‘Gifted and Talented’ Biology Articles

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Teacher's Introduction

This resource is a set of 26 short articles that are designed to stretch the more gifted p

There is far too much demand on a teacher's time to differentiate every lesson. So, d needing additional challenge are often asked to complete more of the same type and These short articles, targeted at high-attaining KS3 pupils, aim to give them somethi they can be used as a basis for further research.

Although there are many ways in which these articles could be used, I have found th kept in the classroom, as the more gifted pupils complete work early or find that the explanation or consolidation, and therefore I am able to direct them to the relevant then spend time reading and digesting the information whilst I help other pupils, pr consolidation and answer their questions without boring those who have already un Depending on the amount of time, pupils read the article and discuss the questions i present the information to the rest of the class, sometimes along with their own furt made available.

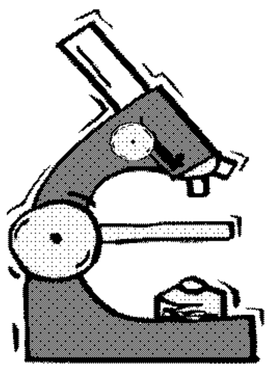
There are wide ranging areas of interest represented including those relating to:

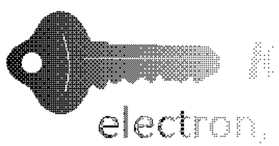
- Environmental concerns (e.g. using lichens as air pollution indicators)
- Worldwide citizenship concerns (such as the impact of cholera in the developing
- Past and future scientific advances (development of the classification system and p
- Every child matters aspects (keeping healthy)
- Some career ideas (such as medical and veterinary related careers)
- Relevant industrial techniques (like microscopes and the polymerase chain reactio

They are aimed to extend a variety of thought processes and skills sets including app analysing data and ethical considerations.

Microscopes

Microscopes used in schools are called light microscopes because it is the light passing through the sample that allows it to be seen. Light is a form of radiation that travels as waves and passes through the sample. However, light microscopes are limited to magnifying up to 1,500 times and i more detail a much higher magnification is needed. In 1931 tw and Knoll, developed the first electron microscope. It actually at the time but two years later Ruska developed another electr higher magnification. Today's electron microscopes, which ca times, are still based on Ruska's original idea.

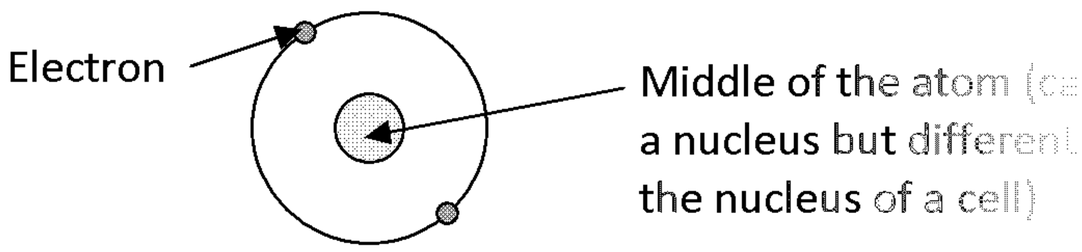




A
electron,
scanning

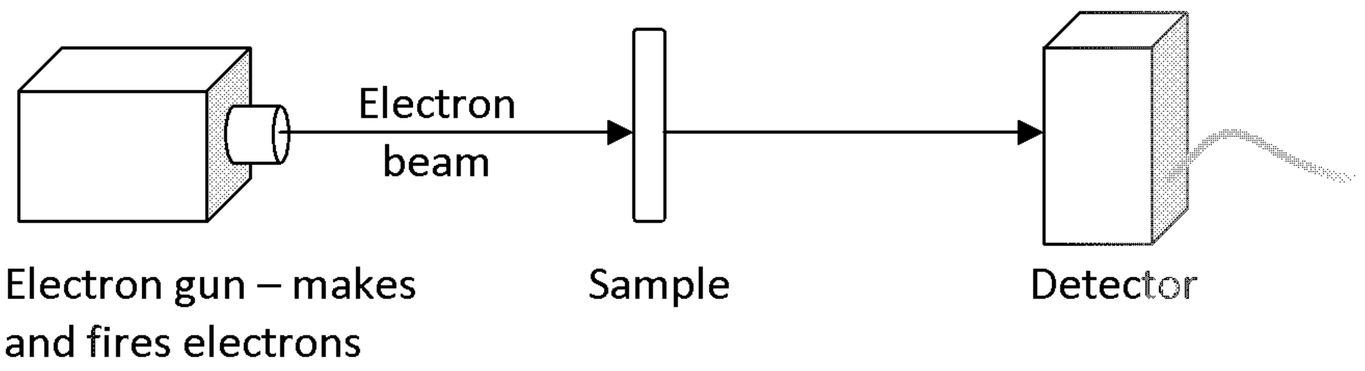
What is an electron?

Electrons are tiny subatomic particles, that means they are smaller than atoms particles that make up all substances). In fact, they are found inside all atoms made to separate from an atom with an electron gun. Electrons are actually p than waves but they are so tiny they can still pass through a sample.



Electron microscopes

Electron microscopes use a very narrow beam of electrons fired at a sample. using lenses just like light has to be focused in a light microscope. When the change because they lose energy. These changes can be detected and interpre



There are two main types of electron microscopes: transmission electron mic electron microscopes.

Transmission electron microscopes (TEM)

In a TEM the electrons are fired at the sample and some are stopped by the s through. The ones that pass through carry information about the sample, bec energy. These electrons are detected by the microscope and the information be looked at.

Scanning electron microscopes (SEM)

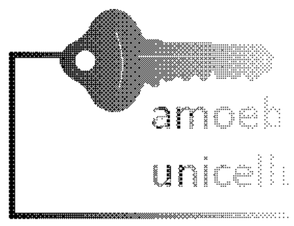
In a SEM the beam of electrons scans across the sample. When electrons hit electrons to be knocked off the atoms in the sample. These electrons are dete the information is interpreted into an image to be looked at.

Task

Describe the similarities and differences between a light microscope that you use microscope.

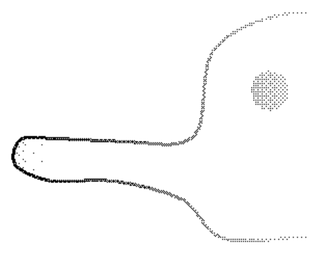
Cells

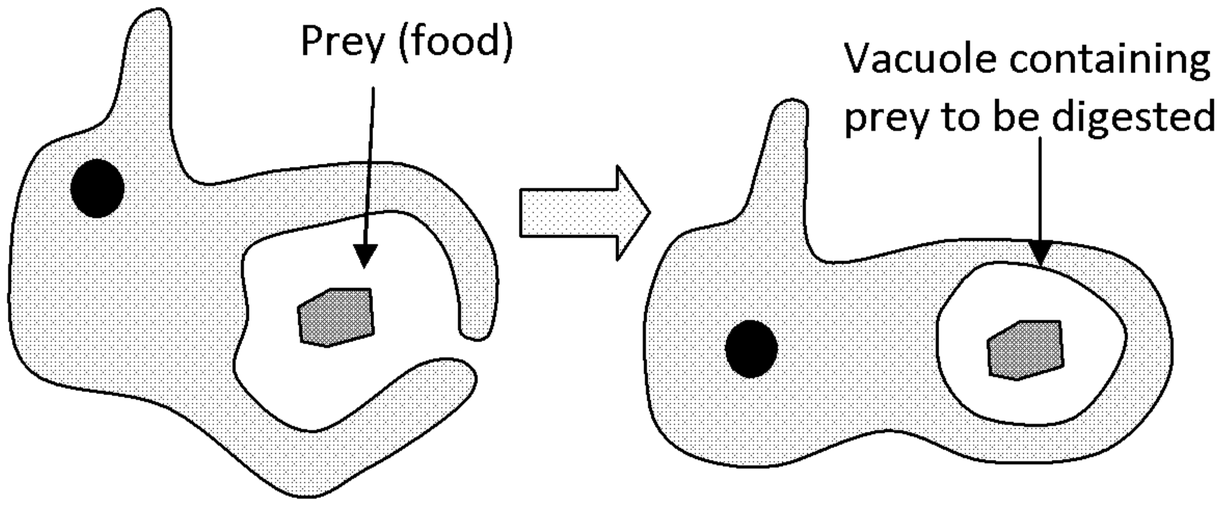
Amoeba are tiny unicellular (one-celled) living organisms. There are many different species (types) of amoeba but they are all characterised by their ability to change shape. They can change shape effectively because they have a very flexible cell membrane. Giant amoeba can grow up to 3mm in size, for exam most types do not get any larger than half a millimetre.



