STRICKLAND

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Isobel Brown

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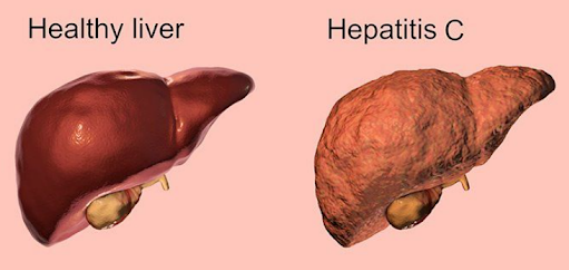
SPOTLIGHT ON A SCIENTIST

Who is Harvey Alter?

Tara Bhatnagar

In 2020, Harvey Alter and his colleagues were awarded 'The Nobel Prize in Physiology or Medicine' for the discovery and isolation of the hepatitis C virus.

Hepatitis C is a disease caused by the hepatitis C virus that targets and infects the liver and usually spreads through blood-to-blood contact. The chances of someone contracting the virus increase if they have come in contact with unsterile equipment such as syringes or needles. This virus can either take the form of acute hepatitis or chronic hepatitis and its severity ranges from mild to lifelong illness. There is currently no vaccine available that offers long-term protection against hepatitis C because there are multiple variations of the virus therefore it is more likely to have the ability to mutate.



Harvey Alter initially worked closely with an American physician who discovered the 'Australia antigen', which was found to circulate in the blood of patients with hepatitis infections. This antigen was detected in 11 percent of American patients suffering from leukemia. Further research was conducted which later led to the Australia antigen being identified as a surface antigen of the hepatitis B virus. Alter found a way to detect the Australia antigen and continued to detect this antigen in patients who acquired hepatitis through blood transfusion, also referred to as 'transfusion-associated hepatitis' (TAH). However, Alter observed that several patients suffering from TAH did not test positive for the Australia antigen or the hepatitis A virus, which led to the conclusion that a new form of hepatitis had emerged, this was called the non-A, non-B hepatitis virus. To confirm the existence of this new form, Alter and his colleagues injected the plasma of patients suffering from non-A, non-B virus into chimpanzees. Consequently, the chimpanzees tested positive for the virus which proved that there was another form of hepatitis to be discovered.

In 1989, Alter and his team tested donor blood for the hepatitis B antibody which was used as a substitute marker to identify the non-A, non-B virus. Alter was able to isolate a clone of DNA derived from the RNA of the 'unknown' virus. By using the new isolated clone of DNA, Alter and his colleagues were successfully able to detect the hepatitis C virus in blood-transfusion patients suffering from the virus.

CONTENTS:

CHEMISTRY

Phosgene Gas in Warfare

Alice Gigney

Chemical warfare involves the use of toxic chemical compounds for the production of chemical weapons. Chemical warfare is the use of the toxic properties of chemical substances as weapons. This has been used heavily in almost all warfare since World War 1 and is still used today. WW1 was the first war where chemical warfare was used. It was estimated that as much as 85 percent of the 91,000 gas related deaths in WW1 were due to the use of phosgene gas.

Phosgene gas is not produced naturally in the environment. It is formed when carbon monoxide reacts with chlorine in the presence of purified carbon which acts as a catalyst, or by the thermal decomposition of chlorinated hydrocarbons. It was initially used in the production of plastics and pesticides, however, in WW1 the Germans discovered that phosgene gas was poisonous at room temperature meaning it had the potential to be used to kill British soldiers from a greater distance in a way that did not endanger German troops as much as previous techniques did. Once it has been released, phosgene gas is hard to avoid as it is less dense than air. This means it is likely to remain close to the ground and spread extremely fast.

