St Benedict's LSC

Journal of Science

(including the History & Philosophy of Science)

Volume 3 · Number 1 · January 2019

Ora et Labora

St Benedict's
Catholic School

The Catholic Secondary School for West Suffolk

Published by the Science Department, St Benedict's Catholic School LSC, Bury St Edmunds, Suffolk, UK.

EDITOR'S NOTE: Welcome to the first issue of Volume 3 of our *Journal of Science*. I apologise for the fact that it has been a year since the last issue and hope to make up for it during the Spring and Summer terms this year!

This issue features a variety of papers and posters containing many fascinating pieces of information ranging from one author's ultrasound scan when she was only 12 weeks old and **still inside her mother's womb**; biographies of some famous scientists; all about different states of matter; animals that don't have bones; and three very thoughtful and insightful papers comparing the work of Rosalind Franklin and that of Watson & Crick in the discovery of the structure of DNA – a topic that still causes much debate.

We take the celebration of New Year's Day, January 1st, rather for granted these days but, when you think about it, January 1st is in the middle of Winter and, although the days are getting longer, nothing much else is going to happen for at least another couple of months. Wouldn't it be better to mark the event on the date of the Winter Solstice, December 21st, which marks the moment when the days actually do start to get longer?

Or maybe at the Vernal (Spring) Equinox, 20th March, when days become longer than nights and the first green shoots of growth are appearing in nature?

The fact is that, in Western Civilisation, the so-called 'New Year' has varied throughout. Its origin can be traced back more than 4000 years to the ancient Babylonians, long before our more modern calendars, who did celebrate it in mid-March to mark their Spring Harvest. The Romans also adopted March as their New Year, but more for political reasons.

At some point around 300-150BC the Romans switched to celebrating New Year on January 1st again more for political reasons than anything else.

There is no direct line from ancient Roman tradition to the modern day, but the desire to 'start anew' pops up repeatedly in Western Civilisation. Most nations of Western Europe, for example, adopted January 1st at various times during the Renaissance Period (14th – 17th century).

January is named after the Roman God Janus, the god with two faces, one looking forward and one looking backward. He is the god of beginnings, transitions, gates, doors, passages, and endings.

Volume 3 - Number 1 – January 2019

Table of Contents

Vol 3, Number 1 January 2019

WHO DID MORE WORK ON DNA? ROSALIND FRANKLIN v WATSON & CRICK

Maximilian Ledgerton 8SOA (Industria)

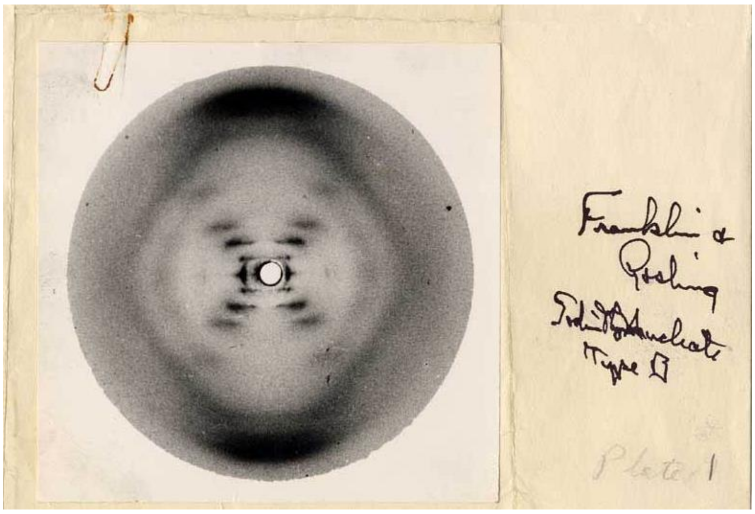
Rosalind franklin, in 1951, went to King's College, London, where her charge was to upgrade the X-ray crystallographic laboratory there for work with DNA. Maurice Wilkins, a New Zealand-born but Cambridge-educated physicist, had already begun to implement X-ray crystallographic techniques at Kings when Franklin was appointed. The relationship between Wilkins and franklin was unfortunately a poor one and probably slowed their progress.

James Watson and Francis Crick worked at the Cavendish Laboratory in Cambridge and, inspired by Linus Pauling's success in working with molecular models in the US, they rapidly put together several models of DNA and attempted to incorporate all the evidence they could gather. Franklin's excellent X-ray photographs, to which they had gained access without her permission, were critical to the correct model.

The four scientists announced the structure of DNA in separate articles that appeared in the same issue of *Nature*. In April 1953, the scientific journal *Nature* published three back-to-back papers on the structure of DNA (the material our genes are made of). Together they constituted one of the most important scientific discoveries in history.

The first, purely theoretical, article was written by Watson and Crick from Cambridge. Immediately following their article were two, data-rich papers by the researchers from King's College, London: one by Maurice Wilkins and two colleagues, the other by Rosalind Franklin and a PhD student, Ray Gosling.

At the end of January 1953, Watson had visited King's College where Wilkins showed him an X-ray photograph that was subsequently used in Franklin's paper. This image, often called *'Photo 51'*, had been taken by Ray Gosling, a PhD student working with Franklin (see photo).



Watson recalled that when he saw the photo – which was far clearer than any other he had seen – *"My mouth fell open and my pulse began to race."* According to Watson, photo 51 provided the vital clue to the structure of the double helix. But questions such as the number of strands and, above all, the precise chemical organisation of the molecule, remained a mystery.

What Watson and Crick needed was far more than the idea of a helix – they needed precise observations from X-ray crystallography. Those observations were unwittingly provided by Rosalind Franklin herself, being included in a brief report given to Max Perutz at the MRC, Cambridge University.

In February 1953, Perutz passed the report to Lawrence Bragg (Director of the Cavendish Laboratory, University of Cambridge) who passed it on to Watson and Crick. They now had the material they needed to do their calculations of the DNA molecule. Ironically, the data provided by Franklin to Perutz were virtually identical to those she presented at a small seminar at King's College in autumn 1951, when Watson was in the audience.

In the middle of March 1953, Wilkins and Franklin were invited to Cambridge to see a model of the DNA molecule and they immediately agreed that it must be correct. It was also agreed that the model would be published solely as the work of Watson and Crick, while the supporting data would be published by Wilkins and Franklin – separately, of course.

Rosalind Franklin died of ovarian cancer in 1958, four years before the Nobel Prize was awarded to Watson, Crick and Wilkins for their work on the structure of DNA. She never learned the full extent to which Watson and Crick had relied on her data to make their model; if she suspected, she did not express any bitterness or frustration and, in subsequent years, she became very friendly with Crick and his wife, Odile.

Had Franklin lived, the Nobel Prize committee ought to have awarded her a Nobel prize too – her conceptual understanding of the structure of the DNA molecule and its significance was on a par with that of Watson and Crick, while her crystallographic data were as good as, if not better, than those of Wilkins. The simple expedient would have been to award Watson and crick the Nobel Prize for Physiology or Medicine, while Franklin and Wilkins received the prize for Chemistry.