The key characteristic of amoeba is the formation of pseudopodia or 'false fe generally only form one pseudopodia at a time, these type of amoeba are call however, form many and these are called polypodial. Pseudopodia have two move and to capture prey for food. The pseudopodia are formed as the cytop changes shape; they are long projections like an arm or leg.

Amoeba move in response to chemical stimuli – they detect a particular chemical and either move towards it or away from it, depending on whether it is released by food or by a threat. The pseudopodia allow the amoeba to move as it uses them to propel itself through water. The cytoplasm in amoeba can actually change from a liquid to a more gel-like, almost solid, substance. By forming the pseudopodia and changing their cytoplasm from liquid to gel they are able to move themselves along.





Amoeba need living organis forming pseud envelop or eng

They will then and excess wa 'packets' surro

Amoeba can reproduce by simple division – they replicate their nucleus and internal parts of their cell and this is process called mitosis. Then the cell mer pinches inwards so that the single cell becomes two separate cells which are daughter cells.

There are many different species of amoeba which all form pseudopodia in or are called shelled amoeba because they use bits of substances around them, e.g. shell which is called a test. There are also some amoeba that cause disease in h parasitic amoeba. For example, *Entamoeba histolytica* is found in raw sewage can cause dysentery – an infection of the gut that causes diarrhoea.

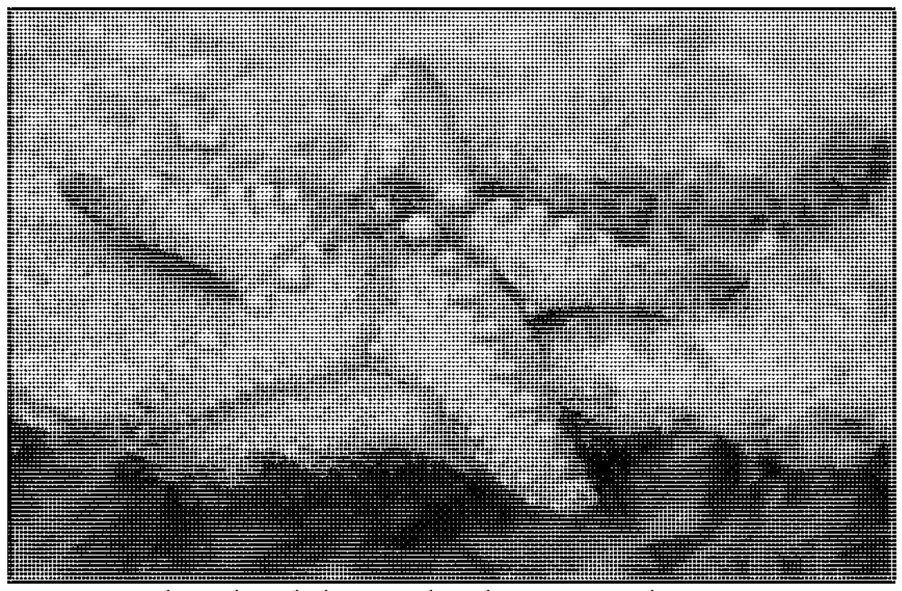
Task

Using the seven features of living organisms, describe why amoeba are classed a

Somewhere along the evolution line mammals lost the ability to regrow severed limbs (arms and legs). However, many other types of animal can regenerate limbs and two examples are starfish and lizards. Scientists are doing a lot of re- regenerating limbs because it has great potential for human beings who have l

Key
regenerate, e

The common starfish



In scientific circles starfish are act they are not, in fact, fish. The co 30cm in diameter and has five ar of sea star grow up to 50cm in di or even 40 arms. The common s Atlantic around rock pools and b that eat mussels, crustaceans, oth- They have tube feet that 'suction sea floor to allow them to move arm in an attack by a predator or grow it back although this is a slow process that takes up to a year to complet- lost arm as long as the central part of the body is intact. However, there are a an entire sea star from a single severed arm if there is a small amount of the co produce the new limb the sea star cells divide and divide to produce enough arm. These cells will be changed to adapt to different roles within the arm so the specialised cells necessary to do its job.

Lizards

Lizards are reptiles and there are lots of different species, many of which live warm climates. Many lizards can escape predators by breaking their tail off at particular point, this process is called autotomy. If caught by the tail the lizard break off the tail and get away to avoid being eaten. Sometimes the tail also provides a distraction to give the lizard time to escape so it may be dropped o if the lizard is not caught by the tail. The skin, muscle, bone, blood supply an nerves all break at a predetermined point below the reproductive organs. Afte the break, bone will be visible and over a short space of time the muscle cells divide so that the muscle grows over the end of the stump. The process is na but is also stressful for the lizard and a lot of energy will be required to regrow the tail. Some lizards also have fat stores around their tail so they may have lo some of their energy reserves. The whole process of losing a limb is dangerou the animal because there is a high risk of infection. It is also possible that a liz will struggle with balance having lost its tail which makes it more vulnerable the future.

Task

What if scientists manage to get humans to regenerate limbs?
What impact might that have on medicine and on society?
What would the advantages be?
What would the risks be?

Reproductive Cells and Orga

There are many variations on reproduction within the animal kingdom. Fertilisation can take place internally (inside the body) or externally (outside the body). There are general rules that can be applied to different animals but there are always exceptions!

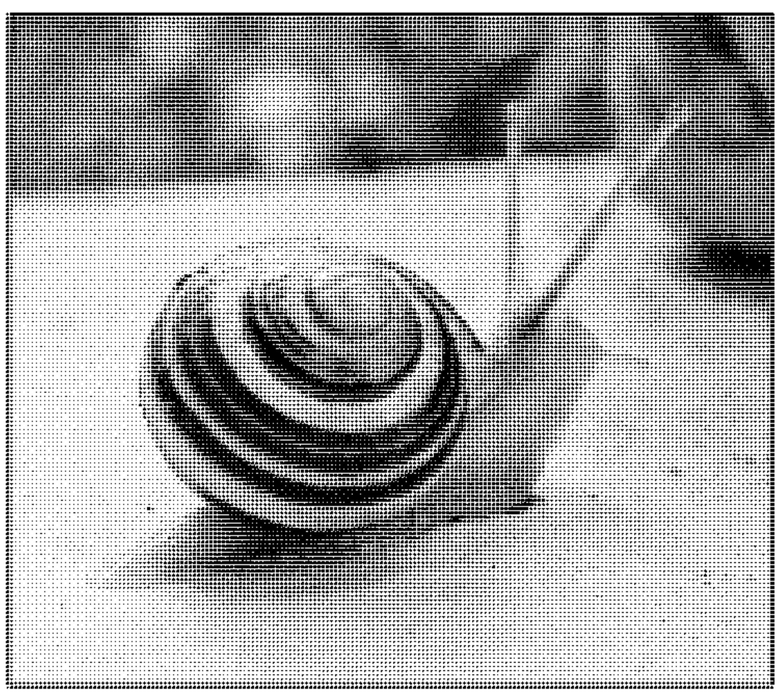
Seahorses

Seahorses are unusual because it is t
pregnant. The female seahorse inse
male seahorse and delivers the eggs
fertilised within the male and hatch
The pregnancy lasts a few weeks dc
during this time the male seahorse
of salt in his brood pouch. He slowl
as the eggs mature until it reaches t
around it before the baby seahorses

Duck-billed platypus

The duck-billed platypus is unusual because it is a mammal that lays eggs. Th
eggs are thin and leathery – more like lizard or snake eggs than bird eggs. Th
eggs develop inside the mother (called *in utero*) for about 28 days, then they
are laid and the mother incubates them for a further 10 days. Once the eggs
hatch the young are fed from the mother's mammary glands (which produce
milk) but the mother has no nipples – the milk is secreted through pores in
the skin of the belly.