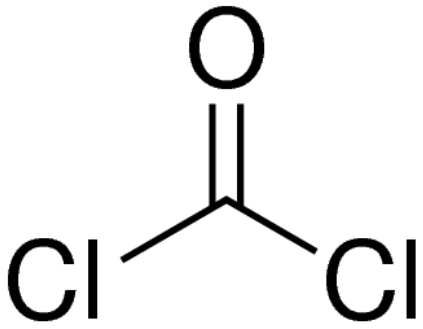
Phosgene gas being released on a battlefield

The gas was released in liquid form by condensing and pressurising the gas and then placing it inside artillery shells. Once deployed these released the liquid which would then evaporate. As the gas is colourless with a musty smell similar to that of freshly mown grass it tends to be harder to detect. The gas is extremely lethal because when inhaled the phosgene gas reacts with the proteins in the alveoli causing fluid to build up in the lungs within two to six hours and eventually resulting in the victim choking to death. At the time there was no potential treatment for soldiers who inhaled the lethal gas.

In order to reduce the use of phosgene gas in warfare, it must be produced and stored in the same plant and must also have the legal documents tied in with it. For example, if a company produces more than 30 tonnes of the gas per year they must declare this with the Organisation for the Prohibition of Chemical Weapons.

Machinery used for the production and storage of phosgene

If phosgene gas is produced in high quantities, it would make it ideal for warfare due to its useful properties. Constant monitoring of the plant and any areas where the gas is stored is also needed because any exposure to gas caused by a leak would be very dangerous, as the concentration would be very high at the time of the leak, making it highly corrosive. Phosgene is still a commonly used chemical in the manufacture of pesticides and some pharmaceuticals.



Phosgene molecule

ENVIRONMENTAL

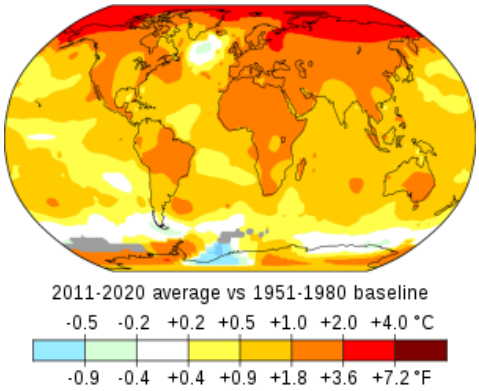
It's Only 2°C

THE EFFECT OF A 2°C GLOBAL TEMPERATURE CHANGE

Sasha Kelbrick

CAUSES OF CLIMATE CHANGE

Climate change is predominantly caused by greenhouse gases. Many of these gases are produced by agricultural processes such as meat production, cattle farming as well as the combustion of fossil fuels. Greenhouse gases contribute to the greenhouse effect by absorbing infrared radiation that is reflected off the Earth from radiation emitted by the sun. Consequently increasing the surface temperature of the Earth.



Temperature changes over the last 50 years

SPECIES

Climate change has already had a massive impact on biodiversity. There are currently thought to be around 105,000 species of insects, vertebrates and plants across the world. If the global temperature increased by two degrees, 18 percent of insect species, 16 percent of plant species and eight percent of vertebrate species would experience a decrease in their geographical range of more than 50 percent. This is the spatial area in which a species is found. As this is 42 percent of the 105,000 species, that approximately 44,100 species would be affected.

MARINE LIFE

An increase in temperature would result in a massive reduction in geographical range, as species would move towards the poles. However, for immobile organisms, the temperature rise could be detrimental. A temperature increase of two degrees could result in the extinction of all coral reefs by 2100. The temperature increase would not only have an effect on ocean temperatures, but also the oxygen levels and the acidity of the water. As the concentration of carbon dioxide dissolved in the ocean increases, the water becomes more acidic. With this, the ocean's oxygen levels would decrease resulting in more areas of the ocean where the oxygen levels are too low, meaning that there is a greater likelihood that aquatic organisms will be lost. These areas are referred to as dead zones.

PEOPLE

The human race will suffer from the knock on effects of a decrease in the populations of species. For example, the reduction in pollinators such as bees would have a destructive effect on agriculture and food production and consumption. The loss in coral reefs would impact around half billion people who rely on them for food, livelihoods and tourism. Other pressing issues include around 30 percent or two billion people will become exposed to extreme heat waves that will re-occur at least once every 20 years. Countries will experience much lower economic growth and the food yield and nutritional value will decrease.

