

St Benedict's SCIENCE NEWS Monthly

Welcome to the January 2023 issue

SCIENCE NEWS *Monthly* is produced by the Science Department,
St Benedict's Catholic Secondary School, Bury St Edmunds, Suffolk, UK.

HERE IS AN UPLIFTING PIECE OF HEALTH NEWS FOR THE NEW YEAR FROM Dr R DAVIES BASE EDITING: REVOLUTIONARY THERAPY CLEARS GIRL'S INCURABLE CANCER

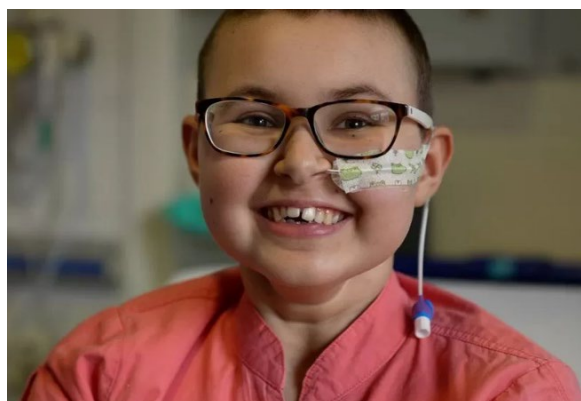
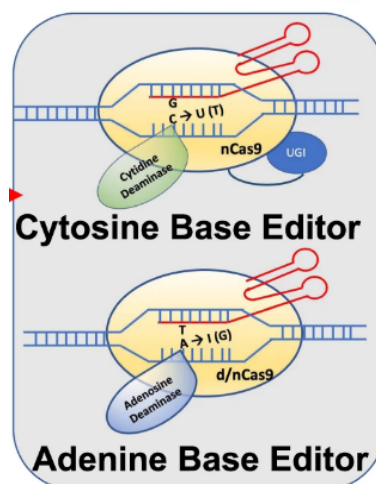
Although treatments for childhood ACUTE LYMPHATIC LEUKAEMIA have improved over the years such that overall survival rates are as high as 90%, there are still a number of cases that do not respond to treatment and are therefore deemed incurable. However, that may be a thing of the past – Drs at Great Ormond Street (London, UK) have used a revolutionary new therapy to successfully cure a young girl's Acute Lymphatic Leukaemia after all other treatments had failed. It is all to do with something called "BASE EDITING".

The Human Genome Project was a landmark global scientific effort whose signature goal was to generate the first sequence of the human genome. In 2003, the Human Genome Project produced a genome sequence that accounted for over 90% of the human genome – this has since been improved. Very early in the Project genetic scientists began thinking about how we could use our knowledge of the Human Genome to detect and repair/treat genetic defects and other diseases, such as cancers. This led to the development of manipulating the bases within the DNA molecule (Adenine, Cytosine, Guanine and Cytosine) – base editing.

The ability to precisely and effectively edit human DNA within living cells had been a long-term goal. The development of CRISPR-Cas enzyme systems in 2012 by Jennifer Doudna and Emmanuelle Charpentier was a major step in this direction. Their technique opened the way for reliable gene/base editing. The credit for base editing largely belongs to two previous postdoctoral students in David Liu's laboratory at Harvard University, Alexis Komor and Nicole M. Gaudelli. They developed a pair of molecular machines that could correct the majority of known human disease-related mutations. Their results were later published in *Nature* and included the first two reported base editors. One paper (2016) described the work led by Komor on the cytosine-to-thymine base editor (CBE). The other (2017) described work led by Gaudelli on the adenine-to-guanine base editor (ABE). Fast forward only 6 years and we have the first successful treatment of a child's leukaemia thanks to base editing.

Bases are the language of life. The four types of base - adenine (A), cytosine (C), guanine (G) and thymine (T) - are the building blocks of our genetic code. Just as letters in the alphabet spell out words that carry meaning, the billions of bases in our DNA spell out the instruction manual for our body. Base editing allows scientists to zoom to a precise part of the genetic code and then alter the molecular structure of just one base, converting it into another and changing the genetic instructions.

Base Editing



Alyssa, who is 13 and from Leicester, was diagnosed with **T-cell acute lymphoblastic leukaemia** in May 2021. T-cells are supposed to be the body's guardians - seeking out and destroying threats - but for Alyssa they had become the danger and were growing out of control. Her cancer was aggressive. Chemotherapy, and then a bone-marrow transplant, were unable to rid it from her body. Without the experimental medicine, the only option left would have been merely to make Alyssa as comfortable as possible.