Common land snails



Common land snails, like all land snail
means they have male and female sexu
sperm and eggs. There is a ritual court
hours. Eventually one of the snails wil
with a solid, calcified (a little like bone
process of sperm swapping. Each snail
organs outwards and deposits sperm in
occurs within the snails and about 100
eggs are laid in damp soil in undergrou
about two weeks. The snails are born
that will harden over time as they beco

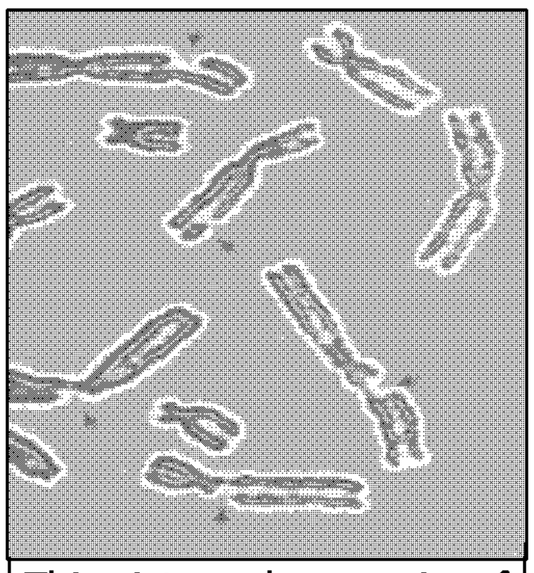
Task

For each of these animals what advantages are there for their method of reprodu

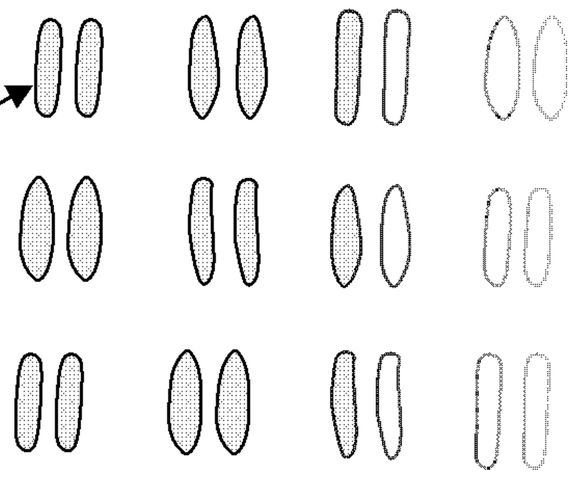
Development of Baby

Key words
DNA, chromosomes, gene

DNA stands for deoxyribonucleic acid and is a very large molecule found in the nucleus of plants and animals. DNA in each human cell codes for all the information needed to make a human being, information about the colour of eyes and hair. The DNA in each human nucleus which are each wrapped particles, for example proteins. Once the DNA molecule with the proteins they are known as chromosomes. paired up to make 23 pairs of chromosomes. The the nucleus is different for different animals and plants be divided into sections known as genes, each gene feature, for example colour of eyes. These 23 pairs the genetic material.



This picture shows pairs of chromosomes, some are damaged and therefore are not complete



A DNA molecule wrapped up with proteins is a chromosome. There are 23 pairs of chromosomes in humans.

The 23rd pair of chromosomes is differ because it determines the sex of the XY and is found in men. If they were t be called XX and this would be female

When sperm and eggs are produced they only have half the genetic material being. Each cell will have one of the pair. This means when a sperm and egg full amount of genetic material needed with half of each pair being contribut the father.

The 23rd chromosome pair is the one that tells the baby to develop as a boy or girl. The egg cell will always carry an X (a 'normal' sized chromosome) because females only have X chromosomes. The sperm cell could carry either an X or a Y chromosome (a shortened chromosome). If the sperm that fertilises the egg contains an X chromosome the baby will be a girl, if it contains a Y chromosome it will be a boy.

A mistake in any one of these chromosomes could lead to a genetic disorder or could be so severe the baby does not survive.

Task

Can you explain how non-identical twins could be a boy and a girl in terms of the Where do they get these chromosomes from?

Puberty and Menstrual Cycle

Key words
castration, spaying, neuter
oestrogen, ovary, testes, a

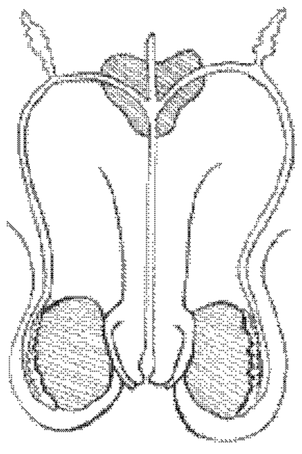
Many dog owners make the decision to have their pet dogs neutered. Male dogs are castrated and female dogs are spayed. This may be done for a number of reasons. In male dogs it is often done to reduce over sexual behaviours such as mounting, dominant or aggressive behaviour as the dog tries to become the 'leader of the pack' or territorial behaviour like 'marking' using their urine. These behaviours are at least partly caused by the hormone (chemical messenger) testosterone. Owners of female dogs are often concerned that their bitch may become pregnant with unwanted puppies. The hormone oestrogen helps to prepare the uterus lining for implantation of a fertilised egg.

Neutering of both male and female dogs usually takes place after the 'puberty' because the hormones testosterone and oestrogen are very important for the d adult so it is safest to wait until after growth has finished to remove these hor

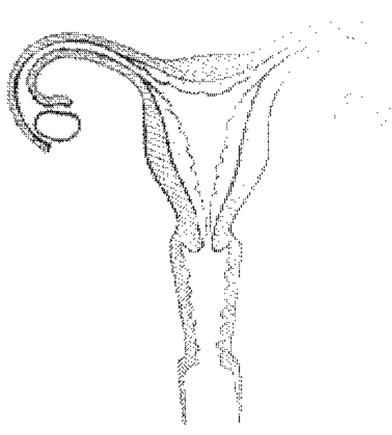
The surgery
Before the surgery both male and female dogs are given a pre-med which is a combination of a sedative and painkiller and reduces the amount of anaesthetic th be given. They are then given the general anaesthetic which makes them fall unconscious. A tube is passed down their wind pipe to pump air and anaesthetic their lungs.

The anatomy of dog reproductive systems is not that different to human anat

Male:



Female:



Male dogs have their testes removed as these are responsible for releasing the done by shaving and cleaning a small area of the scrotum, then the testes are p small incision is made so the testes can be pushed out. The blood vessels are t and the testes removed.

Female dogs have their ovaries removed – these produce the hormone oestroge abdominal cavity, their ovaries are located and the blood vessels supplying them located and the blood vessels tied off. Now the ovaries and uterus can be remove cannot become pregnant. The female castration surgery is much more invasive th

After surgery male and female dogs are given an injection of anti-inflammato painkillers and another antibiotic injection to prevent infection.

Task

How does the surgery affect the hormone levels in male dogs and female dogs? H being produced?

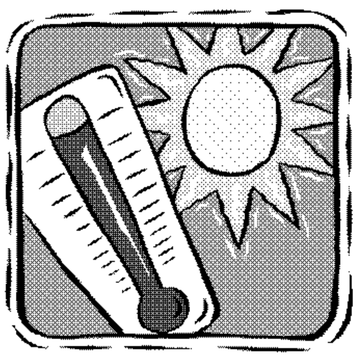
Adaptation and Habitats

Extremophiles are microbes (microscopic organisms) that survive in extreme conditions that would kill most living organisms. There are many different extreme conditions that extremophiles have been found living in, for example:
thermophiles = heat loving
psychrophiles = cold loving
acidophiles = acid loving
alkaliphiles = alkali loving

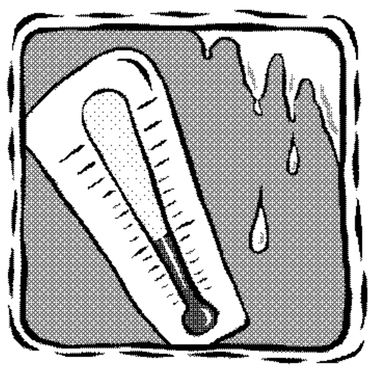
Key
extremophile
acidophile, a

A lot of scientific research involves these extremophiles because they could p breakthroughs for science and industry.