Whether the Nobel Prize committee would have been able to recognise Franklin's contribution is another matter – as the Tim Hunt affair showed, sexist attitudes are ingrained in science, as in the rest of our culture.

Sources of information:

1. **Sexism in science: did Watson and Crick really steal Rosalind franklin's data?** Guardian.
2. https://www.sciencehistory.org
3. BBC History
4. dnaftb.org/19/bio-3.html

EDITOR'S NOTE: the author of the above paper added a personal conclusion resulting from his research. It must also be noted that it is the policy of the Nobel Prize committee to give awards to living recipients only. When they gave the awards to Watson, Crick and Wilkins in 1962, they would have been prevented from giving a posthumous award to Franklin, who had died in 1958.

In conclusion, I believe that without Rosalind Franklin's Photo 51 and her other data, it would have taken Watson and Crick much longer to create their model. It also said in one article that Rosalind Franklin worked on a similar model on her own and did extremely well, but was beaten to it by Watson and Crick.

I am not sure why they just never worked together? Maybe because they were all after the glory? According to reports, franklin did not seem to have an issue with Watson and Crick and later became friendly with Crick and his family.

It would have been nice if Rosalind Franklin had been recognised for all her work with the award of a Nobel Prize too, just as Watson, Crick and Wilkins have been recognised for their important work. Ray Gosling, the PhD student, also doesn't seem to be getting a mention, even though he worked with both Franklin and Williams.

HISTORICAL NOTE: The substance that we now know as DNA was first discovered by a Swiss physician Friedrich Miescher who, in 1869, isolated a compound that was present in the nuclei of all cells – he called it ***NUCLEIN***. Although Miescher didn't know it, he had actually discovered DNA. However, it would take nearly 100 years and many more scientists along the way to reveal its exact chemical nature and, most importantly, its molecular structure.

Friedrich Miescher

Vol 3, Number 1 January 2019

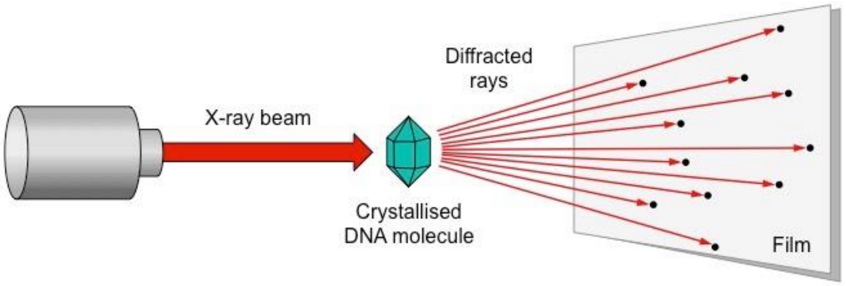
THE DISCOVERY OF DNA
ROSALIND FRANKLIN v WATSON and CRICK
Catherine Dunn 8SOA (Patientia)

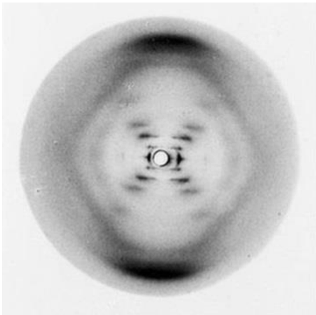
Rosalind Franklin

Rosalind Franklin was born in 1920 in Notting Hill, London. At the age of 18 she attended Newnham Women's College, Cambridge, to study Physics and Chemistry. In 1951, she was offered a 3-year research scholarship at King's College in London.

With her knowledge, Franklin was to set up and improve the X-ray crystallography unit at King's College. She and Raymond gosling found an X-ray diffraction pattern of DNA which triggered the idea that it was a helix. Maurice Wilkins, also at King's College, obtained some of the first X-ray diffraction patterns of DNA from which the size of it could be calculated.

Franklin presented her data at a lecture in King's College at which James Watson was in attendance. At that time, Watson and Francis Crick were also working on the structure of DNA. It was Maurice Wilkins, Rosalind's lab partner at King's College, who showed Watson and Crick franklin's X-ray data. This data confirmed the 3-D structure that Watson and Crick had theorised for DNA.





Watson and Crick

At the beginning of 1953 a Californian chemist, Linus Pauling, suggested an incorrect model of the structure of DNA, prompting Watson and Crick to try their own model. On February 28th, they determined that the structure of DNA was a double-helix polymer, each helix containing a long chain of monomer nucleotides.

According to their findings, DNA replicated itself by separating the two helices into individual strands, each of which became the template for a new double helix. Watson and Crick had solved a mystery of science – how it was possible for genetic instructions to be held inside organisms and passed from generation to generation.

Their find revolutionised the study of Biology and Medicine. Some of the developments that followed include genetically engineered foods; the ability to identify human remains; the design of treatments for diseases such as AIDS; and the accurate testing of physical evidence in order to solve crimes.

EDITOR'S NOTE: the author of the above paper also added a personal opinion:

In my opinion, Rosalind Franklin gave the bigger contribution to the discovery of the structure of DNA as she developed the X-ray crystallography which showed the shape of DNA that Watson and Crick based their model on. However, they all made extremely important contributions to discovering the structure of DNA and the developments that stemmed from this discovery.

ROSALIND FRANKLIN, JAMES WATSON and FRANCIS CRICK: CONTRIBUTION TO THE STUCTURE OF DNA

Bea Savage 8RED (Industria)

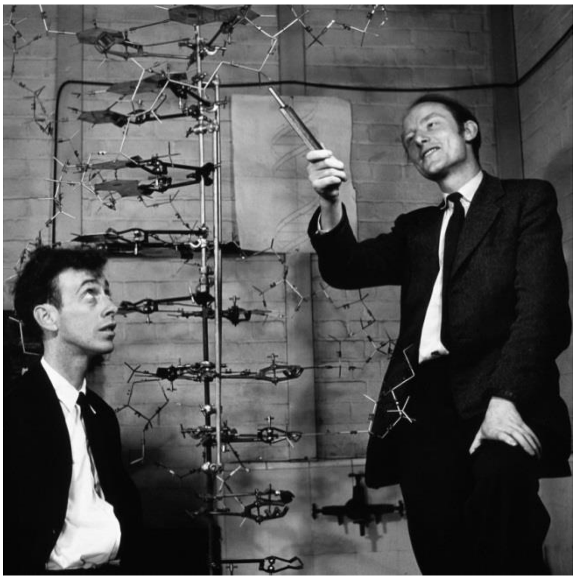
They all contributed vital evidence in the study of the structure of DNA, but there are many arguments about who made more of the discovery.

Watson and crick worked together on determining the double-helix structure of DNA, the molecule that contains the genes. For this, Watson and Crick received a Nobel Prize for medicine in 1962. However, many people suggest that Rosalind franklin was cheated out to winning the Nobel Prize.

Franklin contributed to the discovery of the structure of DNA with evidence produced by the technique of X-ray crystallography. It was said that Watson and Crick didn't have permission when gaining access to the X-ray photographs taken by Franklin, but they were vital to the correct solution when putting together several different models of DNA.

WATSON and CRICK

Experiment:
Build a 3-D model of DNA that reflects the base-pairing rules determined by Chargaff and the distance between bases suggested by Franklin's X-ray photos.