What happened next would have been unthinkable just a few years ago and has been made possible by incredible advances in genetics. The team at Great Ormond Street used a technology called base editing, which was invented only six years ago.

The large team of doctors and scientists used this tool to engineer a new type of T-cell that was capable of hunting down and killing Alyssa's cancerous T-cells.

They started with healthy T-cells that came from a donor and set about modifying them.

- The first base edit disabled the T-cells targeting mechanism so they would not assault Alyssa's body
- The second removed a chemical marking, called CD7, which is on all T-cells
- The third edit was an invisibility cloak that prevented the cells being killed by a chemotherapy drug

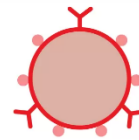
The final stage of genetic modification instructed the T-cells to go hunting for anything with the CD7 marking on it so that it would destroy every T-cell in her body - including the cancerous ones. That's why this marking has to be removed from the therapy - otherwise it would just destroy itself. If the therapy works, Alyssa's immune system - including T-cells - will be rebuilt with the second bone-marrow transplant.

In Alyssa's therapy, each of the base edits involved breaking a section of genetic code so it no longer worked. But there are more nuanced applications where instead of switching an instruction off you can fix a defective one. Sick-cell anaemia, for example, is caused by just one base change that could be corrected. So there are already trials of base editing under way in sickle-cell disease, as well as high cholesterol that runs in families and the blood disorder beta-thalassemia.



How does the treatment work?

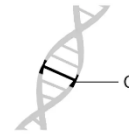
1 Alyssa had T-cell leukaemia



T-cells, a type of white blood cell, destroy threats in the body

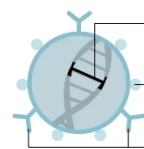
Alyssa's were out of control

2 Doctors used 'base editing' to engineer her therapy



Base editing changes one letter in the genetic code

3 Donor T-cells were edited in three ways

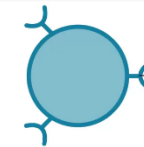


DNA altered to resist chemotherapy

Markings removed to protect donor T-cells

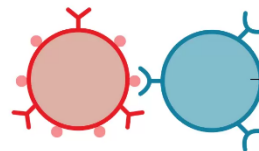
Receptors removed to prevent donor T-cells attacking the body

4 T-cells further modified to attack cancer



T-cell rearmed with new receptors

5 Battle of the T-cells



Modified T-cells find and destroy cancerous T-cells

Source: BBC research

BBC

"She's the first patient to be treated with this technology," said Prof Waseem Qasim, from UCL and Great Ormond Street, who was part of the team that developed the base-editing therapy

He said this genetic manipulation was a "very fast-moving area of science" with "enormous potential" across a range of diseases.

<https://www.bbc.co.uk/news/health-63859184>

ARCHAEOLOGY - King Tut's tomb still holds secrets 100 years after its discovery

It all started on November 4, 1922. The English archaeologist Howard Carter was leading a team to explore Egypt's Valley of the Kings. Many ancient pharaohs and nobles are buried there. Carter's team found a step cut into the valley floor. By November 23, the crew had uncovered stairs leading down to a door. Ancient Egyptian writing on that door identified what lay beyond: the tomb of King Tutankhamun.

Carter organized a 10-year project to document, conserve and remove more than 6,000 items from the tomb. Some objects, like Tut's gold burial mask, are now iconic. Other artifacts include musical instruments, hunting equipment, jewellery and chariots. With such a trove to pore over, it's no wonder scientists are still learning new things about King Tut. Here are three surprising things to know on the 100th anniversary of his tomb's discovery:



1. Always portrayed as a rather frail and deformed person who was buried with a variety of "walking sticks", an interpretation now is that the "sticks" were actually staffs, and a sign of great authority.

2. Tut's initial obscurity led to his fame – Tut's father, the pharaoh Akhenaten, had taken actions that turned his people against him. After he died, his son became king, but Tut also inherited his father's bad reputation. Later pharaohs did not mention Akhenaten or Tut in written records and Tut's tomb was treated just as dismissively.

3. Tut's tomb was a rushed job - Pharaohs usually prepared their tombs over decades. They built many rooms to hold treasures and ornate coffins. But King Tut died too young for that. There was no time for such long preparations. Plus, Egyptian traditions required laying a mummified body in a tomb about 70 days after death.

<https://www.snexplores.org/article/king-tuts-tomb-still-holds-secrets-100-years-after-its-discovery>

THIS PIECE OF NEWS WAS SPOTTED BY Mr D STEWARD

EVOLUTION THEORY - Discovery of world's oldest DNA breaks record by one million years

Microscopic fragments of environmental DNA were found in Ice Age sediment in northern Greenland. The fragments are one million years older than the previous record for DNA sampled from a Siberian mammoth bone. The ancient DNA has been used to map a two-million-year-old ecosystem which weathered extreme climate change. The results could help predict the long-term environmental toll of today's global warming.

