsession with his novel *The Time Machine*, one whose frequent appearances in science fiction testifies to its popularity ever since. Many of the other futuristic concepts Wells and his contemporaries wrote about have long since come true, but we don't seem to be any closer to time travel, at least of the sort popularly envisaged. So, is it even possible?

Physics offers reasons to think it might be, starting with its status as the fourth dimension. However, it also throws up a lot of obstacles, some of which may yet prove insurmountable.

Not that sort of time travel

Answering a question like this needs to start with what one means by time travel. In one sense we are all traveling in time, approaching the future at the rate of one second every second. Of course, that's not what people mean, but it points to the need to think a bit harder about definitions.

Some forms of time travel are definitely possible, but while they may be closer to popular meanings, they're still not really there. We know from **Special Relativity** that time passes differently for someone

traveling at a **substantial fraction** of the speed of light than for someone stationary. Consequently, astronauts on a trip to Mars, particularly a **more rapid one** than is currently considered, would experience very slight time dilation effects. Looked at one way, they would return to an Earth whose clocks, including biological clocks, are very slightly out of step with their own.

For a short trip like that, the differences would be minor, and overwhelmed in terms of aging by the effects of zero gravity. Faster and more distant journeys, where the time shifts would be more noticeable, may be well outside our current capacity,

not to mention budget, but we know they are theoretically possible. The sorts of time travel where space voyagers return to Earth **barely changed** but their families have aged decades could happen, and if humanity does not derail its progress through war or environmental collapse, they probably will.

What we really mean

Pedantry aside, we all know what is meant by time travel: going to a point in either the past or the future and (hopefully) returning safely. Even if this is possible in theory, there are some quite major practical problems to consider.

UNLESS SOME FORCE MAINTAINS THE TRAVELER'S POSITION RELATIVE TO THE PLANET, YOU'D FIND YOURSELF FLOATING HELPLESSLY IN SPACE WAITING FOR THE EARTH TO CATCH UP.

To pick just one example: fictional representations of time travel almost always assume the traveler ends up in the same location in space, relative to the Earth, but would this be the case? After all, even if you just traveled back in time by a week, so you could bet on a sporting contest for example, the Earth would have moved millions of kilometers in its orbit around the Sun in that time, and the Sun would, in turn, have migrated a small way **around the galaxy.**

Unless some force maintains the traveler's position relative to the planet, you'd find



yourself floating helplessly in space waiting for the Earth to catch up. Ignoring this problem reflects a view of the Earth as the center of the universe disproven by Copernicus.

If you assume time travel involves conservation of momentum, the traveler would likely end up close to their location of origin, but slight changes in direction could still result in relative shifts in location that could prove lethal.

Nevertheless, objections like this don't make time travel impossible, just impractical.

The strangeness of space-time

In addition to raising the possibility of time dilation effects, Einstein's special theory of relativity implied that space and time are more intimately linked than had previously been assumed. The idea of a four-dimensional space-time was raised soon after, and developed in the general theory of relativity, where Einstein showed that

huge mass can curve space-time, including what physicists call worldlines.

One consequence of this is that similar time dilation effects can occur in a powerful gravitational field just as they can when traveling close to the speed of light. If you want to experience time travel at the pico-scale, climb a mountain or get in an airplane to put some distance between you and the Earth's gravity.

More significantly, if this distortion becomes sufficiently extreme it should create what is called a "closed timelike curve" (CTC), which followed precisely would take you back to an earlier time.

As the book *The Quantum Physics of Time Travel* **notes**: "If time travel is impossible, then the reason has yet to be discovered."

Nevertheless, there is clearly a lot we **don't know** about time. If it is merely the fourth dimension, why can we easily change our

position in space, but not do so in time, other than letting it carry us forward like a river? The answer could turn out to create physical obstacles to time travel we have yet to identify.

Grandfather paradoxes

The obvious problem with traveling back in time: accidentally (or deliberately) kill your grandparents and you are never born, so how could you kill them? Science fiction writers usually use this as a plot device to force their characters to undo the changes they have made. The ending produces a world where all the crucial details are similar enough that the trip **occurs paradox-free**, but things are nevertheless better.

That's great for fiction, but scientists have to acknowledge that such an outcome is unlikely.