Conclusion:
DNA is a double helix that makes one full turn every 3.4nm with bases 0.34nm apart and sugar/phosphate molecules on the outside.

It is argued on who deserved the most credit for this discovery, as franklin was the only one with a degree in Chemistry and her X-ray photos played a massive role. There have also been many things said and written about sexism and the fairness of why Watson and Crick won the Nobel Prize and not Franklin. Watson and Crick were awarded the Prize in 1962, four years after Franklin had died of cancer in 1958, aged 37.

James Watson and Francis Crick

Rosalind Franklin

It has always been said that Watson and crick were not given permission to access the X-ray photos taken by Franklin. Sources also say that the rumours about this are incorrect as her lab diaries and other evidence gathered has shown that Watson and Crick would publish their model and Franklin agreed that she would publish her evidence separately. No evidence has been shown that there was any anger or frustration on Franklin's part towards Watson or Crick and the way their joint discovery was published in 1953.

After all this, Franklin no longer worked on the study of DNA. She had lived her life unmarried and with no children, but devoted to her work. Sadly, she died from ovarian cancer at the very young age of 37, probably from exposure the X-ray radiation that helped her make her discovery.

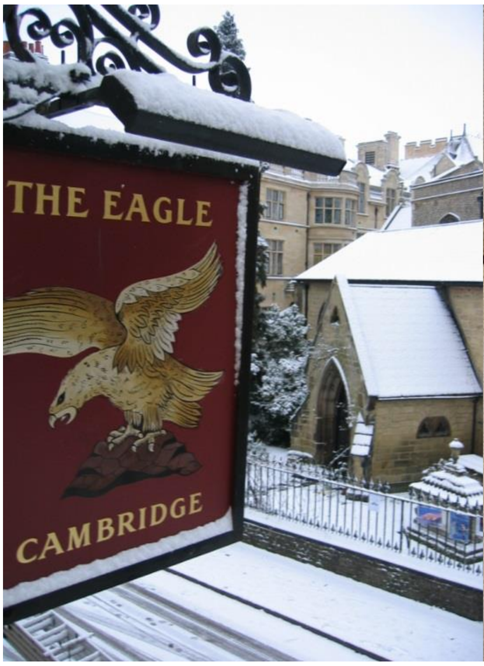
EDITOR'S NOTE: the author of the above paper also added a personal conclusion:

The discovery of the structure of the DNA molecule became one of the most important scientific discoveries of the 20th century and there were most likely many facts and contributions that helped lead to this discovery.

I think that Rosalind Franklin and Maurice Wilkins supplied vital evidence for this discovery.

ANOTHER EDITOR'S NOTE: As the responsible Editor of a school publication, I would not normally promote a public house, but this is different………………………………

On the 28th February 1953 James Watson and Francis Crick walked into the bar of the Eagle public house in Cambridge and announced to all present that they had *"Discovered the secret of life!"*



The pub, which was actually a 16th century coaching inn, is closed and having a makeover between 14th and 25th January this year. One of its attractions is its RAF bar, dedicated to the many allied airmen who fought in World War 2 and who were stationed in and around Cambridge between 1942 and 1945.

I would like to tell you more about that particular history of the Eagle pub, but perhaps that is for another day and another Journal.

ULTRASOUND

Adam John 8SOA (Patientia)

What is ultrasound?

Ultrasound is sound waves that have such a high frequency that it is beyond the upper audible limit of which humans can hear. Ultrasound is not different to normal sound waves, it has an amplitude, period, wavelength... It is just a sound with a very high frequency. Ultrasound is measured at approximately 20 kilohertz in a healthy, young adult.

Why can we not hear it?

We cannot hear ultrasound as it has got too high a frequency to do so. This means that it is too high-pitched to hear. The human hearing range is roughly between 64Hz and 23kHz (23,000Hz). However, other animals can hear ultrasound, such as dogs. Dogs have a much wider audible range, starting at 67 Hz, and going as high as 45kHz (45,000Hz). Yet, it is apparent that sounds in the upper frequencies of a dog's hearing range makes it irritated and uncomfortable.

What is ultrasound used for?

Ultrasound is used for many purposes, such as cleaning your teeth. Sometimes, bacteria on your teeth come in the form of plaque, and then create a whitish film called bio film. If they are not removed, they can cause pockets - gaps between your teeth and gum. The bacteria then settle into the pockets and harden to make calculus or tartar. Now we use ultrasound. The high frequencies of ultrasound create lots of energy, and so the hard calculus is crushed and removed by the ultrasound. Ultrasound also creates shockwaves that disrupt bacteria cells.

Another example of ultrasound being used is animal echolocation. Echolocation, also known as bio sonar, is the process in which an animal emits ultrasound waves out into their surroundings, they then listen for the echoes to return, and they don't only find out distance, but can also identify the object, whether an animal or rock or tree. An example of animal that uses echolocation is the microchiropteran bat. Bats are not blind, but can see better through their eyes during the day than night, so that's why they use echolocation during the night. They use ultrasound echolocation to navigate their way during the night, as well as to hunt - they mainly eat insects.

BREAKTHROUGH ULTRASOUND TREATMENT TO REVERSE DEMENTIA MOVES TO HUMAN TRIALS: An extraordinarily promising new technique using ultrasound to clear the toxic protein clumps thought to cause dementia and Alzheimer's disease is moving to the first phase of human trials this year. The innovative treatment has proven successful across several animal tests and presents an exciting, drug-free way to potentially battle dementia.

(Source: University of Queensland, Australia)

ULTRASOUND

Beatrice Widmer 8PNR (Industria)

Ultrasound is extremely high frequency sound waves. In fact, these sound waves have such a high frequency that they cannot be heard by humans. Ultrasound is considered to be anything higher than 20,000 hertz as this is the normal limit of human hearing. The sound itself is no different from other sound: it is simply too high for us to hear. As different people have different limits for when a sound becomes such a high frequency that it cannot be heard, there is no fixed definition for ultrasound. For example, what is ultrasound for humans can be heard easily by bats.

Ultrasound can be used for a variety of purposes. One such use is ultrasound scans. These are used to examine soft tissue inside a body (x-ray is used for bone). This includes obstetric ultrasound. Ultrasound scans display an image often known as a sonogram. This is achieved by sending pulses of ultrasound into soft tissue using a probe. The ultrasonic sound waves echo off the tissue and the echoes are used to produce an image which can be examined for the purpose of diagnosis.

These ultrasound scans are commonly used to check on the development of foetuses during pregnancy. The image produced is used to confirm pregnancy timing; to measure the foetus for growth abnormalities; to make sure the foetus does not have a congenital malformation; and to check that it is not a multiple pregnancy (twins, triplets, etc.).

This is my obstetric ultrasonogram at approximately 12 weeks gestation.