The discovery was made by a team of scientists led by Professor Eske Willerslev and Professor Kurt Kjær. Professor Willerslev is a Fellow of St John's College, University of Cambridge and Director of the Lundbeck Foundation GeoGenetics Centre at the University of Copenhagen where Professor Kjær, a geology expert, is also based. The results of 41 samples found hidden in clay and quartz are published in the journal *Nature*.

"A new chapter spanning one million extra years of history has finally been opened and for the first time we can look directly at the DNA of a past ecosystem that far back in time," says Willerslev. *"DNA can degrade quickly but we've shown that under the right circumstances, we can now go back further in time than anyone could have dared imagine."* *"The ancient DNA samples were found buried deep in sediment that had built-up over 20,000 years,"* says Kjær. *"The sediment was eventually preserved in ice or permafrost and, crucially, not disturbed by humans for two million years."*



The samples, a few millionths of a millimetre long, were taken from the København Formation, a sediment deposit almost 100 metres thick tucked in the mouth of a fjord in the Arctic Ocean in Greenland's northernmost point. The climate in Greenland at the time varied between Arctic and temperate and was between 10-17°C warmer than Greenland is today. The sediment built up metre by metre in a shallow bay. Evidence of animals, plants and microorganisms including reindeer, hares, lemmings, birch and poplar trees were discovered. Researchers even found that Mastodon, an Ice Age mammal, roamed as far as Greenland before later becoming extinct. Previously it was thought the range of the elephant-like animals did not extend as far as Greenland from its known origins of North and Central America.

Some of the DNA fragments were easy to classify as predecessors to present-day species, others could only be linked at genus level, and some originated from species impossible to place in the DNA libraries of animals, plants and microorganisms still living in the 21st century. The 2 million year old samples help academics build a picture of a previously unknown stage in the evolution of the DNA of a range of species still in existence today.

<https://www.cam.ac.uk/stories/a-new-chapter-in-the-history-of-evolution>

PLANETARY SCIENCE – Jupiter's moon Io, the most volcanically active place anywhere

The surface of Jupiter's innermost moon is covered in scorching lava lakes and gored by hundreds of active volcanoes, some spitting molten rock and sulphur dozens of kilometres high. Over the years, the moon's restless, mesmerizing hellscape has attracted the attention of many planetary scientists. Now, researchers are digging into the nature of Io's infernal interior to explain what is driving the spectacular volcanism on the moon's fiery surface.



Researchers generally agree that Io gets most of its energy from a gravitational tug-of-war between its parent planet Jupiter and its sibling moon Europa. Those grand forces pull on Io's rocky body, generating tremendous frictional heat in its interior. But how that heat is stored and moved around remains a mystery. One explanation is that Io's interior may house **an enormous ocean of liquid magma**, planetary scientist David Stevenson of Caltech says. Though the exact size of the proposed molten sea remains uncertain, it would need to be relatively large, he said. *"The magma ocean could be, say, 100 kilometres thick."*

But there are other possibilities. *"A lot of information is consistent with a large, global conductive layer that could be a magma ocean,"* says planetary scientist Samuel Howell of NASA's Jet Propulsion Laboratory in Pasadena, Calif, *"But I wouldn't say there's consensus on how to interpret that data."* Instead, the truth may lie within Io's heart, where a core made of solid metal may lurk. Previous research has suggested that Io has a core rich in metals. Howell and colleagues calculate that a metal core that's about as rigid as solid ice and a rocky mantle as viscous as Earth's could fully dispense the immense quantities of heat that Io is estimated to emit. That would fulfil the energy-shedding role of a magma ocean.

Future measurements collected by NASA's ongoing Juno mission as well two future spacecraft — NASA's Europa Clipper and the European Space Agency's JUICE — may provide the data needed to determine whether either, or some combination, of the hypotheses is correct.

<https://www.sciencenews.org/article/io-magma-ocean-hot-metal-core-jupiter>

RECORD BREAKERS! - Here are 5 record-breaking science discoveries from 2022

EARLIEST SURGERY The first known surgical operation was a leg amputation. That's the conclusion researchers came to after investigating the skeleton of a person who lived on the Indonesian island of Borneo about 31,000 years ago. Healed bone where the lower left leg had been removed suggests the individual survived for several years after the procedure. The discovery pushes surgery's origin back by some 20,000 years.