One possible solution to the grandfather paradox lies in the **many-worlds interpretation**. If true, there are an

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infinite number of universes branching off from each other every time an event occurs that could turn out in different ways. In this scenario, the universe where your grandfather was mysteriously killed before conceiving your parent is as real as the one you experience, and traveling in time merely means hopping from this universe to that one.

A variation on the grandfather paradox is the **Bootstrap Paradox**, where time travel creates the conditions for itself to happen. An example might be a person receiving instructions from the future on how to build a time machine, leading to the creation of a world where their future self can send those instructions back. While self-consistent, these situations nevertheless leave open the question of where the information came from in the first place. Once again, this is the sort of thing fiction writers can casually gloss over in films like *The Terminator*, but physicists have to face directly. Calling them closed causal loops may speed communication but doesn't solve the problem.

What isn't clear, however, is whether paradoxes actually prevent someone from traveling through time, even if they potentially make it a very bad idea.

A one-way trip?

Most time travel stories today involve efforts to go back in time to try to change the endless things we're unhappy about. However, Wells's tale is of a traveler going forward to witness the decline of humanity and eventually the Earth. This avoids the grandfather paradoxes and is quite possibly more plausible.

Such forward traveling might have its appeal, particularly if you expect the future to be better than the past – you'd get to reap the benefits of those solving today's problems without having to do any of the work. The problem would come if you started missing your loved ones and wished to return home. At the very least,

a return to one's own time would risk the bootstrap paradox, where the information collected on the trip is used to bring the foreseen world into reality.

If so, how?

If we accept that time travel is possible, paradoxes can be resolved, and it's something we are willing to risk, that still leaves the question of how.

The simple-sounding explanation is that one needs to travel faster than the speed of light, but this is easier said than done. It's possible to travel faster than the local speed of light in a medium that slows light down, something we witness in the **Cherenkov Effect**. This, however, does not get you a ticket to the 19th century. For that, you need to travel faster than the speed of light in a vacuum. Although faster-than-light travel is not inherently impossible, an object with mass cannot travel at exactly the speed of light, which poses something of an obstacle to traveling faster than it. In practical terms, how does one accelerate from slower than light speed to faster without going at the speed of light in between?

According to **Stephen Hawking**, a prerequisite for time travel is the presence of exotic matter, specifically matter with negative energy. This isn't necessarily as impossible as it might sound, but so far we have not identified the existence of any negative mass particles, in contrast to **antimatter**, which, while rare, definitely exists.

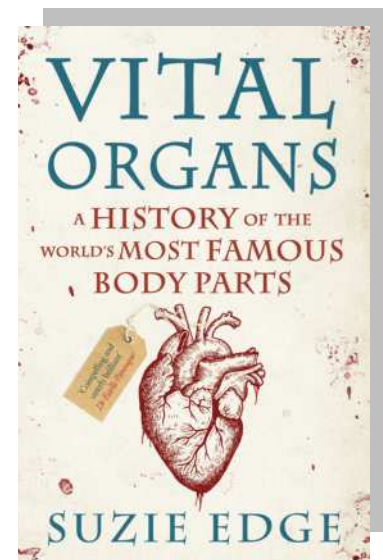
Why aren't they here?

Ultimately, the strongest evidence against time travel is probably its own equivalent of the **Fermi Paradox**. If time travel is possible, why have we not encountered any tourists from the future? Hawking even **sent them an invite**.

Either humanity has never invented time travel, or our descendants have, but have used it very responsibly. Given our record with every other technology, the latter seems unlikely. ●



MARIE SKŁODOWSKA-CURIE'S BONE MARROW



Medical historian Dr Suzie Edge details the demise of two-time Nobel Prize-winning chemist Marie Skłodowska-Curie after years of radiation exposure took its toll on her bone marrow in this excerpt from her latest book *Vital Organs*.

Unseen, deep down in her long bones, Marie Skłodowska-Curie's marrow cells were paying the ultimate price for her brilliance. Marie's bone marrow was failing, destroyed by radioactivity, the very thing that has saved so many lives since she discovered its potential.

Marie Curie was the first woman to win a Nobel Prize. She was also the first (and only) woman to win the Nobel Prize twice. She remains the only person to have won the prestigious prize in two different disciplines. Her work, which continues to save lives, took hers at the age of 65.