All organisms contain special chemicals called enzymes which make reactions most living things these enzymes work best at temperatures between 20°C an cannot survive in extreme temperatures. However, thermophiles and psychro work in very high or very low temperatures.



Thermophiles can thrive in temperatures above 45°C an hyperthermophiles can survive comfortably above 80°C even over 100°C. One thermophile called *Thermus aqu* contains an enzyme that is used in DNA fingerprinting – forensics procedure for identifying criminals. The enzym called taq polymerase is used in a process called the poly chain reaction which takes a very small sample of DNA copies it over and over so that it can be worked with.



Psychrophiles thrive in very low temperatures, too high (for example, over 12°C) stops the psychrophiles reprod possible that there could be enzymes that can be used fo manufacturing refrigerated foods. The food could then b without having to raise the temperature and risk spoilin

Extremophiles living in extremely acidic or alkaline conditions have to surviv alkali outside their cells because the extreme pHs might damage the DNA in

Acidophiles might provide enzymes that can work in th stomach, whilst alkaliphiles might be useful in detergent are alkaline to dissolve oily stains and enzymes that work be added to get rid of food stains.

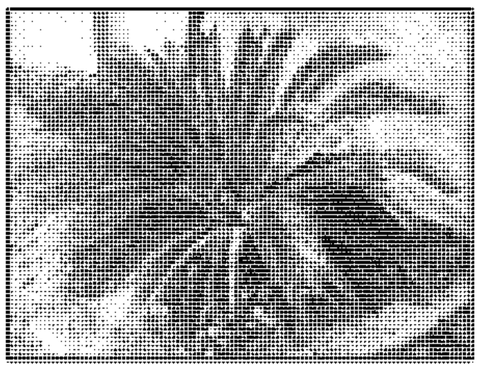
Task

What could have happened to humans if we had developed enzymes like some o in extreme temperatures and pHs?

Feeding Relationships

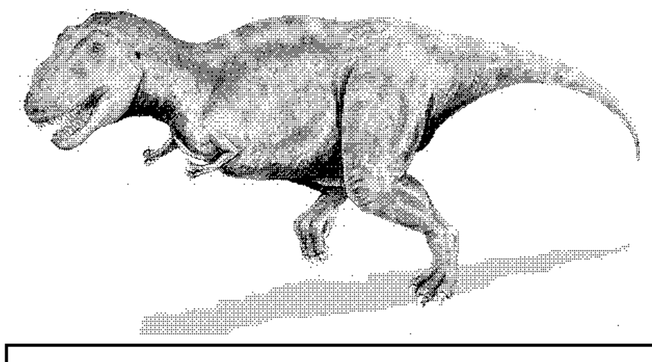
Millions of years ago dinosaurs dominated the earth and mammals were small and much less prevalent than they are now. It is possible for scientists to find out a lot about what these dinosaurs ate from fossils of their jaws. A suggested food chain might be:

Cycads → Triceratops → Tyrannosaurus rex



Cycads are plants known as 'living fossils' because the have changed very little, if at all, over millions of yea found that are 280 million years old.

Triceratops was a herbivore, eating only plant material. They had quite blunt teeth that were good for stripping leaves off plants and flat teeth for grinding up the tougher bits of plant material.



A sketch of what a tyrannosaurus rex probably looked like

Tyrannosaurus rex was a carnivore, eating energy. They had flat incisor teeth at the sharp, serrated teeth down the sides. Thei up to a one metre wide gap. Their jaws w enough to rip another dinosaur apart and some controversy over whether the T. re for its food, or a scavenger that ate dinosa other predators.

Duck-billed dinosaurs, called hadrosaurs, had long been a point of confusion for scientists. It was unclear how they actually managed to eat as they did not have a jaw like mammals do – there was no joint between the lower and upper jaws that would allow them to chew. However, they were the dominant herbivores on Earth for a long period of time so they must have been very successful. Scientists have recently discovered that they did have a joint in their jaws but not between the lower and upper jaws, the joint was between the upper jaw and the rest of the skull and this allowed them to grind up their food. It is thought that they would have mainly eaten a plant called horsetail –there was a lot of this around at the time when hadrosaurs were common. Also there were minute remains of hadrosaur teeth which indicate they probably took in a lot of grit low growing plant (near to the ground), and animals eating plants like these grit along with the plant itself.

Task

What do you think human teeth say about the human diet?

Variation

Key words
hybrid, fertile, offspring, species, characteristic

Members of the same reproduce to make fe children are able to gi unusual for animals to mate with animals outside their own species it does hap cases zoos have deliberately encouraged it and there are ethical questions surr cases it has just happened – both in captivity and in the wild.

Examples of hybrids (produced from cross-species reproduction) include liger hebras; zeedonks; beefalo; wolphin.

Ligers are produced when a male lion mates with a female tiger. Hercules was a particularly large liger born in 2002 – at three years old he was already 10 foot tall on his back legs and was expected to reach up to 90 stone in weight. When a male tiger mates with a female lion (the reverse) a tigon is produced – these tend to have less lion-like characteristics. Neither the liger nor the tigon are fertile, so they can only be produced by the mating of lions and tigers.

The zorse is a hybrid of a male zebra and a female horse. They tend to be 2– and have been bred in Africa to act as trekking animals for carrying heavy loa base colour from the horse and get stripes from their father – however, in 20 Eclyse, born in Germany that did not have the normal colourings. Eclyse had pure white main body with another striped section on the back left leg – a ve that clearly showed the inheritance from both mother and father. Zebras can a male zebra and female donkey is known as a zeedonk.

Generally, when two animals that are not from the same species produce offs further offspring, however, occasionally it is possible.

Beefalo are a hybrid bred for meat – a cross between a bison and cattle that g quality of the bison with the ease of handling and milking of the cow. Althou the crosses correct, beefalo nowadays (of about three eighths bison and five e reproduce.

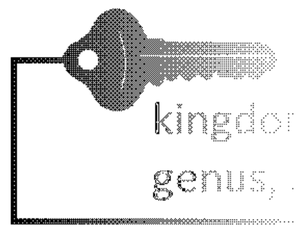
This is Kawili Kai – offspring of Kekaimulu

The wolphin is another, very rare, hybrid that bottlenose dolphins mate with a false killer wh dolphin). For example, Kekaimulu born in H have offspring. This is perhaps because the ge parents is quite closely related.

Task

How could agriculture change in the future if farmers and scientists are able to su can reproduce?

Classification of Animals

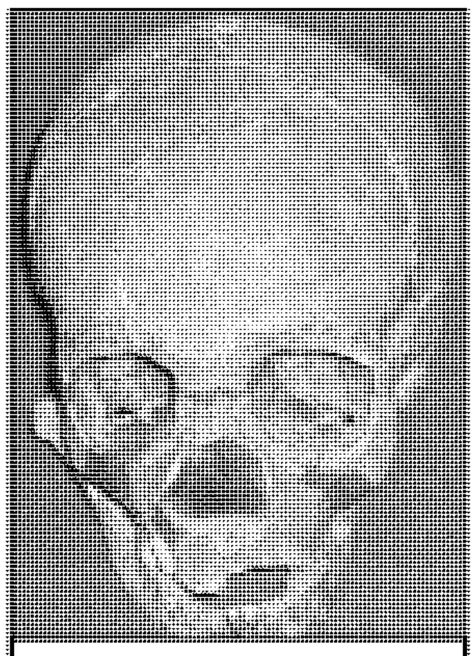


In the eighteenth century Carl Linnaeus, a Swedish scientist, developed a system for classifying all living organisms. Prior to his work, the identification of living things was disorganised and confusing, scientists often had to work from descriptions that were not always easy to distinguish. The system that Linnaeus proposed has additions but it remains fundamentally the same and Linnaeus is known as the 'fa

The classification system involves a hierarchy of groupings that becomes more going down the hierarchy:

Hierarchy of groupings	Humans as an example
Kingdom	Animalia
Phylum	Chordata
Class	Vertebrata
Order	Primata
Family	Hominidae
Genus	Homo
Species	Sapiens

This classification is for human beings, also known as *Homo sapiens*. Original humans were the only living animals included in the hominidae family, alongs with extinct ancestors. However, the classification system is fluid in nature an more recently gorillas, orang-utans, chimpanzees and bononos have been included. This is because as technology has developed it has become increasingly clear that we are very similar to these other primates on a molecu level (i.e. in DNA). Humans actually share 98.8% of their genes with chimpanzees and 98.4% with gorillas.