BIGGEST SINGLE-CELLED BACTERIUM Bacteria normally dwell in the microscopic world. Not *Thiomargarita magnifica*. Averaging about a centimetre long, this newfound bacterium is visible to the naked eye. *T. magnifica*, which lives in the mangrove forests of the Caribbean's Lesser Antilles, is about 50 times larger than other species of big bacteria and about 5,000 times larger than typical bacteria. Why this species evolved into such a giant is unknown.



FASTEST SUPERCOMPUTER A supercomputer named Frontier crunched numbers with mind-blowing speed this year: 1.1 quintillion operations per second. That makes the machine, run by Oak Ridge National Laboratory in Tennessee, the first exascale computer — a computer that can perform at least 10^{18} operations per second. The next fastest computer tops out at 442 quadrillion (that's 10^{15}) operations per second. Exascale computing is expected to lead to breakthroughs in everything from climate science to health to particle physics.

LARGEST FISH COLONY Deep off the coast of Antarctica, icefish congregate in a breeding colony as big as Orlando, Fla. Some 60 million nests of Jonah's icefish (*Neopagetopsis ionah*) stretch across at least 240 square kilometres of seafloor. Previously, nest-building species of fish were known to gather in only the hundreds. An abundant food supply and access to a zone of unusually warm water may explain the exceptionally large group.



CLOSEST BLACK HOLE By sifting through data released by the Gaia spacecraft, astrophysicists discovered a black hole that's just over 1,560 light-years from Earth. Dubbed Gaia BH1, it's about twice as close as the previously nearest known black hole. But that record may not stand. About 100 million black holes are predicted to exist in the Milky Way. Since most are invisible, they're hard to find. But when Gaia, which is precisely mapping a billion stars, releases its next batch of data in a few years, even closer black holes may turn up.



<https://www.sciencenews.org/article/record-breaking-science-discoveries-2022>

WARNING: THE FOLLOWING ITEM IS NOT FOR THE SQUEAMISH OR THOSE OF A NERVOUS DISPOSITION!

AGRICULTURE - Let's learn about eating bugs

We go to great lengths to satisfy our need for protein by raising livestock and growing protein-rich plants. But all this takes up a lot of land and requires quite intensive farming, which is now being recognised as detrimental to our planet's climate prospects. Staring us in the face is a food supply that is so abundant and renewable as to be virtually inexhaustible – BUGS!



Eating insects and worms rather than other kinds of meat may be better for the planet. Such “mini-livestock” require less land, water and other resources than cows or pigs. And bugs are a good source of protein, vitamins and minerals. Eating bugs, or **entomophagy**, is common in parts of Asia, Africa and South America. Some people chow down on ants or beetles. Others enjoy caterpillars, worms or giant water bugs. And this isn't exceptional. Humans have had an appetite for bugs since ancient times. In fact, this type of grub may have helped early humans and other primates evolve big brains. But somewhere along the way a lot of us, particularly in the western world, have lost our appetite.

To overcome this barrier, scientists are testing how best to advertise edible insects. And some are even inventing new seasonings to make bugs more mouth-watering. For example, you'd happily feed dried mealworms to the birds, but you'd probably not consider eating them yourself. But adding sugars to powdered, cooked mealworms creates a new food seasoning to add to kitchen pantries. It has an appetizing “meatlike” odour, researchers have reported at the *American Chemical Society* autumn meeting in Chicago.

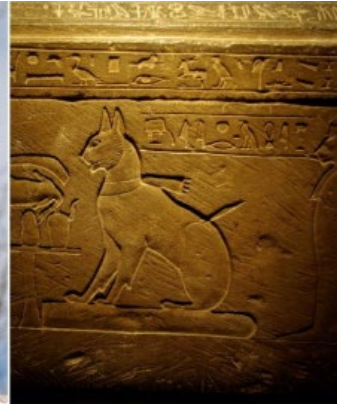
We often judge food by its odour, so scientists are looking at ways to make cooked insects more appealing – after all, shrimps, prawns and lobsters are simply arthropods, the group that insects belong too, and they're OK.

<https://www.snexplores.org/article/lets-learn-about-eating-bugs-insects>

CAT SCIENCE - Feline genetics help pinpoint first-ever domestication of cats

Regular readers will know that cats crop up from time to time and one question is always “*when did they first become domesticated?*” A study, published in the journal *Heredity*, sheds light on when this may have happened.