That work involved the study of radioactivity, a term she and her husband Pierre Curie coined together as they worked tirelessly to free radioactive elements from ore. Working long hours in their leaky shack of a lab in

Paris, they extracted only 10 grams [0.35 ounces] of pure radium chloride salts from many tonnes of pitchblende. It was a long and difficult task.

Physics and chemistry came together in the study of radioactivity. Marie learned from scientist Henri Becquerel, who had discovered that uranium salts emitted penetrating radiation without an external energy source. That was fascinating to Marie, who saw that it had many potential applications. She took it up as her field of study and discovered two more elements. One she named polonium after the country of her birth, Poland. The other, which was far more radioactive than Becquerel had shown uranium to be, she named radium. In 1903 she wrote her thesis, *Research on Radioactive Substances*. Together, the Curies and Becquerel won the Nobel Prize, but Marie and Pierre were not there to collect the award. There was simply too much work to be done.

In 1906 Pierre Curie was killed in an accident. On the rain-soaked and busy Rue Dauphine he was crushed under the wheels of a horse-drawn carriage. Marie carried on the work alone and she was offered his chair at the university, becoming the first female professor at the Sorbonne.

Radioactivity's usefulness in the field of medicine for both diagnosis and treatment started with Marie Curie's work. She quantified the effects of radiation on

living cells, allowing for the development of radioactive treatments. She also demonstrated that X-rays could pass through materials and interact with photographic papers. That meant that they could show us inside our bodies, outlining human tissues, pathologies and foreign bodies. During the Great War, Marie kitted out trucks with X-ray equipment and travelled between field hospitals where she used the devices to show bullets and shrapnel lodged inside the bodies of the injured. The X-rays meant surgeons could now visualise the injuries within their patients. Marie trained other women to use the vans and she installed X-ray rooms in field hospitals. She took along her eldest daughter, Irene, who she trained and who herself won a Nobel Prize in 1935. What a remarkable family.

She worked for many years with radium and other radioactive materials with no protection. Though there was a growing understanding that radiation could be used as a treatment for errant cancerous cells, she refused to believe that the work was causing her own ill health. Even Pierre Curie had been feeling unwell before his tragic accident, but how could they know it was radiation poisoning?

There is no way that our bodies can sense ionising radiation. We can't see the electromagnetic waves. There's no smell to the subatomic particles. We can't touch it and we can't feel it as it moves through our cells, detaching electrons from molecules and damaging DNA. Not until it is too late. ●

Q&A
AUTHORWITH
SUZIE EDGEDOCTOR, HISTORIAN, AND AUTHOR OF *VITAL ORGANS*

In *Vital Organs*, TikTok sensation and medical historian Dr Suzie Edge delights (and horrifies) with tales of the world's most famous body parts, from Queen Victoria's armpit to Marie Antoinette's teeth.

What is *Vital Organs* about?

Vital Organs takes a cheeky peek at body parts that have shaped history. I've brought together well over 40 cases of how we have used, abused, dug up, displayed, experimented on, and worshipped body parts. We look at body parts that have started wars and appendages that have helped develop medicines and surgery. From head to toe, there's a fascinating body part story for everyone.

What inspired you to write this book?

Being a medical doctor and a historian, I'm just fascinated by how we have treated the human body, in life and in death. For years I have collected these stories where body parts have been involved. When I started to tell the stories on my TikTok channel, followers loved the bizarre and gruesome and they shared even more stories with me until I thought these would be great to tell all together, head to toe if

you like. After my first book, *Mortal Monarchs*, which looked at 1,000 years of royal deaths in Britain, *Vital Organs* has allowed me to go further afield, all around the world in search of the weird and wonderful.

Do you have a favorite history-making body part?

I love to tell the gruesome stories that make people gasp, like what happened to Napoleon's penis (it now lives in New Jersey) or Jeremy Bentham's preserved head (preserved so badly it's like a prop from a horror movie) but I also like to think about how ideas and society's views are changing and how we are now starting to think about the impact of displaying body parts the way we do. So many pieces have been sold and displayed over the centuries and now they are making their way home. Some stories, like the incredible impact on the world made by **Henrietta Lacks' cervical cells** (without her consent or her family's knowledge), just feel too big to do justice as a chapter in a book.