Skull from a Neanderthal boy found in Teshik Tash

The classification system can also be used to classify example, Neanderthals were primates that evolved a ago. They were able to make complex stone tools a but died out not long after *Homo sapiens* arrived in has been much research surrounding the reason for t simply been that they could not compete for resour other scientists suggest it was a more violent end an Neanderthals are sometimes classified as a separate sp genus: *Homo neanderthalensis*, and sometimes as a s *Homo sapiens neanderthalensis*.

The classification system is still constantly adapting t discoveries, whether these be related to extinct orga discovered species.

Task

If you were to try and design the classification system from scratch, given everyt animal now – including their DNA, how would you consider arranging all living th

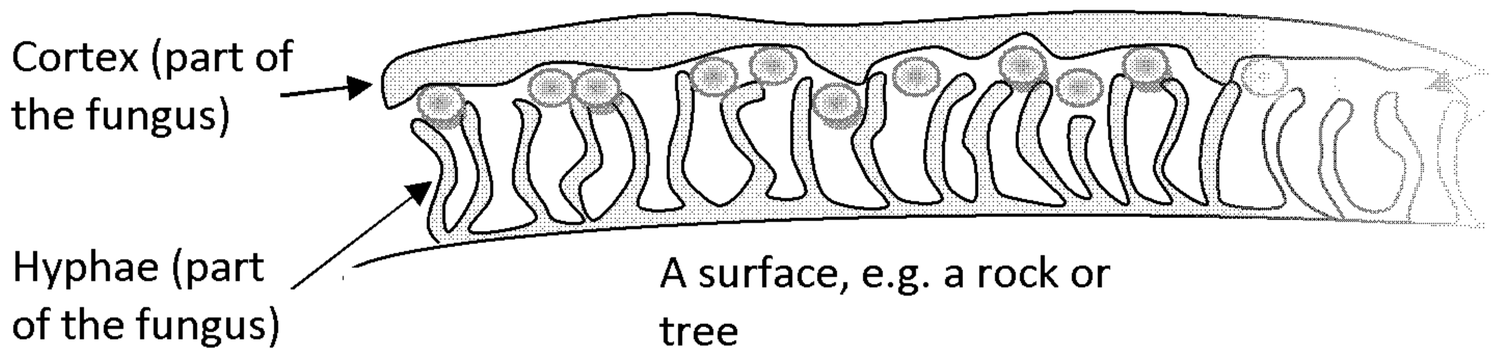
Classification of Plants

One of the more unusual organisms that are often thought to be plants are lichens. These are found on rocks, trees and in soil and are able to survive in virtually every habitat on the planet – they are the dominant vegetation found in the Arctic and Antarctic. They are not actually just a plant, they are a fungus (which is a simple plant) – the fungus cannot actually survive without its relat

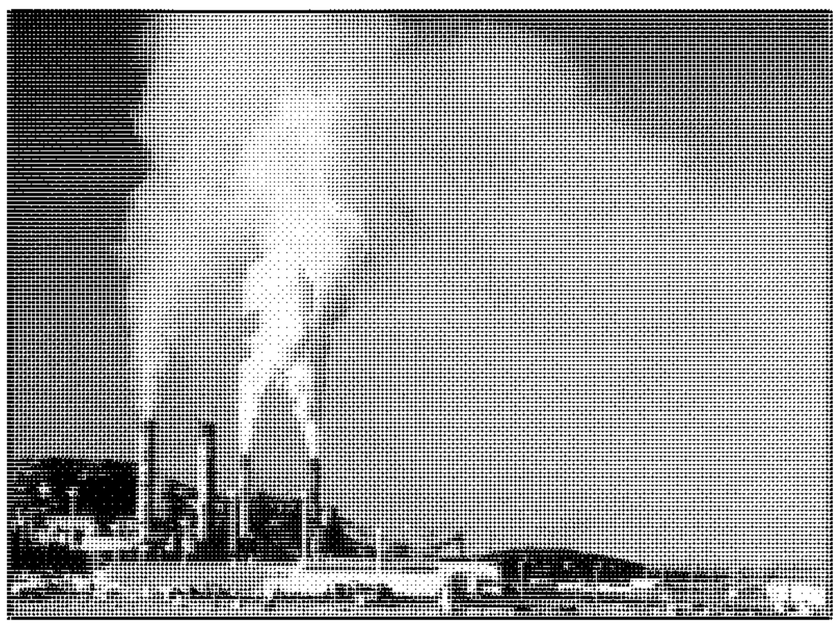
Ke
lichen, alg
fungi), spo

The lichen can reproduce in two ways: firstly, when part of the lichen breaks elsewhere. Alternatively, the fungus can produce spores (which are a bit like s structure) which can combine with algae to germinate and produce new liche

The fungus is unable to photosynthesise so the alga, which can photosynthesi the sugars it needs for growth. In return the fungus forms a layer around the a low or high temperatures and from droughts. There are many variations in th produce but the following diagram shows the general idea:



Lichens have many uses including the preparation of litmus indicator that is u acids and alkalis. This is because lichens can act as dyes and will form differen It is because lichens can be many colours that humans have long used them as etc.