Nearly 10,000 years ago, humans settling in the Fertile Crescent, the areas of the Middle East surrounding the Tigris and Euphrates rivers, made the first switch from hunter-gatherers to farmers. They developed close bonds with the rodent-eating cats that conveniently served as ancient pest-control in society's first civilizations. A new study by the University of Missouri-Columbia found this lifestyle transition for humans was the catalyst (*Ha! Ed*) that sparked the world's first domestication of cats, and as humans began to travel the world, they brought their new feline friends along with them.



Leslie A. Lyons, a feline geneticist and Gilbreath-McLorn, endowed professor of comparative medicine in the MU College of Veterinary Medicine, collected and analyzed DNA from cats in and around the Fertile Crescent area, as well as throughout Europe, Asia and Africa, comparing nearly 200 different genetic markers. “*One of the DNA main markers we studied were microsatellites, which mutate very quickly and give us clues about recent cat populations and breed developments over the past few hundred years,*” Lyons said. “*Another key DNA marker we examined were single nucleotide polymorphisms, which are single-based changes all throughout the genome that give us clues about their ancient history several thousands of years ago.*”

Lyons added that while horses and cattle have seen various domestication events caused by humans in different parts of the world at various times, her analysis of feline genetics in the study strongly supports the theory that cats were likely first domesticated only in the Fertile Crescent before migrating with humans all over the world. After feline genes are passed down to kittens throughout generations, the genetic makeup of cats in western Europe, for example, is now far different from cats in southeast Asia, a process known as ‘isolation by distance.’

<https://www.sciencedaily.com/releases/2022/12/221205121616.htm>

A CAT WRITES: “We cats are happy to tolerate the humans’ delusion that it was they who domesticated us. Of course, it is obvious that it was we who domesticated them! I must go now, as my servant informs me that my dinner is ready.”

ONE OF LIFE’S MYSTERIES - Why does chocolate turn white (and is it safe to eat)?

It has probably happened to all of us at some time, especially Christmas – a friend gives you a lovely box of chocolates but when you open the box you find the chocolates have developed a white, crusty covering, almost like mould. Rather than make a fuss, you simply throw them away. But you are actually throwing away perfectly good chocolates!

What you see is the result of a natural reaction known as “chocolate blooming.” To learn why chocolate blooms — and what you might want to do about blooming — it helps to understand how chocolate is made. Chocolate is made with cocoa beans that are fermented and roasted to help trigger chemical reactions that create delicious flavours. The average cocoa bean contains about 50% cocoa butter and 50% cocoa fibre - cocoa butter is the fatty part of the cocoa bean, while cocoa fibre is the dark part of chocolate. Cocoa fibre helps give regular chocolate its colour and much of its taste, while cocoa butter is responsible for chocolate's richness and its “melting sensation”.



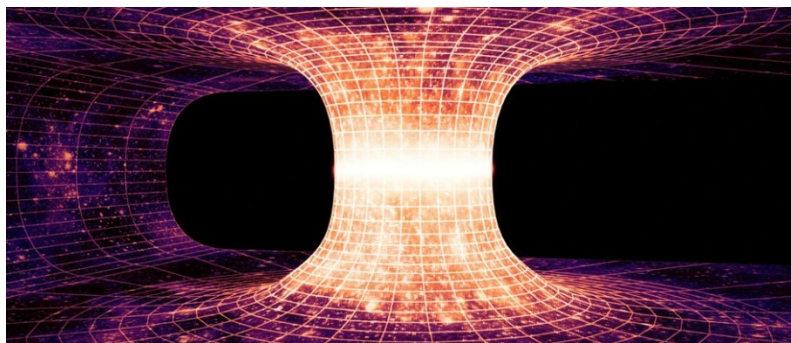
Chocolate blooming happens when molecules within the chocolate start moving. There are two basic types of bloom — sugar bloom and fat bloom. Fat bloom happens when cocoa butter migrates to the surface of the chocolate due to heat, light exposure or improper handling. Fat bloom appears as a white sheen or blotchy white spots. Sugar bloom is brought on by storing chocolate in a moist environment, or by removing cold chocolate from a refrigerator and exposing it to the moist air. Sugar bloom is noticeable as a rough, gritty surface and finely speckled appearance.

Although it is unsightly, chocolate blooming is actually harmless. The good news is that it is pretty easy to revive bloomed chocolate: Instead of throwing it away, give it a quick go in the microwave and it will be as good as new!