SOLUTIONS

A 50 percent drop in emissions would not stop the increase in temperature, but would reduce the rate at which it rises. This shows that reduction in wildlife mentioned previously is likely to become a reality if we continue to produce as much carbon dioxide and methane as we are currently. To minimise the effects of this, we need to absorb as much carbon dioxide as we emit, some believe we even need to remove more carbon dioxide than we produce. Currently, scientists are working towards achieving zero emissions around the world and reducing carbon dioxide produced by food and manufacturing.

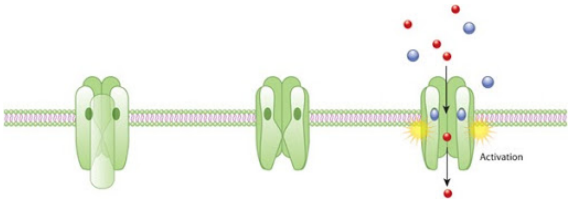
Optogenetics

Lukshana Ketheswaran

Optogenetics is a revolutionary branch of biotechnology that utilises the genetic alteration of nerve cells and optic techniques to control neuronal activity within living organisms. Having discovered light-gated ion channels in algae, scientists came to realise that light could be used to activate neurons genetically modified to express these proteins. Simply put, optogenetic technology allows neurons to turn on and off like switches. Unlike any other biological technique, optogenetics is a non-invasive, time-efficient and precise method that manipulates the function of neurons. With optogenetics, we can link specific neurons to certain behaviours and control brain activity. This technique could play a key role in helping scientists to pinpoint the exact changes in the brain that result in neurodegenerative diseases such as Alzheimer's and Parkinson's.

WHAT ARE ION CHANNELS?

Ion channel receptors are proteins located in the plasma membrane. These proteins arrange themselves forming passageways called ion channels. Ion channels have the ability to open or close in response to chemical or mechanical signals. Most ion channels close after opening and enter a resting state where they do not respond to any signals for a short period of time.

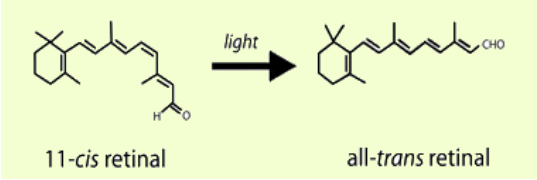


Ion channel receptor activation in the plasma membrane

Opsins are light-sensitive receptors that convert light into electrical signals by allowing ions to cross the membrane as either channels or pumps. These opsins are able to respond to light due to the presence of a light sensing chromophore - the part of the molecule responsible for its colour - like retinal found in the photoreceptor cells of the retina. When a particular wavelength of light is directed at retinal, it changes from 11-cis to all-trans. This causes the opsin to become activated and causes ions to move across the membrane.

WHAT IS CIS-TRANS ISOMERISM?

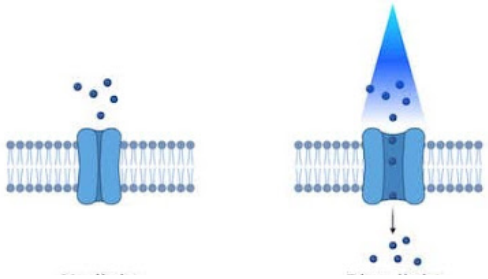
Cis-trans isomerism, also known as geometric isomerism, is one form of stereoisomerism. Stereoisomers can be defined as compounds with the same structural formula, but with a different spatial arrangement. In this case, retinal changes from 11-cis to all-trans. All of the double bonds are in the trans configuration in the all-trans retinal, hence why it is named all-trans.



Retinal changes from 11-cis to all-trans in the presence of a certain wavelength of light

HOW DO NEURONS FIRE?

Neurons fire in response to electrical signals created by the relative charge between the outside and inside of the cell. The inside of the neuron is more negative at its resting potential. We can bring in positive ions such as sodium and potassium ions since the influx of these ions through channels causes the neuron to become more positive until it reaches a threshold. Since the neuron has reached a certain threshold, the polarity of the membrane at the dendrite is reversed creating an action potential. The positive charge is then relayed down to the synapse causing the release of neurotransmitters into the synapse. Likewise, negative ions entering the cell have the opposite effect, making the relative charge inside the neuron more negative, consequently firing is inhibited. By introducing opsins to neurons, we can control these electrical signals using light.