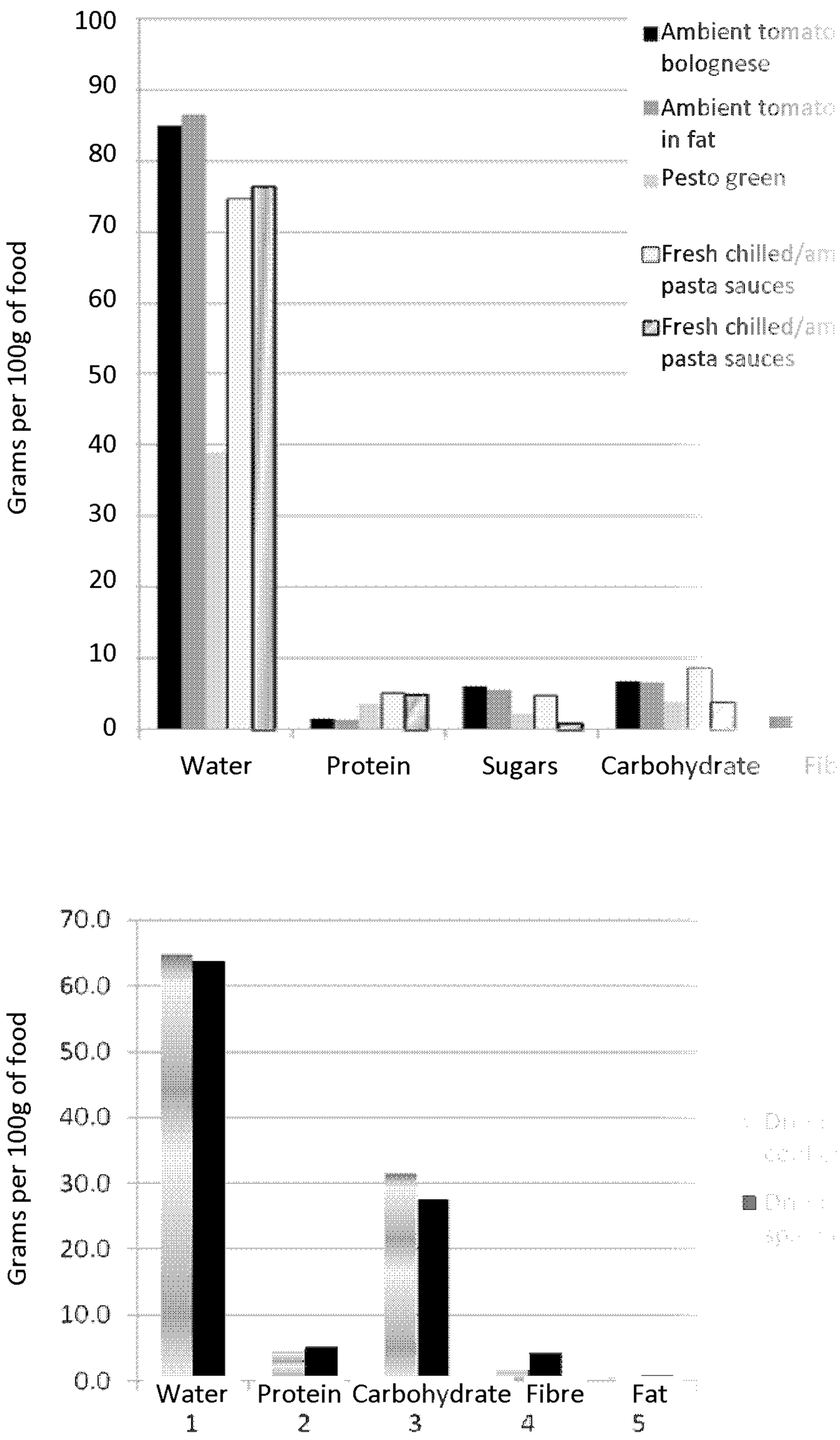
Lichens absorb water from the atmo very vulnerable to air pollution. The pollution and lichen populations wa 1800s. There are many research pro diversity of lichens (the number of s the level of air pollution. This is bec different degrees of sensitivity to dif at the amount of each species provid the amount and type of pollution p particular many lichen are sensitive this is produced whenever coal or o by many different industries. Lichen that grow on trees or plants are best for s that grow on rocks or soil may be influenced by other forms of pollution fou metals.

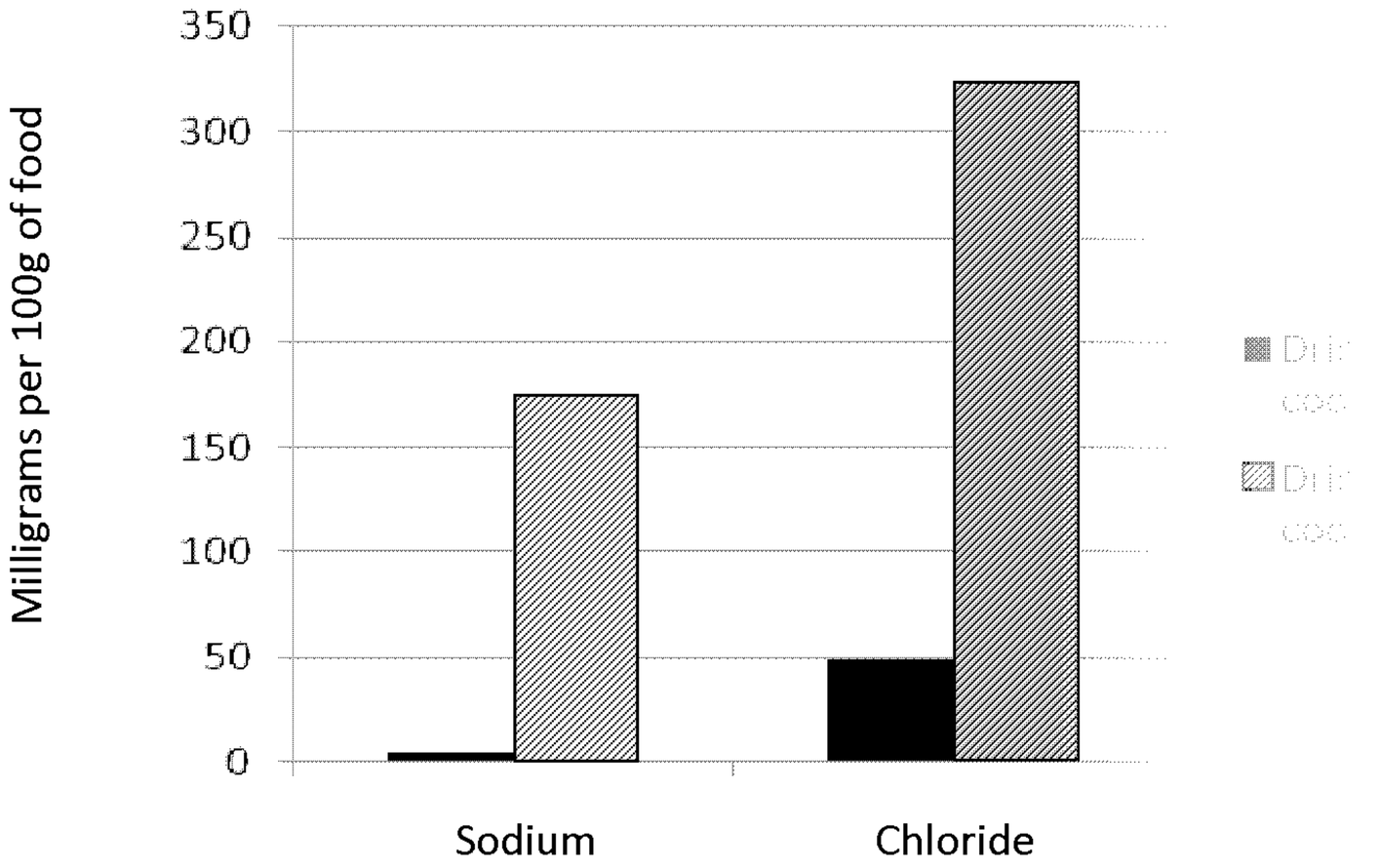
Task

The relationship between the fungus and the alga is called symbiotic (both gain fr explain why this term is used to describe this relationship?

Food and Food Tests

The Food Standards Agency regularly carries out tests on food content to assess the accuracy of labelling and to allow clear comparison between different types of a food. The FSA carried out research recently into pasta sauces and pasta to compare the nutritional co





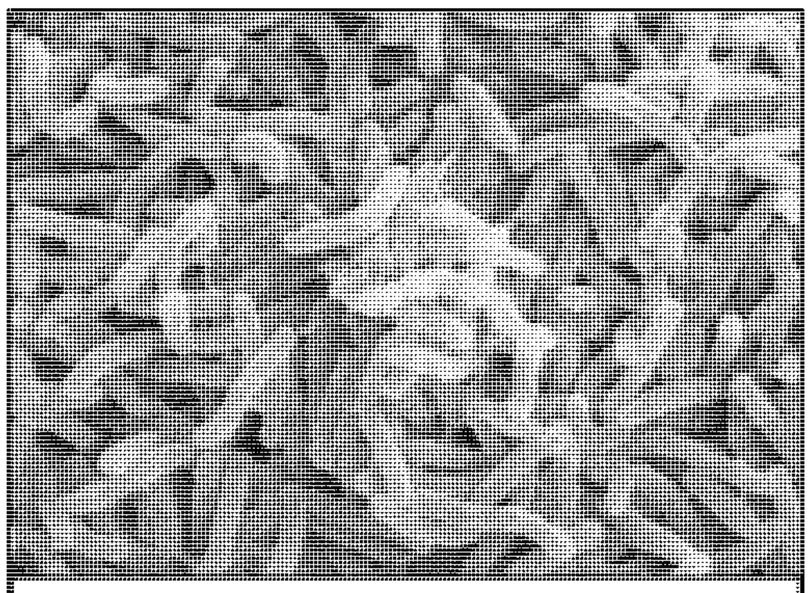
Task

What conclusions could be drawn from each of these graphs?