<https://www.livescience.com/why-chocolate-turns-white>

UNIVERSAL PHYSICS - How a simulation wormhole could help physicists finally unite gravity and quantum theory

Since the publication of his *General Theory of Relativity* in 1915, Albert Einstein and others had pondered the theoretical existence of “black holes”. A black hole would consist of a singularity, a point in space of infinite density. Matter and radiation could be drawn into the black hole by its gravity but nothing, not even light, would be able to escape – hence the name. They found that they could extend this notion to include the polar opposite of black holes: white holes. These hypothetical white



holes also contain a singularity, but they operate in reverse to a black hole: Nothing can enter a white hole, and any material inside the white hole gets ejected immediately. Einstein found that, theoretically, every black hole is paired with a white hole. Because the two holes would exist in separate places in space/time, a tunnel – a wormhole – would bridge the two ends.

From the 1920s to the present day physicists deal with two main areas of theory in the Universe – **quantum theory** and Einstein’s **theory of gravity**. It would be nice for the two theories to fit perfectly together, but they don’t. In fact, they are on the face of it incompatible. The two theories reign supreme in their own domains: quantum theory in the ultra-small realm of atoms and their constituents, and Einstein’s theory in the ultra-large world of stars and the Universe. However, during the Big Bang, the ultra-large universe was ultra-small. So, if we are ever to understand the origin everything, we need to unite quantum theory and Einstein’s theory of gravity. The problem is that they appear fundamentally incompatible: Whereas Einstein’s theory is based on certainty - describing, for instance, the exact trajectory of planet through space; quantum theory is based on uncertainty and describes only the chance, or “probability”, of an atom following any of a number of possible paths.

Einstein and colleagues showed in theory that subatomic particles born together are forever afterwards connected by a “spooky action at distance”, or ‘**entanglement**’: when one is disturbed, the other reacts instantaneously, even if on the other side of the Universe. In other words, subatomic particles can influence each other instantaneously because they are connected by a wormhole.

In November 2022, physicists using Google’s Sycamore quantum computer in the US carried out a calculation that is equivalent to sending matter through a ‘wormhole’. What this means for physics is a matter of controversy. But the physicists themselves believe they have demonstrated a way to reveal deep connections between the two apparently incompatible theories: quantum theory and Einstein’s theory of gravity.

“It is important to understand that experiments of this type are not simulations, but actually involve real phenomena. The wormhole in the laboratory experiment is as real as it would be if it connected two astronomical black holes,” says Prof Leonard Susskind of Stanford University. *“The attention the experiment has focused on the new paradigm that quantum theory and Einstein’s theory of gravity, when interpreted through the holographic principle, are almost the same thing.”*

<https://www.sciencefocus.com/news/simulation-wormhole-unite-gravity-quantum-theory-physics/>

WORD(S) OF THE MONTH

INFECTION (noun, “*In-FEK-shun*”)

An infection occurs when harmful germs, or pathogens, invade the body and begin to reproduce. These pathogens can be bacteria, viruses, fungi or parasites. Some illnesses caused by infections are minor. For instance, most people recover quickly from common colds. But other infections may be much more severe and even life-threatening.

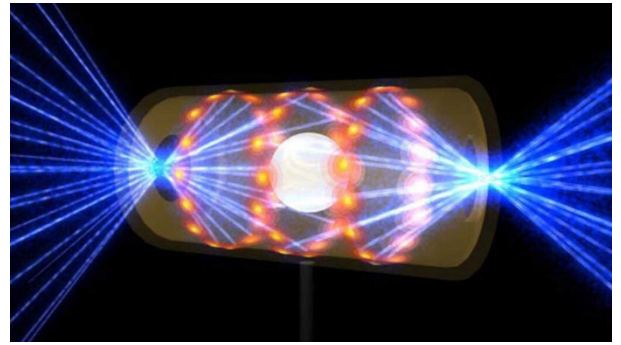
Infectious agents often enter the body through the nose, mouth or skin. Those germs can spread from person to person. For example, someone with COVID-19 can spew virus-loaded droplets into the air when they sneeze or cough. Someone else who inhales those droplets may become infected.

People can also pick up infections from contaminated food or water. Consider *E. coli* bacteria. Those germs sometimes live in uncooked meat. Someone who eats contaminated meat that has not been cooked enough may get an *E. coli* infection. Insect bites can also spread infections, too. Some mosquitoes carry the parasite that causes malaria. And some ticks carry bacteria that lead to Lyme disease.

Vaccines help prevent many infectious diseases. They do this by training the body’s immune system to recognize and fight off pathogens. Someone may still get sick with an infection after being vaccinated. But their symptoms are usually much less severe than they would have been without the vaccine. That’s why it’s important to get vaccinated for infections such as COVID-19 and measles. Other healthy habits, such as washing your hands often, cooking meat thoroughly and using bug spray, can also ward off infections.