Another use for ultrasound is echolocation. This is mostly used by animals such as bats and odontocetes (toothed whales and dolphins). Echolocation involves the animal producing high frequency sound and listening to how long it takes for the sound waves to bounce off a nearby object and come back to them. These animals use echolocation for navigation because it can construct a map of the area they are in: effectively they see with sound. We will use bats as an example. As bats are nocturnal, when hunting it is difficult to see their surroundings and prey in the dark. For this very reason, bats have evolved to use echolocation to navigate, forage and hunt. The high frequency sounds made by the bats don't travel far in the air - there is greater acoustic attenuation than in lower frequencies - meaning bats would be unable to locate their prey more than a couple of metres away. Scientists think they compensate for this by amplifying the calls, e.g. the lesser bulldog bat reaches a deafening 137 dB (that's nearly 20 dB louder than a rock concert).

You might expect that this would deafen the bat itself, but the bat has a method of dealing with this: by contracting the inner ear muscle, the three bones in the ear are separated temporarily and the intensity of the sound therefore does not affect the bat making it. Most bats produce high frequency sounds by contracting their larynx (voice box) or clicking their tongues, but the Old World leaf-nosed bat emits echolocation calls through its nostrils!

The Old World leaf-nosed bat produces ultrasound through its nostrils.

THOMAS HODGKIN – a biography

Emilia Migut 7TAY (Industria)

Thomas Hodgkin

Born: 17th August 1798, Pentonville London
Died: 5th April 1866, Jaffa Tel Aviv Israel
Nationality: British

About

About me
I was a British physician, considered one of the most prominent pathologists and pioneer in preventive medicine. I have mastered several foreign languages perfectly : Latin, French, Italian, German and Spanish.

The things I am most famous for…
I was best known for the first account of Hodgkin disease, a form of lymphoma and blood disease in 1832.

Work, education and personal life…
At the age of 21 years I was entered as a student of medicine at The United Hospitals of St. Thomas's and Guy's. One year later I went to Edinburgh to continue studies at the University of Edinburgh. I married a lovely wife her name was Dorothy Hodgkin she was an England chemist.

History by year
1798: T.Hodgkin was born
1819: Hodgkin was admitted to medical school
1821: Hodgkin went to France where he learned to work with the stethoscope, recent invention of René Laennec
1823: he qualified for his M.D at the University of Edinburgh Medical School with a thesis on the physiological mechanisms of absorption in animals
1825: Hodgkin found a position at Guy's as the curator of the museum there, also carrying out autopsies.
1866: Thomas Hodgkin

ALESSANDRO VOLTA – a biography

Emily F Walkowska 8PNR (Caritas)

sciencebook

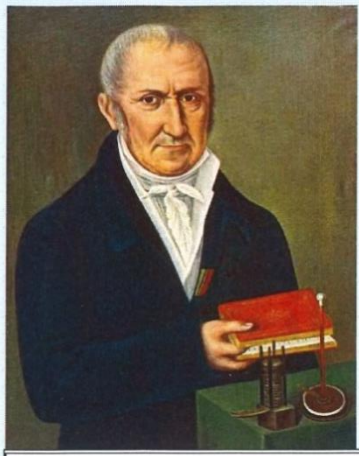
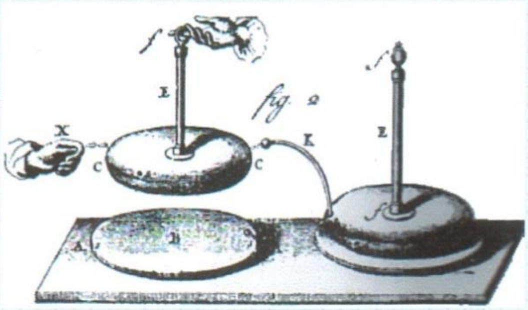
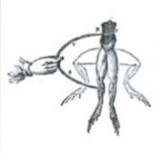


Diagram of Volta's electrophorus



ALESSANDRO VOLTA

Born: 18 Feb 1745
Died: 5 Mar 1827
Nationality: ITALIAN



About me: I was born in 1745 in Como, Italy into a Royal Family. One day I suddenly became a genius at the age of 55 when I was working as a Professor of Physics at the University of Pavia. I created the VOLTAIC PILE, which I named after myself.

The things I am most famous for: I was a physicist, chemist and pioneer of electrical science. I am most famous for my invention of the electric battery. In brief, I invented the first electric battery in 1800 and called it the 'Voltaic Pile'.

Work, education and personal life: I was not an infant prodigy at all. I didn't talk until I was four and my family was convinced that I was retarded, although I was a Professor of Experimental Physics at the University of Pavia for 25 years!

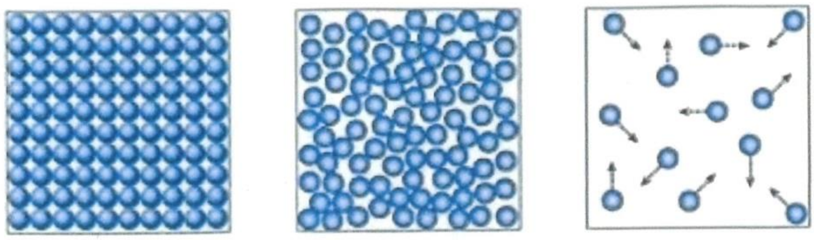
History by year:
Born: 18 February 1745
In 1779 I became Professor of Experimental Physics.
In 1794 I married Lady Teresa Peregrini with whom I raised three sons: Zanino, Flaminio and Luigi.
I died on 5th March 1827, just after my 82nd birthday.

3 STATES OF MATTER

Bea Price 7TAY (Caritas)

3 STATES OF MATTER

Solid, liquid and gas



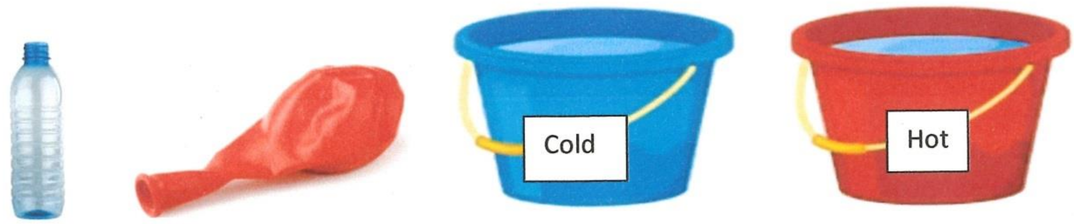
Solid Liquid Gas

This also has dashes coming out the sides because it shows it is moving around quickly

Solid is particles close together in a neat formation. They move by vibrating.

Liquid is particles still close together but moves by sliding over each.

gas is particles spaced out and move around randomly.



This is an experiment you can do at home!

This is because heat molecules has more space between them then cold molecules, so the heat molecules expand to make more room for them.