Channelrhodopsin-2 (ChR2) is activated when illuminated by blue light, causing neuronal firing.

HOW CAN OPSINS BE INTRODUCED INTO NERVE CELLS?

Opsins need to be genetically modified and introduced into cells as DNA through the processes of viral delivery with AAV or electroporation. This is because opsins cannot be found naturally in nerve cells. Adeno-associated virus (AAV) gene therapy is a vector technology which involves engineering the virus so that it can be used to deliver DNA to target cells. Unlike AAV gene therapy, electroporation involves using a pulse of electricity to briefly open the pores in the cell membranes in order to deliver DNA to the target cells.

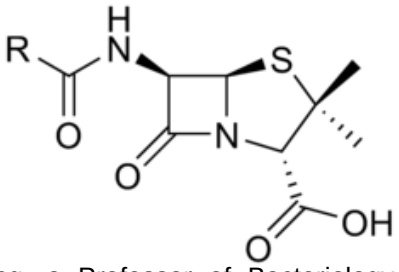
PHARMACOLOGY

Penicillin

Destiny Okonkwo

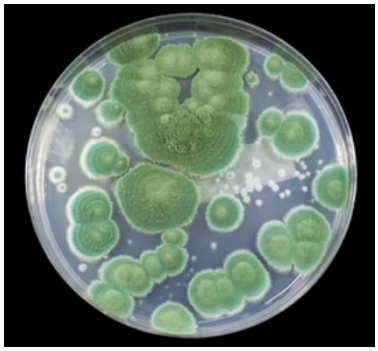
Penicillins are a group of antibiotics, belonging to the beta-lactam family, that are used to treat a variety of bacterial infections. Examples of penicillins include Amoxicillin which is used to treat ear and throat infections and Penicillin V which is used to treat bronchitis and pneumonia.

Chemical structure of penicillin



During 1928, Alexander Flemming, a Professor of Bacteriology at St. Mary's Hospital in London, experimented with the influenza virus. When he returned from his holiday in September, Fleming noticed that an invading fungus had developed in his Petri dishes containing colonies of Staphylococcus bacteria that he had been growing. He observed that there was a clear zone around the green mould which inhibited bacterial growth. In an article written by Alexander Flemming and published in 1929 in the British Journal of Experimental Pathology, he describes the colonies as being a "fluffy white mass which rapidly increases in size and after a few days the formation of spores". The accidental discovery of penicillin by Fleming, paved the way for the rise of the first true antibiotic.

Alexander Flemming



Formation of penicillin around Staphylococcus bacteria colonies

After isolating the green mould and identifying the translucent zone around the mould as a strain of Penicillium notatum, more commonly referred to as Penicillin, multiple experiments were carried out which led to the conclusion that penicillin had an antibacterial effect on staphylococci and other gram-positive pathogens. These are bacteria that turn a crystal violet colour when a Gram stain is applied, such as streptococcus, meningococcus and the diphtheria bacillus.

The conversion of penicillin from a laboratory curiosity to a life-saving drug was brought about by Howard Florey and Ernst Chain at the Sir William Dunn School of Pathology at Oxford University.

It was Florey's vital experiments on mice in 1940 that demonstrated that penicillin provided protection from infection caused by deadly Streptococci. Oxford penicillin was first administered to a human in 1941 after he had developed a life-threatening infection from a scratch he had obtained while pruning roses. Within days he made a full recovery.

Penicillin has made a significant impact, especially during the 20th century, as it drastically reduced the number of deaths and amputations during the Second World War. This was due to penicillin's ability to prevent the growth of new bacteria by inhibiting the action of the enzyme responsible for constructing the peptidoglycan cell wall. Without a cell wall, the cell bursts causing the bacteria to die. Currently, penicillin is used to treat a wide range of bacterial infections, including skin and chest infections and urinary tract infections.