PHYSICS - nuclear fusion finally makes more energy than it uses....well, almost

Nuclear fusion is regarded as the “Holy Grail” of electricity production, where you get huge amounts of electrical energy from an almost limitless supply of fuel – water! However, there have always been two jokes associated with this dream since it was first visualised in the 1950s – one, at any point since then the goal has always been stated as “30 years away”; and two, we have always needed to put more energy into the fusion process than we have ever got out of it.....until now!



At 1:03 a.m. PST on December 5, researchers with the National Ignition Facility in Livermore, Calif., ignited controlled nuclear fusion that, for the first time, resulted in the net production of energy. A 3-million-joule burst emerged from a peppercorn-sized capsule of fuel when it was heated with a 2-million-joule laser pulse. Details of the long-awaited achievement, which mimics how the sun makes energy, were revealed in a news conference December 13 by U.S. Department of Energy officials.

Fusion potentially provides a clean energy source. The fission reactors now used to generate nuclear energy rely on heavy atoms, like uranium, to release energy when they break down into lighter atoms, including some that are radioactive. While it's comparatively easy to generate energy with fission, it's an environmental nightmare to deal with the leftover radioactive debris that can remain hazardous for hundreds of millennia. Controlled nuclear fusion, on the other hand, doesn't produce such long-lived radioactive waste, but it's technically much harder to achieve in the first place. In nuclear fusion, light atoms fuse together to create heavier ones. In the sun, that typically occurs when a proton, the nucleus of a hydrogen atom, combines with other protons to form helium.

Getting atoms to fuse requires a combination of high pressure and temperature to squeeze the atoms tightly together. Intense gravity does much of the work in the sun. At the National Ignition Facility, 192 lasers directed at a small capsule filled with deuterium and tritium, heavy types of hydrogen, provided a blast of energy that did the trick instead. About 4 percent of that fuel was fused in the process. The new result far surpassed the 1.3 million joules of energy produced by an earlier NIF experiment that marked the first time the team managed to ignite nuclear fusion. However, there is still a long way to go before we have a truly energy-efficient system:

This latest fusion burst still didn't produce enough energy to run the laser power supplies and other systems of the NIF experiment. It took about 300 million joules of energy from the electrical grid to get a hundredth of the energy back in fusion. *“The net energy gain is with respect to the energy in the light that was shined on the target, not with respect to the energy that went into making that light,”* says University of Rochester physicist Riccardo Betti. *“Now it's up to the scientists and engineers to see if we can turn these physics principles into useful energy.”*

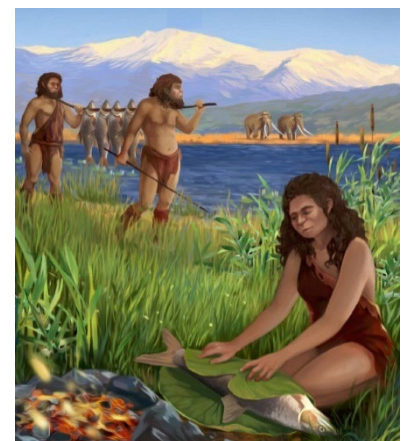
<https://www.sciencenews.org/article/nuclear-fusion-breakthrough-energy>

ARCHAEOLOGY - Scientists Find Earliest Evidence of Hominins Cooking with Fire

There are two intriguing questions about human evolution: when did our early ancestors first control fire; and when did they first use it to cook their food?

There is some evidence to suggest that *Homo erectus* already practiced a controlled use of fire approximately 1.7 million years ago. However, evidence regarding the use of heat specifically for food preparation by this human ancestor is inconclusive and controversial. While it is likely that early fire-using hominins had already cooked their food, definitive evidence of this practice was by early *Homo sapiens* and Neanderthals 170,000 years ago. New analysis of the remains of a large carp-like fish recovered from Gesher Benot Ya'aqov, a waterlogged site located in the northern Jordan Valley, on the shores of paleo-Lake Hula, pushes that date back 610,000 years.

Early humans began to eat fish around 2 million years ago but cooking fish — as found in this study — represented a real revolution in the Acheulean diet and is an important foundation for understanding the relationship between man, the environment, climate, and migration when attempting to reconstruct the history of early humans.



In this study geochemical methods were used to identify changes in the size of the tooth enamel crystals of the fish remains, as a result of exposure to different cooking temperatures. When they are burnt by fire, it is easy to identify the dramatic change in the size of the enamel crystals, but it is more difficult to identify the changes caused by cooking at temperatures between 200 and 500 degrees Celsius. The fact that the cooking of fish is evident over such a long and unbroken period of settlement at the site indicates a continuous tradition of cooking food. The scientists suggest that the location of freshwater areas also determined the route of the migration of early humans from Africa to the Levant and beyond.