What you need:

·plastic bottle

·balloon buckets with water

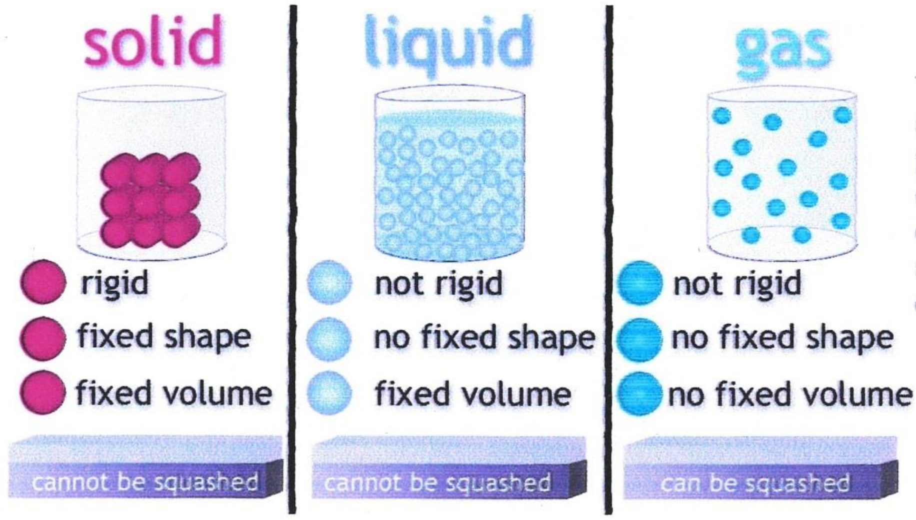
First you will fill two buckets of water (one cold and one hot).

Then you will take the cap of and put the balloon over it.

Now put it in the hot water and the balloon will rise but when you put it in the cold water it deflates.

3 STATES OF MATTER

Simon Vieira 7CPR (Patientia)



The three states of matter are the three distinct physical forms that matter can take in most environments: solid, liquid, and gas. In extreme environments.

Solid: a solid is a sample of matter that retains its shape and density when not confined. The adjective 'solid' describes the state, or condition, of matter having this property.
The atoms or molecules of matter in the solid state are generally compressed as tightly as the repulsive forces among them will allow. Some solids, called 'crystalline solids', tend to fracture along defined surfaces that have a characteristic shape depending on the arrangement of, and the forces among, the atoms or molecules in the sample. Other solids, known as 'amorphous solids', lack any apparent crystalline structure.
Examples of solids are table salt, table sugar, water ice, frozen carbon dioxide (dry ice), glass, rock, most metals and wood.

Liquid: a liquid is a sample of matter that conforms to the shape of the container in which it is held, and which acquires a defined surface in the presence of gravity. The term 'liquid' is also used in reference to the state, or condition, of matter having this property.
The atoms and molecules of matter in the liquid state are compressed as tightly as those of matter in the solid state, but in a liquid they can move freely among each other.
Examples of liquids are water at room temperature (approximately 20°C, oil at room temperature and alcohol at room temperature.

Gas: a gas is a sample of matter that conforms to the shape of the container in which it is held and acquires a uniform density inside the container, even in the presence of gravity and regardless of the amount of matter in the container. If not confined to a container, gaseous matter (also known a vapour) will disperse into space. The term 'gas' is also used in reference to the state, or condition, of matter having this property.

Although we teach, at least at KS3, that there are 3 states of matter: SOLIDS, LIQUIDS and GASES, there are in fact 2 more! The most easily understood one is PLASMA. Although it is rare on Earth, it is perhaps the most common state of matter in the Universe - it consists of highly charged particles with extremely high kinetic energy. Stars are essentially superheated balls of plasma. The most recent (and bizarre!) state of matter was produced here on Earth in 1995 and is known as a BOSE-EINSTEIN condensate (BEC). Space doesn't permit any further detail, suffice to say that studying this state of matter may help us understand exactly what goes on inside a black hole!

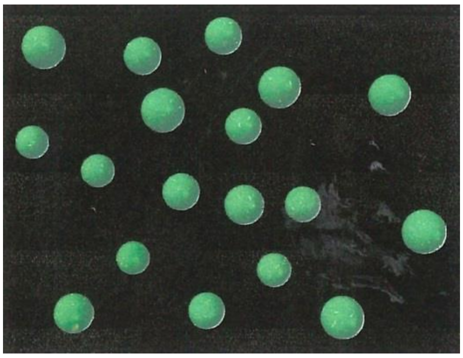
STATES OF MATTER

Jack Rawlings 7TAY (Industria)

States of matter are the conditions of where something exists, either a gas, solid or liquid. For example steam, ice and water.

GAS

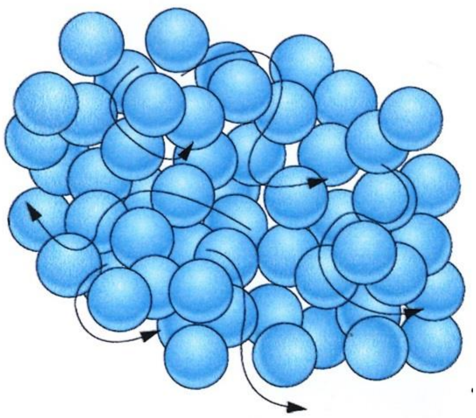
Steam is an example of a gas. Gas is made when energy is added to a liquid, for example heat, which causes the liquid to evaporate into a gas. Gas is all around us, the most common being air. The particle layout of gas looks like this:



The particles are randomly spaced and going very fast, hitting into each other.

LIQUID

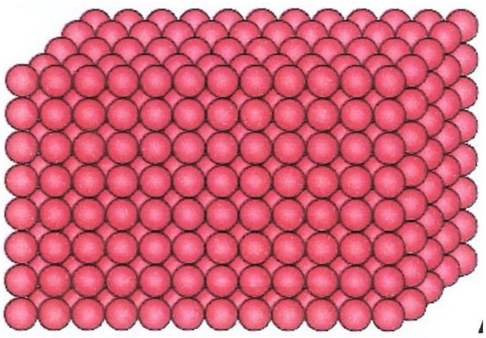
Water is an example of a liquid. Liquid is produced when you add energy, such as heat, to a solid causing it to melt. The particle layout of a liquid looks like this:



The particles flow randomly over each other but are still touching. A liquid will take the shape of the container it is in, but not fill it.