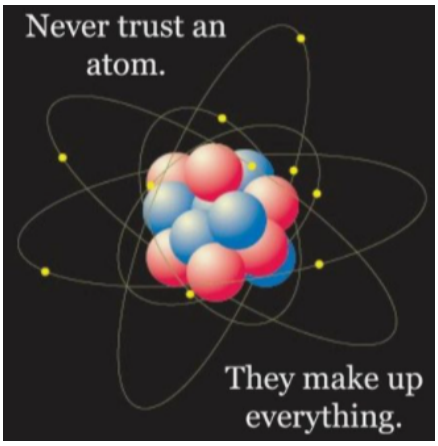
Although penicillin has proven to be very useful, there are some downsides. Some people may be allergic to penicillin, causing mild symptoms typically including hives, wheezing and swelling of the face, to more severe symptoms like anaphylaxis, involving low blood pressure and difficulty breathing. Fortunately, even patients with severe penicillin allergies are generally able to take penicillin safely, because the allergy often does not endure for life. Aside from allergies, another drawback of penicillin is the increasing bacterial resistance which therefore results in a decrease in its effectiveness. In order for bacteria to obtain immunity from penicillin, they must be able to produce the enzyme penicillinase which has the potential to degrade penicillin. This characteristic can spread throughout the bacterial population through a process called conjugation which is the temporary joining together of bacteria to exchange genetic material, the bacteria equivalent to sexual reproduction. Other bacteria can subtly change the format of the penicillin-binding proteins in their peptidoglycan wall so that penicillin can no longer bind to it.

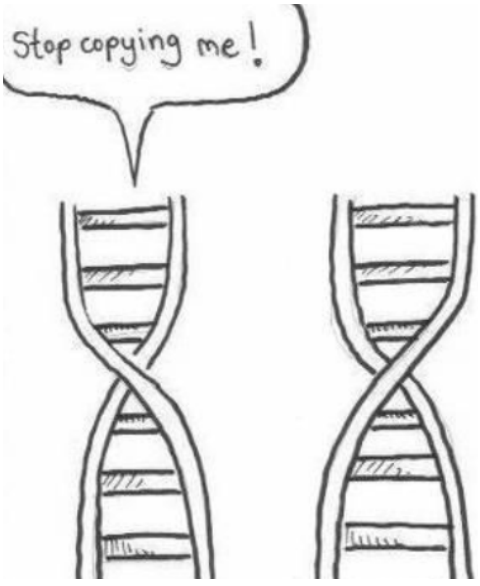
Puzzles

SODUKU:

	Ni		Cu				Fe	
	Co	V				Cu	Cr	Mn
	Ti							
		Co			Cu			Cr
Ti	Cu		Co		V		Mn	Sc
Cr			Sc			Ti		
							Ni	
Cu	Mn	Ti				Cr	Sc	
	Cr				Fe		Ti	

Solve the chemistry soduku to win a reusable Periodic Table cup! Submit your answers to brown.isobel@bro.gdst.net or bhatnagar.tara@bro.gdst.net





DID YOU KNOW?

Plants talk to each other

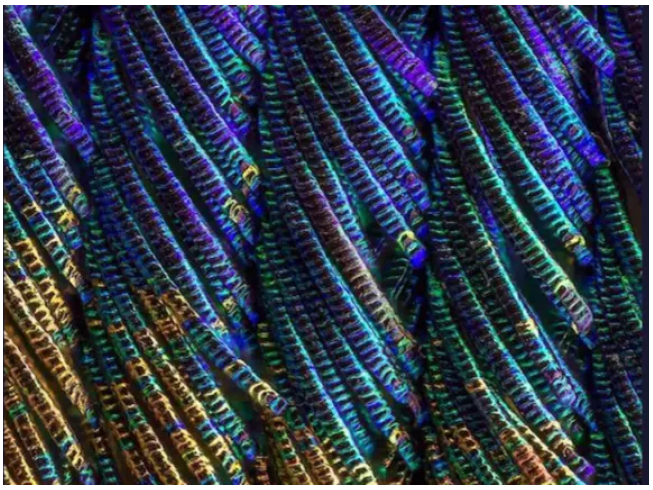
Yes, it is true. There are multiple ways in which plants communicate with one another. Plants use their roots to 'listen' to their plant neighbours, they also brush against each other in order to alter their growth strategies depending on their environment. Another way in which plants communicate is by releasing aromas in order to alert other plants know that they are under attack from insects.