What about the most gruesome?

There's a wonderful story about Louis XIV King of France who had an abscess on his bum that turned into a fistula. After trying to treat it with herbs and poultices and prodding it with red-hot irons, the physicians allowed a surgeon to take a look. He hadn't operated on such a thing before so he practiced on the people of

Paris and developed tools and a technique to derroof the fistula. When he was ready, he operated on the King's rear end. It took hours and there was no anaesthetic or antiseptic. Remarkably, the King survived, and as was the craziness of the French court, it became fashionable to undergo rear-end operations whether they had a fistula or not!

Where did your fascination with the human body and history of medicine begin?

Since I was a teenager I wanted to be a doctor. I have no family members in medicine but it was all just fascinating to me. I also loved hearing historical stories about Bubonic Plague or weird and wonderful stories of early biological warfare: how we used the natural world against each other. It's hard when you are a kid and you have to choose between humanities and sciences if you want to study medicine. I was lucky enough to be able to study history later on and bring my two interests together.

What do you get up to when not writing about the world's most famous body parts?

I just love all aspects of storytelling. I've ruined movies for my kids with my script obsession. I read a movie or TV script most days and bore them with it! I also love sports, watching and playing. I have a black belt in the martial art of Sooyang Do and am an instructor. My teenage kids have overtaken my grade, which makes me very proud.

What's it like being a TikTok "sensation"?

I owe a huge amount to TikTok. People still say it's an app for kids for dancing and that couldn't be further from reality. Telling stories and making connections on there has been massive for me. It has opened so many doors. My agent found me on TikTok and we've gone from strength to strength – but I'm writing some kid's books too now, so that's a lot of fun. Still not dancing though. ●

Vital Organs by Suzie Edge
is published by Wildfire and is
available from September 28.



A pups-only playground can be found tucked inland near the coastal town of Kaikōura on New Zealand's South Island. Here, fur seal pups splash their way upstream to reach the Ōhau Waterfall that, for a few months each year, becomes a nursery.

NEW ZEALAND'S SEAL CRECHE WATERFALL

Thousands of seals call Kaikōura, New Zealand, home, but when the winter weather starts to kick in come April, the Ōhau Point Seal Colony's pups make a unique journey. They swim inland, following a stream to Ōhau Waterfall, which for one to three months of the year acts like a creche for young seals.

The falls are a pups-only party where they can practice swimming, chase each other in the pool, and socialize with other seals as they chill out on the rocks. Ōhau waterfall is what's known as a horsetail waterfall, meaning its falling water maintains contact with the rockface for the 15-meter (49-foot) plummet.

The colony is made up of fur seals (*Arctocephalus forsteri*) and it's believed to be the only place in the world where their young make this unusual inland journey to use a waterfall as a nursery. Pups will need to travel semi-regularly during their stay here so that they can stock up on mom's milk before getting back to the fun.

Access to the waterfall for humans has been affected by a devastating 7.8 magnitude earthquake that struck Kaikōura in 2016, sending loose rock and debris cascading across the landscape, including main access roads. The area has since been secured but the risk of rockfall at the Ōhau Stream walkway has made it difficult to decide if tourists should be granted access to the seals' playground.

The waterfall itself didn't escape the quake scot-free. Kaikōura Tourism manager Glenn Ormsby told **Stuff** that Department of Conservation managers reported there had been some destruction including the addition of a new giant boulder in the middle of the pond. However, that hasn't stopped the young seals.

According to the **New Zealand Herald**, the "quake generation" of fur seals born in the aftermath of the seismic event were thriving one year on, despite the initial loss of around 100 seals from rockfall and natural causes. Some had predicted the earthquake and ongoing disruption due to humans' construction efforts might push the seals to migrate elsewhere, but they've proven to be remarkably resilient in the face of the fallout.

New Zealand is prone to earthquakes because it straddles the Pacific and Australian tectonic plates. As they grind together, pressure builds up which can cause the crust to give way, resulting in massive, sudden movement that we recognize as an earthquake. The location means New Zealand experiences earthquakes every day, but only around 250 each year are strong enough to be noticed. ●



How to get there

The waterfall trail is closed due to earthquake damage, but you can safely soak up the seals from the Ōhau Point Lookout that's 30 minutes North of Kaikōura.