SOLID

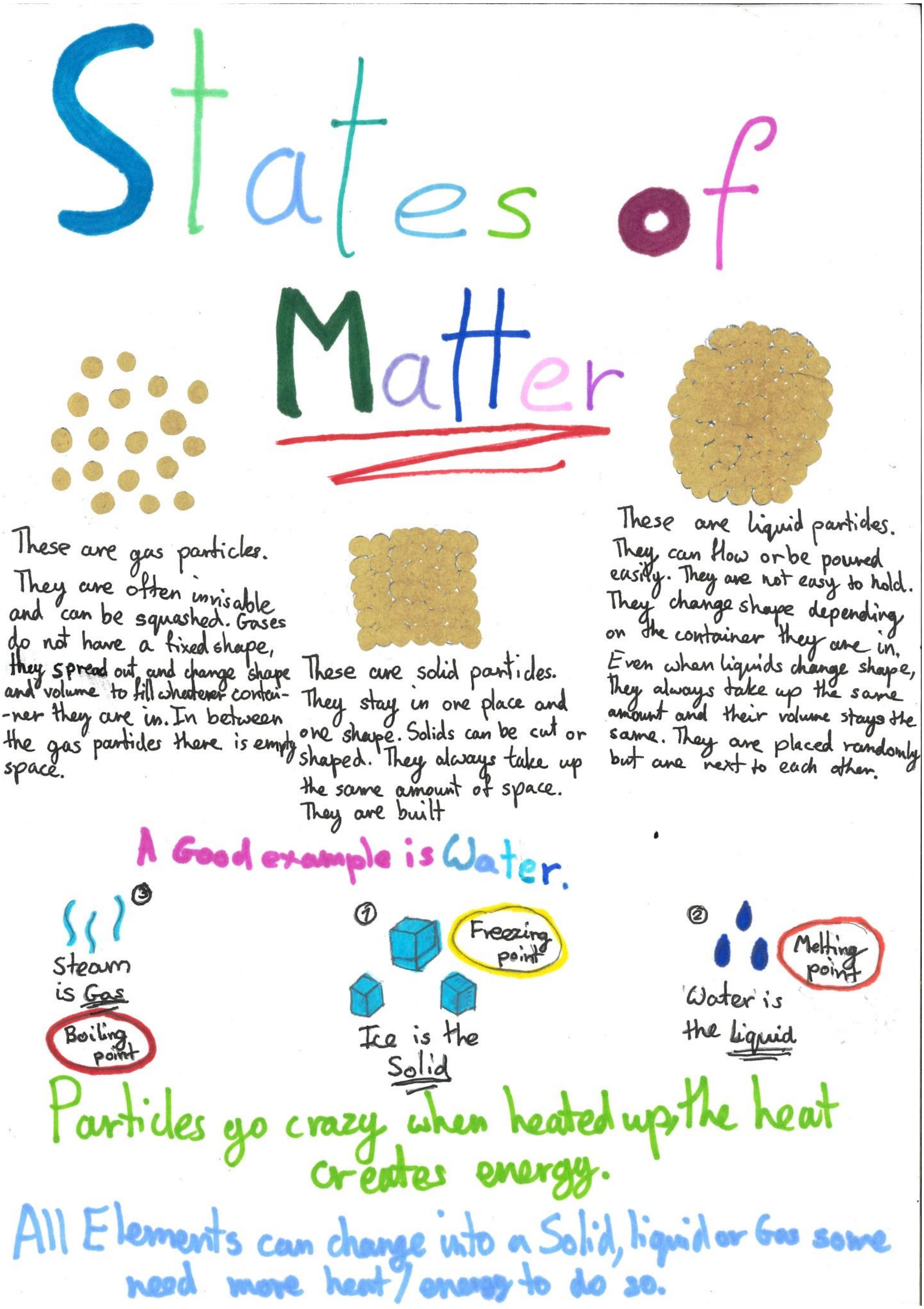
Ice is an example of a solid. A solid is produced when you remove energy from a liquid which freezes it. Solids are the objects around you. The particle layout of a solid looks like this:



A solid is when all the particles are spaced together and it cannot be changed unless it is put under a certain amount of pressure

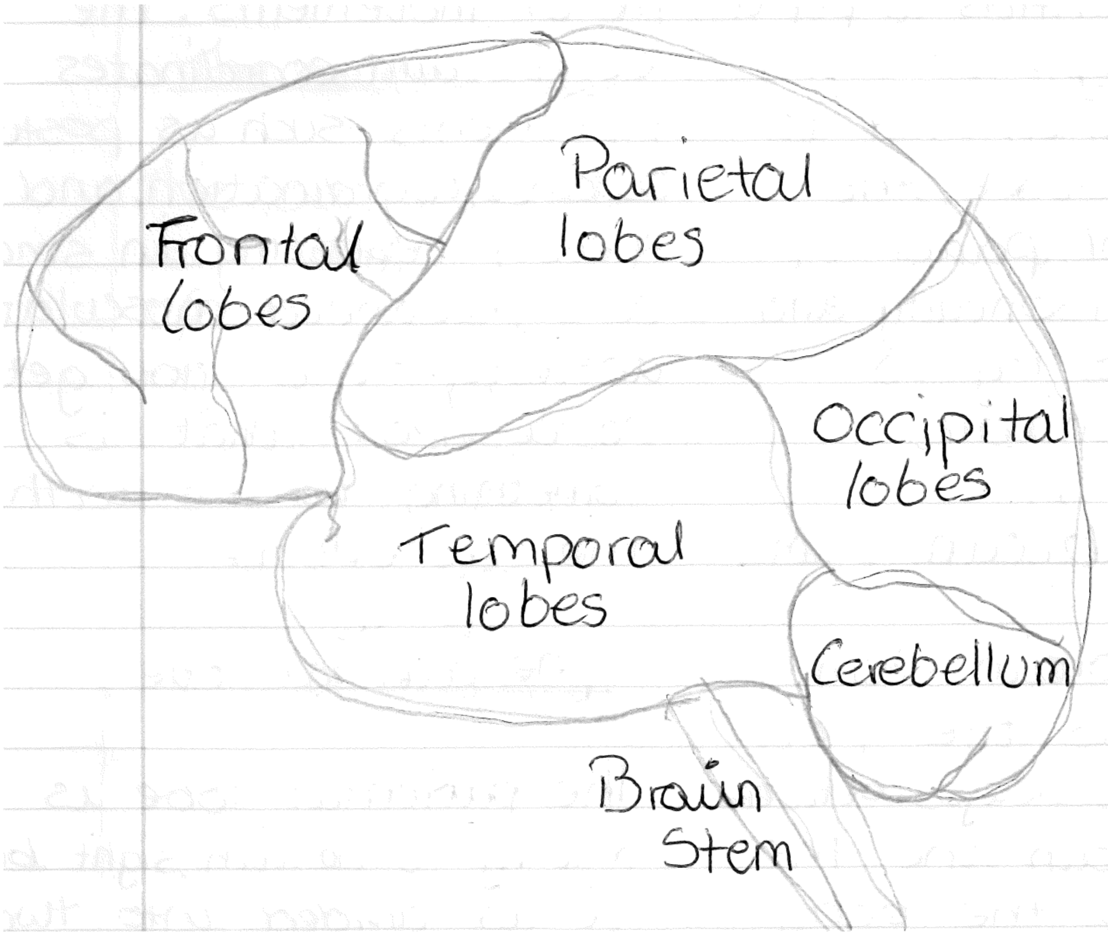
STATES OF MATTER

Aleksandra Bulacz 7CKD (Industria)



AND NOW A BIT OF SCIENCE – BRAINS!

Dominic Zielen 8RED (Patientia)



The **FRONTAL LOBES** are used for decision-making, emotions, memory, language, problem solving and much more. The frontal lobe area is the largest part of our brain and the part that controls important cognitive skills in humans. It is, in essence, the 'control panel' of our personality and our ability to communicate.

The **BRAIN STEM** controls the flow of messages between the brain and the rest of the body. The stem also controls basic body functions, most importantly breathing, swallowing, heart rate, blood pressure, consciousness and whether one is awake or asleep.

The **CEREBELLUM** receives information from the sensory system, the spinal cord, other parts of the brain and it then regulates motor movements. The cerebellum coordinates movements such as posture, balance and coordination, resulting in smooth and balanced muscular activity. If one gets paralyzed then it is likely something to do with the cerebellum.