DID YOU KNOW?

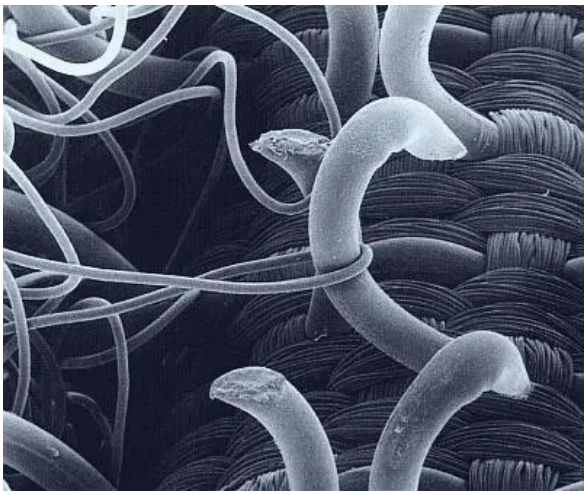
There is a species of fish that can walk on land.

'Mudskipper' is a species of fish which has the ability to live three quarters of its life on land. The reason for this is because this species has adapted to living, mating and eating on land. These fishes spend a lot of time out of water and have also adapted their shoulder joints as well as their fins which allows them to jump, swim and walk!

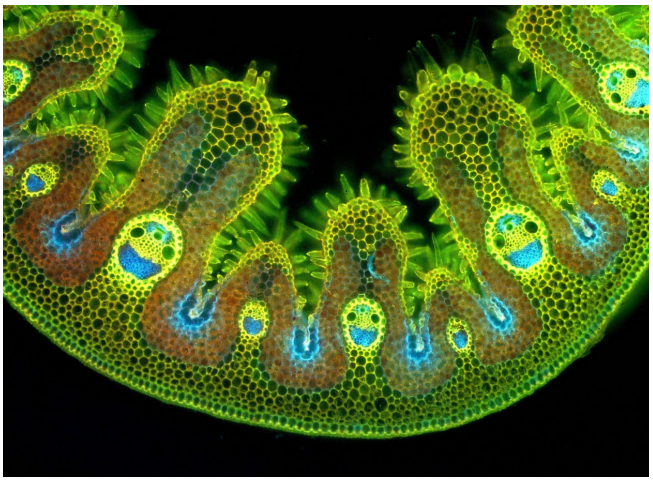
What is Under the Microscope?



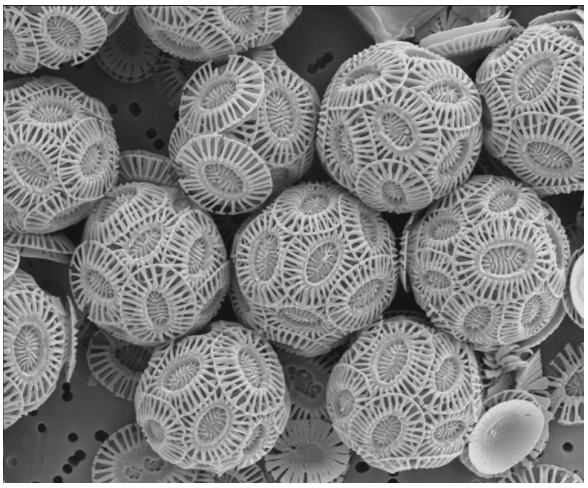
A. A roll of yarn
B. A peacock feather
C. Bed sheet