LISTEN



The Big Questions

Podcast from IFLScience

We know **solar storms are on the rise**, but what does that actually mean for us? As the Sun heads towards its peak of activity for this cycle, host Dr Alfredo Carpineti asks: Are we ready for the next massive solar flare? This dramatic episode marks the season three finale, but you can catch up with all of season 3 (and 1 and 2) on all good podcast platforms.

Available from **October 12**

READ



BENNU 3-D: Anatomy Of An Asteroid

Book by Brian May and Dante Laurotta

Bennu is the **most dangerous known asteroid**, with a very small chance of hitting Earth in the 2100s and 2200s. In 2020, NASA's OSIRIS-REx mission landed a spacecraft on its surface to collect a sample that has now been returned to Earth. This book details how stereo pictures compiled by Queen's Brian May and collaborator Claudia Manzoni played a crucial role in selecting the landing site and mapping the asteroid.

Available **now**.



WATCH



Ancient Earth

Documentary series from NOVA

Witness some of the most destructive events in Earth's 4.5-billion-year history in this documentary series that tracks the birth of the planet to the emergence of humankind. See the landscape transformed from a molten hellscape to a frozen planet, and the devastating extinction and explosive evolution that saw life endure it all.

Available from **October 4** on PBS.

SEE



Immersion

Exhibition of art (that's going to the Moon)

The works of fine artist Heather Horton are among a portfolio being sent to the Moon as part of the Lunar Codex project. Containing contemporary art, poetry, and other cultural artifacts, they will travel aboard uncrewed rockets for permanent installation on our satellite. See Horton's work at this solo exhibition in California.

Exhibiting from **October 14 to 22**

ATTEND



CURIOUS Live

Virtual festival of science by us!

Our first-ever virtual event, CURIOUS Live, will be kicking off with discussions on Life, Death, and Creation across virtual "stages" on October 21. The free festival of science will stream online so you can join in wherever you are to experience a packed line-up of speakers with exceptional knowledge around some of the most CURIOUS questions in science.

Streaming October 21, **sign up now** to secure your spot.



SCIENCE IN MEDIA





DATES TO REMEMBER

Forget Halloween, October is also the month for incredible science and important cultural celebrations, including Black History Month and World Mental Health Day. It's jam-packed full of space spectacles, too: there are a couple of meteor showers, a partial lunar eclipse, and, of course, World Space Week.

OCTOBER

Black History Month

The month of October is Black History Month in the UK, an annual observance to acknowledge and celebrate the invaluable contributions of Black people to British society. In 2023, this will focus specifically on Black women. "Black women have been at the heart of social justice movements throughout history, courageously battling oppression and advocating for change. However, their accomplishments have frequently been neglected or forgotten," **write** the organizers, who hope to rectify this by "honouring the matriarchs of movements and saluting our sisters". Find out more on the Black History Month **website**.



4-10 World Space Week

World Space Week is an international celebration of science and technology and the largest annual space event in the world. Each year, between October 4 and 10, thousands of people from across the globe unite in a shared love of space, attending education and outreach events held by space agencies, aerospace companies, schools, planetaria, museums, and astronomy clubs. In 2023, there will be more than 10,000 such events, all aiming to inspire, educate, and foster international cooperation. Find out how you can get involved **here**.



22 Orionids Peak

The Orionids meteor shower will be gracing our skies this month, peaking on October 22 at approximately 12:05 am UTC. The Orionids originate from probably the most famous comet of all, Halley's Comet, which only swings by Earth every 76 years or so. Fortunately, the dust and debris it leaves behind provide a fiery annual spectacle for us to behold. Meteor shower fans should also keep an eye on the sky on October 8, when the **most convenient shower** of the year is set to peak.

10 World Mental Health Day

October 10 is World Mental Health Day, which aims to raise awareness of mental health issues around the world and promote efforts to help improve them. "We must do as much as possible to prevent mental ill-health – as individuals and as a society," says the **Mental Health Foundation**. It will continue to call on governments to achieve this, and encourages us all to have more conversations about our own mental health and how we can look after it.