The Human Body – The Digestive S

Cholera is an acute intestinal infection caused by the bacteria *Vibrio cholerae*. It has a short incubation period (that means a short time from picking up the bacteria to symptoms) and can be rapidly fatal but is very easily treated. The bacteria is transmitted by the feco-oral route (from faeces then in areas where the drinking water supplies are dirty and unsanitised.

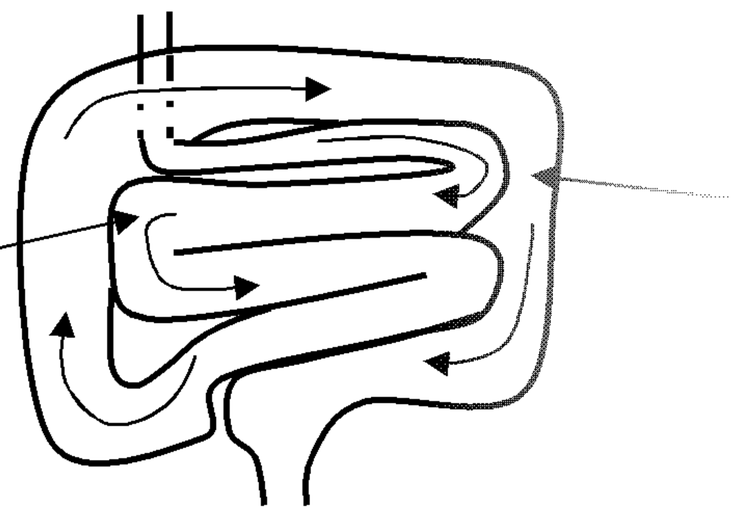
Key
bacteria, ch
diarrhoea, d



Vibrio cholera

Food or water containing the bacte bacteria passes through the digestive small intestines along with the food enterotoxin that causes the small in onto the food inside. The large int water from the food but the large a the small intestines overwhelms the diarrhoea – very watery faeces.

The toxin from the bacteria causes water to be released onto the food in the small intestines



The symptoms include severe diarrhoea, dry skin, dry mouth, thirst, lack of e The reason that this disease is fatal is dehydration – the body loses so much w cannot survive. This means that it is extremely easy to treat, sufferers need to replace the water that has been lost. This is usually done orally (through the m fluids can be pumped directly into blood vessels.

The fact that it can be prevented by providing clean water supplies and is rel cheap and easy to treat makes the number of deaths surprising. According to t World Health Organisation, in 2005 there were 131,943 cases reported and 2 deaths. 125,082 of these cases and 2,230 of these deaths were reported in Afri

Vaccines have recently been developed that help people to fight off the infec developing. However, they are not yet widely used in the areas that most nee

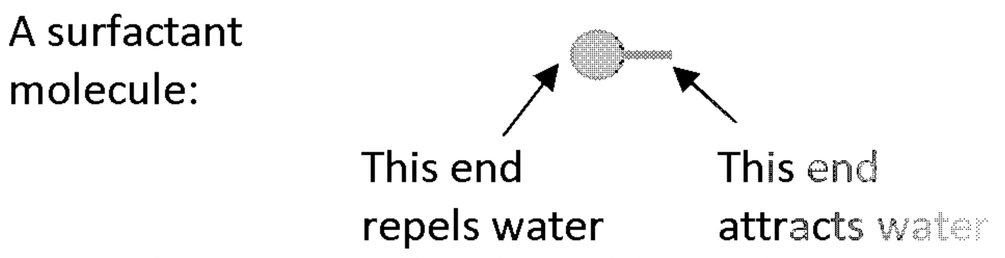
Task

Can you explain how the bacteria cause death?
What do you think could be done about deaths from cholera?

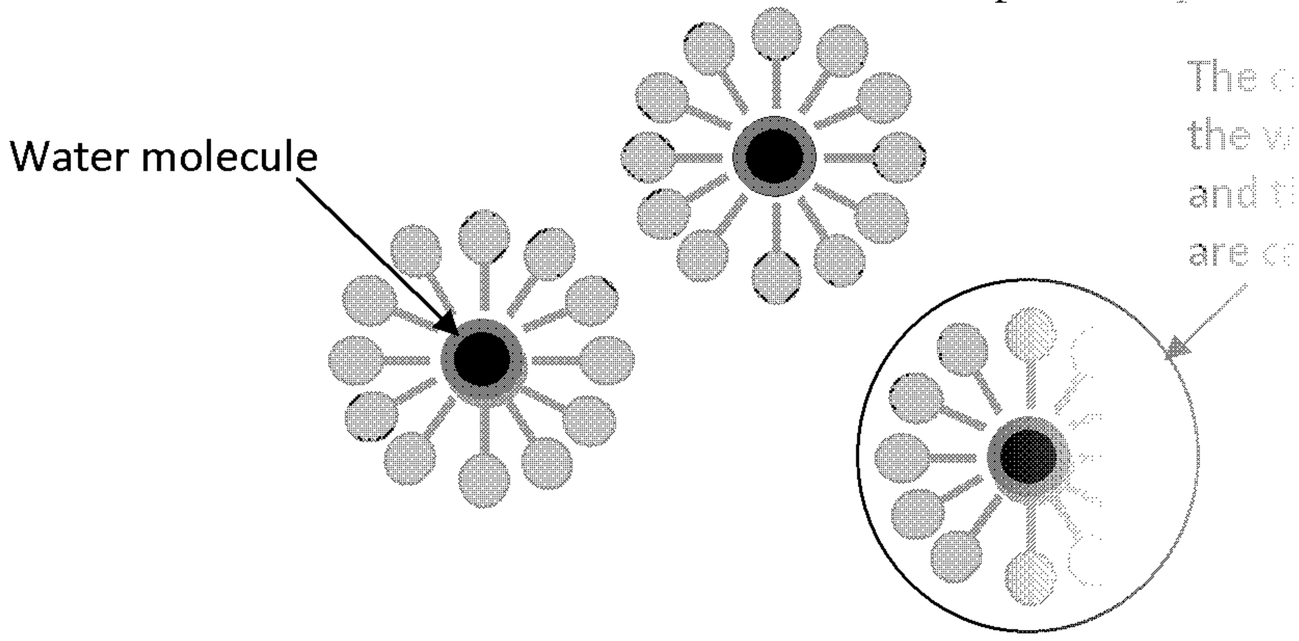
The inside of the alveoli (air sacs) in our lungs is moistened with a small amount of liquid so that gases can dissolve. The moist inner lining would stick to itself like the inside of a wet plastic bag if we did not have a liquid called pulmonary surfactant. This is found in our lungs and prevents the alveoli from

A surfactant reduces the surface tension of a liquid such as water. Surface tension is caused by the attractive force between water molecules; it causes th surface of the water to resist a small amount of force. This allows insects to skim across pond surfaces and allows a cup of tea to be filled slightly above th top of the cup. The surface tension could also cause the moist inside surfaces the air sacs to stick together because the water molecules on opposite sides of the alveoli would be attracted to each other. This would prevent gas exchang from happening.

The pulmonary surfactant molecules work by surrounding the water molecul being attracted to one another (sticking together), therefore stopping the surf alveoli to collapse in on themselves.



The surfactant molecules surround the water molecule and keep them apart f



Babies that need surfactant will have to spend several weeks in a special care baby unit

In babies, the pulmonary surfacta lung development (remember, b to breathe in the uterus – they g through the placenta). When bal they commonly suffer from respi known as hyaline membrane dis producing pulmonary surfactant inhale and exhale and require ex a ventilator. Fortunately, doctor babies artificially produced surfa producing their own.