A. DNA strand
B. Pasta
C. Velcro

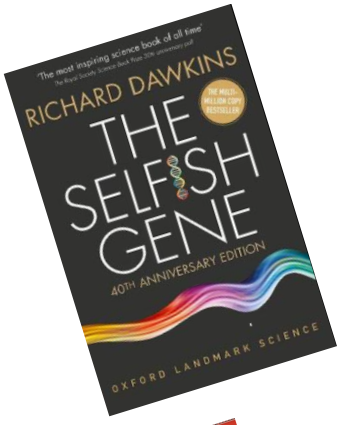


A. Grass
B. Tennis ball
C. Watermelon rind

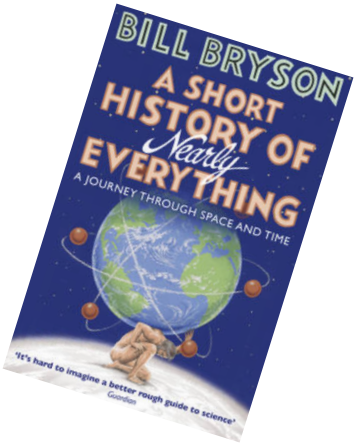


A. Bubble wrap
B. Chalk
C. Golf ball

Recommended Reading

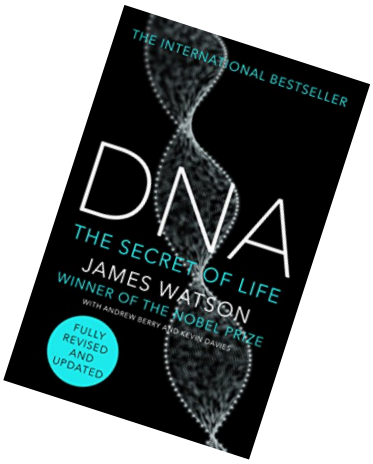


The Selfish Gene - Richard Dawkins

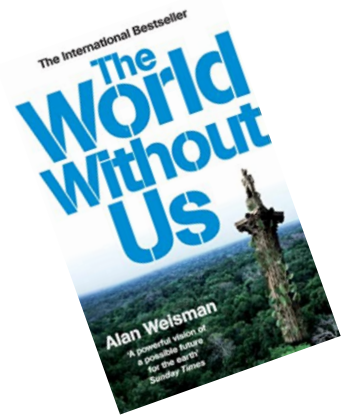


A Short History of Nearly Everything
- Bill Bryson

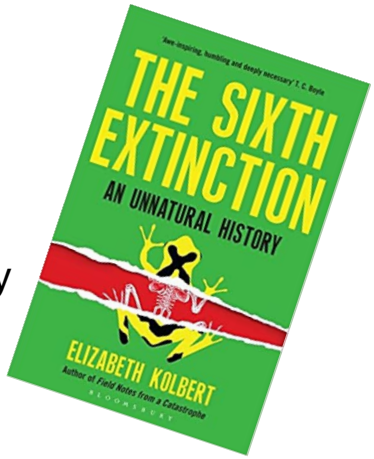
Humble Pi - Matt Parker



DNA: The Secret Life
- James Watson



The World Without Us
- Alan Weisman



The Sixth Extinction, An Unnatural History
- Elizabeth Kolbert

Competition:

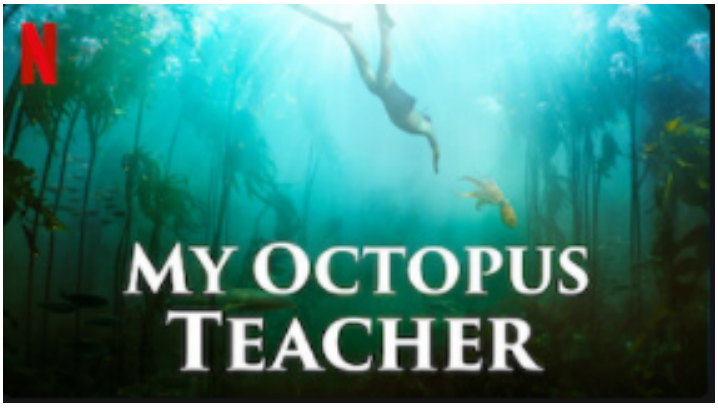
Write a book review for any of the above books and all entries will receive house points. The winning book review will receive bonus house points!

Recommended Watching

Human - The world within:
This documentary series gives you an insight into the functions of your body's complex systems and how we respond to the world around us.

Night on Earth:
Discover the hidden lives of animals across the globe.
From night goggles to camera technology, we can observe how nature and wildlife behaves at night.

My Octopus Teacher:
The story of how a filmmaker formed an unforgettable bond with an octopus in a South African kelp forest. An underwater adventure of a lifetime.



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