The **PARIETAL LOBEs** are mainly to do with sight and are actually divided into two functional regions: one involves sensation and perception; the other is sight.

The **TEMPORAL LOBES** are for hearing and being involved with primary auditory perception. The lobes also contain the primary auditory cortex.

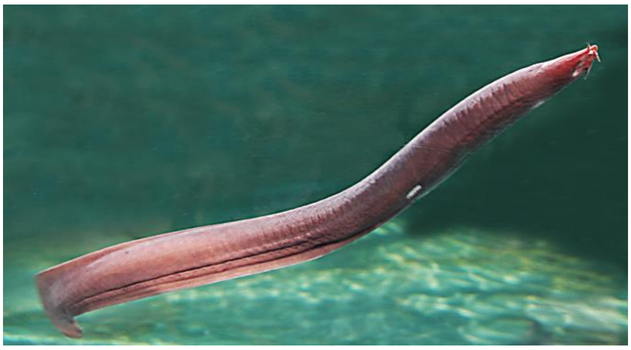
The **OCCIPITAL LOBES** are involved in eyesight and is regarded as the visual processing centre of the mammalian brain.

ANIMALS THAT DON'T HAVE BONES!

Ella-Lee Macgillvray 7NOX (Caritas)

THE HAGFISH

Romilly Findley 7HLM (Patientia)



Kingdom: Animalia
Scientific name: Myxini
Length: 30-80cm (approx.)

FUN FACT: Hagfish slime is super strong and is being researched as a potential fabric!

Hagfish, the class *Myxini*, are slime producing, eel-shaped marine fish. They are the only known living animals to have a skull but no vertebral column. Hagfish can produce litres of slime in a matter of minutes. They have barely evolved over the last 330 million years.

Hagfish live in the so-called 'midnight (bathypelagic) zone' where there is hardly any light, so they hardly get any food. They have learned to go months without eating. No one is sure whether it is a vertebrate or an invertebrate, but I think that it is an invertebrate because it has no actual bones.

The hagfish protects itself from predators by producing slime. The glands lining their body excrete stringy proteins and when this meets seawater it turns into a slime which makes the hagfish very slippery. If the hagfish was ever consumed, it would excrete the slime making the predator gag and spit the hagfish out; however, this ordeal would take weeks to recover from.

The hagfish moves with a snake-like motion, using a paddle on its tail. It also uses its ability to tie itself in knots to move; to lever the flesh off a carcase; to writhe itself out of its own slime; and to escape from predators. Hagfish have a soft, flexible *faux* spine to support itself, that is not made out of bone. It uses this to give itself more flexibility and protection.

There are 75 species of hagfish, all unique, but they do all have one thing in common: they all have four hearts. They have one main heart that does the same as a human heart – the other three are mainly just accessory pumps to assist the main heart.

ANOTHER FUN FACT: the hagfish's skin has been described as a "loosely fitting sock!"

HAGFISH EYES...although today's living hagfish have what are undoubtedly eyes in their heads, they are degenerate and may only enable the hagfish to tell light from dark - essentially they are blind. However, research led by the University of Leicester has investigated the eyes preserved in fossilised hagfish over 300 million years old. This research has overturned a longstanding theory on how vertebrates evolved their eyes by identifying remarkable details of the actual lens and retina in the fossil specimens.

The study, published in the journal *Proceedings of the Royal Society B* (2016), led by Professor Sarah Gabbott from the University of Leicester Department of Geology, shows that fossil hagfish eyes were actually well-developed, indicating that the ancient animal could see, whereas their living counterparts are completely blind after millions of years of eye degeneration -- a kind of reverse evolution.

The researchers examined the eye tissue in two fossil jawless fish species -- *Mayomyzon* (a lamprey) and *Myxinikela* (a hagfish) found in the Carboniferous age Mazon Creek fossil bed, Illinois. Using a high-powered scanning electron microscope to magnify the eye 5,000 times they could see that the fossil retina is composed of minute structures called melanosomes -- the same structures that occur in human eyes allowing us to form a clear visual image.

Professor Gabbott added: "Sight is perhaps our most cherished sense but its evolution in vertebrates is enigmatic and a cause célèbre for creationists. We bring new fossil evidence to bear on an iconic evolutionary problem: the early evolution of the vertebrate eye. We will now scrutinize the eyes of other ancient vertebrate fossils to see if we can finally build a picture of the sequence of events that took place in early vertebrate eye evolution."

INVERTEBRATES

Phoebe Harpur-Davies 7CPR (Caritas)

95% of the world's animal species are invertebrates. Here are some examples:

Echinoderms

Two examples of echinoderms are Starfish and Sea Urchins.
Echinoderms are marine animals that live on sand or rocks. They have an external skeleton made of calcium and have a pentamerous symmetry (ie., divided into five parts).They can have spines, or tubicles, which can release toxins for defence. They also use their spines and tubed feet to move around.

Molluscs

Molluscs are the most common of the invertebrates. They vary in size from the tiny snails to the giant octopus. They have soft bodies, some being protected by shells – these can either be internal (eg., squid) or external (eg., snails).

Molluscs can be found either on land or in salt and fresh water. There are three different types:

Gastropods
Gastropods, eg., snails, move by means of a muscular foot.

Bivalves
These have two shells that can close tightly to protect its body, eg., the clam.

Cephalopods
They have tentacles to move around and capture food, eg., the octopus.

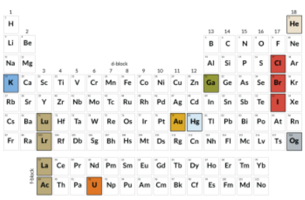
Arthropods

Arthropods have jointed legs; a body that is divided into segments; a protective exoskeleton; and are symmetrical. They can be found in water and on land. Arthropods are the most diverse of the invertebrates and include:

Crustaceans
They have 10 legs, eg., crabs.

Insects
They have 6 legs, a pair of antennae, and some have wings, eg., the butterfly.

Myriapods
They have many legs, eg., centipedes have 2 legs per segment, while millipedes have 4 legs per segment.



150 YEARS AGO…March this year marks the 150th anniversary of the creation of one of the world's most instantly recognised scientific images – the *PERIODIC TABLE OF ELEMENTS*.

Its creator, the Russian chemist DMITRI MENDELEEV, considered all the various properties of the 63 elements known at the time and put them into a logical order that coincided with their atomic weights. Mendeleev stated in his paper, published on 1st March 1869, *"Elements arranged according to the size of their atomic weights show clear periodic properties. All the comparisons which I have made…lead me to conclude that the size of the atomic weight determines the nature of the elements."*

One of the most remarkable aspects of Mendeleev's work was that he recognised that there were gaps in his table, which led him to predict that new elements would hitherto be discovered to fill these gaps. So, from his listing of the 63 elements known to him, we now have a complete table of 92 naturally occurring elements.

95% OF ANIMALS DO NOT HAVE BONES!

Phoebe Reeve 7CKD (Humanitas)

It might come as a surprise, but 98% of animals on Earth don't have a backbone and 95% don't have any bones at all. So how do all these creatures support and protect themselves?