28 Partial Lunar Eclipse

The second and final lunar eclipse of the year will take place on October 28. Visible over all of Europe, Asia, Africa, and western Australia, it will be a partial lunar eclipse, which occurs when only part of the Moon enters Earth's shadow.





ARE YOU DRAWN TO THE DARKER OR LIGHTER SIDE OF SCIENCE?

Choose how you end each issue. For those who prefer the darker side, Holly Large explains how a much grosser kind of gold nugget could help rhino conservation. If you like your science lighter, find out all about a game that can help you flex your evolutionary biology knowledge.

ENDANGERED FECES

Auctioneers have successfully sold off a gilded piece of poop to raise money for rhino conservation in Africa.

Every year, Cotswold Wildlife Park in Burford, UK, has a Rhino Month. The four-week-long event aims to increase awareness of the threat to wild rhinos and raise funds for their conservation. Due to persistent poaching and changes in their natural environments, African rhino populations have suffered – black rhinos, for example, are considered to be critically endangered, their population down 97 percent since 1960.

THEY COLLECTED A DROPPING FROM ONE OF THE PARK'S RHINO CALVES AND ENLISTED A PROFESSIONAL GILDER TO GIVE THE NUGGET A GOLDEN GLEAM.

However, conservation efforts are starting to turn the tide. Although it is likely **too late for the northern white rhino**, the southern white rhino is now classified as near threatened. Fundraising events like Rhino Month hope

to further boost population increases by supporting anti-poaching initiatives.

This year, the park decided to get down in the dung, auctioning off gold-leafed poop to raise funds for **Tusk**, an African wildlife conservation charity it works closely with. They collected a dropping from one of the park's rhino calves and then enlisted professional gilder, JoJo Hull, to give the nugget a golden gleam. Using a process called oil gilding, Hull coated the poop with 23.75 karat Italian gold leaf.

The auction began with a bit of the X Factor to kick off proceedings; the first to place a bid was music mogul Simon Cowell, offering up £2,500 (around \$3,160). When the auction came to a close, the winning bid was a whopping £5,050 (\$6,400), making it one pricey number two. The lucky recipient of the golden turd was one James Sainsbury, who now has quite the conversation piece – maybe not over dinner, though.

Of course, anyone who doesn't want to get their hands on a lustrously decorated piece of dung and become the owner of an ornate lump of feces can make a dung-free donation to Tusk, which amplifies Africa-driven conservation and anti-poaching efforts across the continent.



**The Darker Side
of Science**

MYSTERY METAZOOA

If you like your morning coffee with a side of evolutionary biology, then **Metazooa** might just be the game for you.

It's the latest offering in a trend of Wordle-esque games – each day there is a new mystery animal, and the goal is to figure out what it is in as few guesses as possible. What makes Metazooa different is its taxonomic twist, neatly packaging a biology lesson into a detective game.

In biology, taxonomy is a way of classifying organisms based on their shared characteristics and putting them into groups, or taxonomic ranks. Metazooa features creatures from a group in the second rank down: Kingdom. Specifically, the animal kingdom. The game's name is a play on "Metazoa", a Greek term that was previously used to refer to the kingdom Animalia.

The game starts at Metazoa – given there are an estimated 1.6 million described animal species, the prospect of making a first guess might seem a bit overwhelming. Thankfully, the creators considered this.

"The animals in Metazooa were selected based on how

familiar they are to people, as well as for the breadth of species that would make the game more interesting," says the website's **FAQs**.

FOR THOSE WITH A COMPETITIVE STREAK, THERE'S A GROWING COMMUNITY OF EVOLUTIONARY SHERLOCKS SHARING THEIR METAZOOA RESULTS ONLINE.

With each wrong guess, the answer is narrowed down by taxonomic rank; say the mystery animal is "human" and a player guesses "zebra", the game will reveal that both are in the class Mammalia.

Players needn't worry about being well-versed in taxonomic terminology either. By clicking on a name, the game shows information about the selected group, providing clues about what the next best guess could be. As players continue guessing, they can learn more about how similar two animals are to each other.

For those with a competitive streak, there's also a growing community of evolutionary Sherlocks sharing their Metazooa results on X, formerly known as Twitter. If you'd prefer to become versed in vegetation instead, a plant-based version of the game called Metaflora is on its way too.



**THE LIGHTER SIDE
OF SCIENCE**