<https://www.sci.news/archaeology/earliest-evidence-cooking-11393.html>

ALL OUR YESTERDAYS

100 YEARS AGO - 1923

Here are just a few of the notable scientific discoveries and events 100 years ago this year:

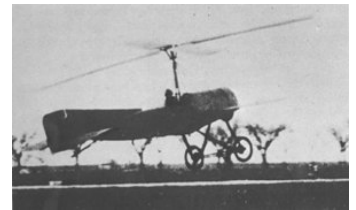
DISCOVERY OF INSULIN BY BANTING AND BEST The Nobel Prize in Physiology or Medicine 1923 was awarded to **Frederick Grant Banting** and **John James Rickard Macleod** "for the discovery of insulin".

It was actually in 1921 that the discovery took place and it is a mark of its importance that it took the Nobel Prize committee only two years to make the award.

Prior to the discovery of insulin, the hormone that controls the level of glucose in the blood, a diagnosis of Type 1 Diabetes was a virtual death sentence as there was no treatment. According to a recent World Health Organization report, about 9 million people with type 1 diabetes are alive today thanks to insulin.



THE WORLD'S FIRST AUTOGYRO TAKES FLIGHT Juan de la Cierva was a Spanish engineer and aeronautical enthusiast. In 1921, he participated in a design competition to develop a bomber for the Spanish military. De la Cierva designed a three-engined aircraft, but during an early test flight, the bomber stalled and crashed. De la Cierva was troubled by the stall phenomenon and vowed to develop an aircraft that could fly safely at low airspeeds. The result was the first successful rotorcraft, which he named *Autogiro* in 1923. It would later be developed into the helicopter.

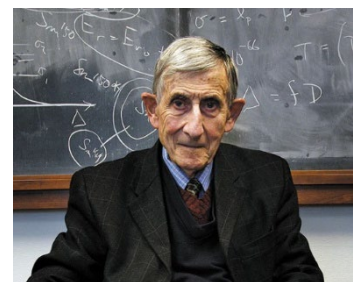


MOUNT ETNA ERUPTS - OVER 60,000 MADE HOMELESS Mount Etna, in eastern Sicily near the city of Catania, is one of the world's most active volcanoes and is in an almost constant state of activity. In the summer of 1923, after 2 weeks of increasing activity, there was a major eruption. This is how it was reported by the New York Times:



CATANIA — The eruption of Mount Etna, which has been going on for the last fortnight, suddenly assumed alarming proportions last night [June 17], when, after a series of loud explosions accompanied by violent shocks, a large number of new fissures appeared on the north-eastern side of the volcano, flooding the vineyards and a whole forest of pine trees with molten lava. The station of the little town of Castiglione was completely destroyed today. Several villas on the outskirts of the town have been overrun by the advancing lava, and the inhabitants have fled in terror to the countryside.

FREEMAN DYSON IS BORN The physicist Freeman Dyson became famous within science for mathematical solutions so advanced that they could only be applied to complex problems of atomic theory/quantum physics and popular with the public for ideas so far-fetched they seemed beyond lunacy. For example, he proposed the ultimate solution to the energy crisis: a sufficiently advanced civilisation would, he argued, crunch up all the unused planets and asteroids in their solar system to form a giant shell around its parent star, to reflect and exploit its radiation. Science fiction writers were delighted. The first suggestion became known as the Dyson tree. The second is called the **Dyson sphere**.



FROZEN FOOD! Go into any freezer section of any shop and what is the brand of frozen foods that sticks out the most? **Birds Eye**, of course. But you probably don't know that the name comes from a real person: **Clarence Birdseye**. Prior to 1923 people had been freezing food for long term storage, but with little success. The freezing process was slow causing large ice crystals to form. During the thawing process the food's cells became damaged and the food ended up mushy and dry and not at all appetising.

In the early 1900s Birdseye, born in New Jersey (US), travelled through northern Canada and observed that the Inuit stored their fish by freezing it rapidly. This prevented the formation of large ice crystals and resulted in the thawed fish being as good as the fresh.

So in 1923, with an investment of \$7 for an electric fan, buckets of brine, and cakes of ice, Clarence Birdseye developed and later perfected a system of packing fresh food into waxed cardboard boxes and flash-freezing under high pressure. And by 1927, his company General Seafoods was applying the technology to preserve beef, poultry, fruit, and vegetables. The rest, as they say, is history.