Many invertebrates and all *arthropods* have a protective, external casing called an exoskeleton., which literally means 'outside skeleton' and its role is to cover the animal's soft tissues and also provide a rigid structure to which the creature's muscles can attach.

Insect exoskeletons are made of chitin which is embedded in a tough protein matrix.. Chitin is a nitrogen-based biopolymer similar, at least in function, to keratin which is the material our own hair and nails are made of. *Arthropods*, such as crustaceans, have additional calcium carbonate in their exoskeleton for extra armour plating. As well as supporting and protecting the creature, the exoskeleton also creates a watertight barrier that prevents the creature from dying out

The exterior of an exoskeleton can also contain sensory hairs or bristles, while some animals can secrete various pheromones and chemicals onto the surface of their shell as a means of repelling predators.

Although exoskeletons contain flexible leg joints to enable the creatures to move about, once it's formed this armour does not expand with the rest of the body; therefore, the animals will eventually outgrow it. At this point a process called *ecdysis*, or moulting, takes place whereby the creature will shed its overly tight exoskeleton in order to make way for a new one.

There are three main types of skeletal system in the Animal Kingdom: exoskeletons (on the outside), endoskeletons (on the inside, for example in humans) and hydrostatic skeletons, which are rather different as they have no real framework but maintain their shape by the pressure of the fluid inside the animal's body. Examples of creatures with hydrostatic skeletons include slugs, worms and jellyfish.

ARE THERE INTELLIGENT ALIENS ON EARTH?

Well probably not. But if I told you that I had visited another planetary body with a liquid water ocean, like Jupiter's moon Europa, and I had found a creature like this, you would likely think that, yes, I had found an alien and it is indeed intelligent.

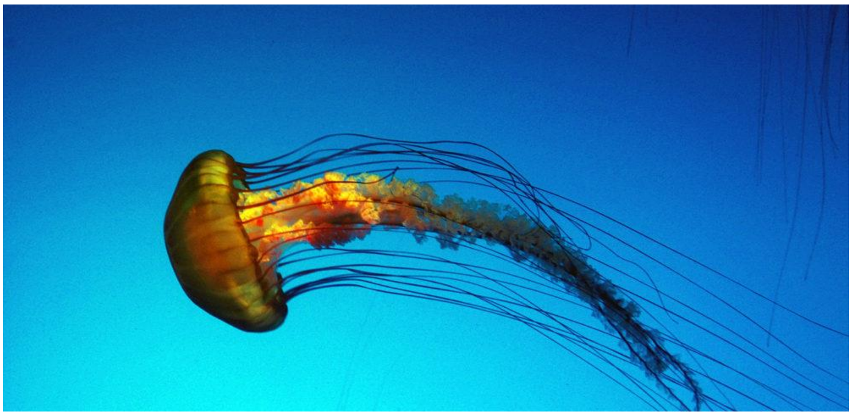
It is, of course, an OCTOPUS, one of many types that live in our own Earthly oceans and we are now beginning to understand how amazingly intelligent they are. Indeed, their brains have a greater mass to bodyweight ratio than many vertebrates.

They have powers of reasoning that we are only now being able to understand. And here's the thing –

THEY DON'T HAVE BONES!

JELLYFISH

Kirsten Taylor 7CKD (Caritas)



How are jellyfish alive?

While jellyfish don't have a brain or central nervous system, they do have a very basic set of nerves at the base of their tentacles. Since they don't have a brain they live passively, depending entirely on their automatic reflexes.

Do jellyfish have bones?

No. Their body is almost totally made of water and is therefore soft, having no bones at all. In fact, a jellyfish has no ears, eyes or nose and no brain or heart. They don't even have a head

How do jellyfish work?

Jellyfish are probably some of the most unusual and mysterious creatures that you'll ever encounter. With their gelatinous bodies and dangling tentacles, they look more like something from a horror movie than a real animal. But, if you can get past their weirdness and the fact that getting too close to one results in a nasty sting, you'll discover that jellyfish are pretty fascinating. They have actually been around for more than 650 million years and there are thousands of different species, with more being discovered all the time.

How do jellyfish move without bones?

The comb jellies have tiny, transparent, hair-like cilia that beat continuously as a form of propulsion. Unlike the jellyfish, sea anemones and corals are rooted to one spot in the ocean, while jellyfish can swim or just float on the ocean currents.

Do jellyfish live forever?

Scientists have discovered a jellyfish that can live forever. It is now officially known as the only immortal creature. The secret to eternal life, as it turns out, is not just living a really, really long time – it is all about maturity, or rather, the lack of it!

Support of the jellyfish system?

'Skeletal' support system: although jellyfish have no basic skeleton, they use their 'hydrostatic' skeleton for support and movement. The hydrostatic skeleton consists of a fluid-filled cavity (*coelom)* surrounded by muscles. The muscles change the shape of the cavity using contractions.

The protection of the jellyfish?

Jellyfish stings! Jellyfish, sea lice, sea nettle, coral, sea anemones and many other organisms belonging to the phylum *Cnidarian* are all equipped with stinging cells (*nematocysts).* The jellyfish toxins are delivered into the prey through a needle, which resembles a multi-headed poisonous arrow. Jellyfish use these special stinging cells on their tentacles.

50 years ago

Now that we have recovered from our various celebrations and are looking forward to a New Year, I should like to reflect on a most remarkable event that took place at Christmastime 50 years ago. The event produced one of the most famous photographs in the history of Mankind…….

Known as the '**EARTHRISE PHOTO**', it was taken by the crew of **APOLLO 8** on Christmas Eve 24th December 1968. The three crew members, Frank Borman, Jim Lovell and Bill Anders were the first humans to leave the confines of Earth's gravity and orbit another planetary body, the Moon.

They were therefore the first to be able to look upon the Earth in space from another world. As they orbited the Moon they were able to see the Earth rise above the lunar horizon, just as we see the Moon rise here.

To finish their live TV broadcast on that Christmas Eve, the astronauts read a familiar passage from Genesis:

In the beginning God created the heaven and the earth.
And the earth was without form, and void; and darkness was upon the face of the deep. And the Spirit of God moved upon the face of the waters.
And God said, Let there be light: and there was light.
And God saw the light, that it was good: and God divided the light from the darkness.
And God called the light Day, and the darkness he called Night. And the evening and the morning were the first day.
And God said, Let there be a firmament in the midst of the waters, and let it divide the waters from the waters.
And God made the firmament, and divided the waters which were under the firmament from the waters which were above the firmament: and it was so.
And God called the firmament Heaven. And the evening and the morning were the second day.
And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear: and it was so.
And God called the dry land Earth; and the gathering together of the waters called he Seas: and God saw that it was good.

Mission commander Frank Borman then signed off in his own words: "And from the crew of Apollo 8, we close with good night, good luck, a Merry Christmas – and God bless all of you, all of you on the good Earth."

Keep an eye out for announcements from Ms Coogan regarding Astronomy events at the USC involving the use of our outstanding 12-inch Langley Newtonian telescope. We won't be able to bring you an 'Earthrise', but we will certainly bring you incredible views of the Moon and other astronomical objects.