Task

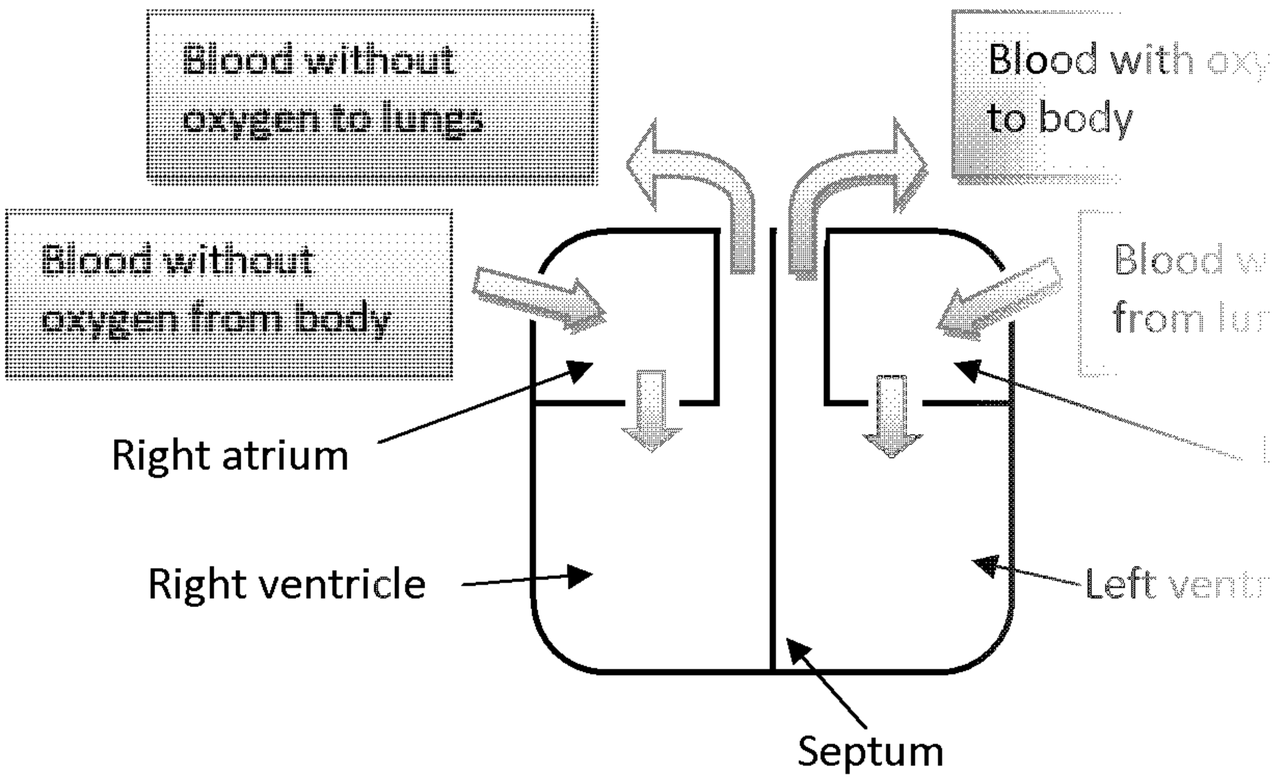
Pulmonary surfactant is an extremely important treatment in neonatal medicine.

Congenital heart defects are faults in the structure of the heart that you can be born with. With scans at 12 weeks and 20 weeks approximately two thirds of congenital heart defects can be diagnosed before birth.

Key
congenital, a
septal, aorta

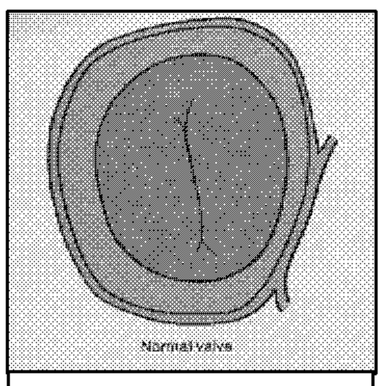
This allows parents to make a choice about whether or not to continue the p

The heart consists of four chambers – the right and left atria and right and lef
The blood passes through the heart twice in each circulation of the body: onc
has picked up blood from the lungs and once more after it has dropped off ox
on its way back to the lungs for more oxygen. Each chamber in the heart is s
valves that keep the blood flowing correctly.



There are two main types of congenital heart defects: septal defects (known a
obstruction defects (narrowed heart valves).

Septal defects are literally holes between the different parts of the heart. The hole
between the ventricles or between all four of them. The holes are a natural part
foetus and are meant to close up soon after birth but sometimes this does not hap
can move from one side of the heart to the other and the heart has to work much
amount of blood around the body. This can lead to an enlarged heart and raised b
of people can live with a hole in the heart with no symptoms. If necessary the hol
patch over the hole or just sewing it up. During surgery the patient is connected



A normal heart valve will open and close to allow plenty of blood to flow

Obstructions (called stenosis) are caused by valves being too n
to flow through. These blockages are usually between the ve
leading away from the heart but can occur between the atria

Like septal defects, these can be asymptomatic (have no sy
treatment. This may have to be open heart surgery in seve
treated with balloon valvuloplasty. This involves inserting
balloon on the end into a blood vessel in the groin using l
usually awake for this procedure). The tube is threaded up
the heart, guided by X-ray. In the heart the balloon is inse
valve and inflated repeatedly to open it up.

Task

How do you feel about parents being given the option to halt a pregnancy if a he

Respiration

Respiration is a chemical reaction that takes place in all cells to release energy from glucose. The energy is carried by a molecule called ATP (Adenosine triphosphate). Under normal circumstances this takes place with oxygen present and is called aerobic respiration. However, even w rate and heart rate it is not always possible to get enough oxygen to cells, if th respiration takes place.

Ke
anaerobic,
mitochond

Respiration takes place in a small part of the cells called the mitochondria – t 'powerhouse' of the cell as they supply the cell with the energy it needs to co

Both aerobic and anaerobic respiration use glucose to produce ATP molecule but anaerobic respiration produces about one twentieth as much as the aerobi reaction. Anaerobic respiration also produces lactic acid instead of carbon dioxide and water.

Aerobic respiration:

Glucose + oxygen → carbon dioxide + water

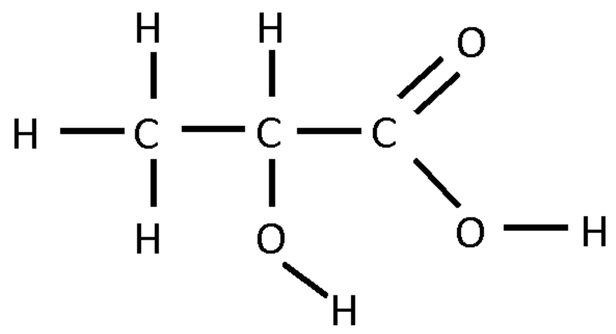
$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Anaerobic respiration:

Glucose → lactic acid

$C_6H_{12}O_6 \rightarrow 2C_3H_6O_3$

The lactic acid molecule looks like this:



Lactic acid has a systematic name which is 2-hydroxypropanoic acid.

Anaerobic respiration occurs as part of the normal process for dealing with exertion in exercise, but also occurs in a number of diseases. The levels of lactic acid in the blood will increase in conditions that reduce the amount of oxygen delivered to the cells, such as a severe infection (sepsis), shock or heart failure.

Lactic acid is normally present in the blood in low levels and is removed by the liver as necessary. Very high levels of lactic acid can cause severe, sometimes life threatening, symptoms. The blood is naturally about pH 7.2 and the body maintains this within a very narrow range (approximately 7.1–7.3) in order to stay healthy. Lactic acid disrupts this delicate balance and can cause lactic acidosis. The symptoms of this includes rapid breathing, excessive sweating, cool and clammy skin, sweet smelling breath and nausea. The treatment is to fix the underlying cause of increased lactic acid which is the reduction of oxygen reaching the cells.

Task

What happens to the way the body releases energy from glucose as you exercise

The Human Body – The Immune S

Key wo
autoimmune, ho
rheumatoid facto

The immune system is the body's defence against attack from foreign material that may be bacteria, viruses, fungi or parasites. However, our immune systems can turn against our own body and this is called an autoimmune disc of autoimmune conditions including type I diabetes mellitus, Guillain–Barré arthritis and anaphylaxis.

Type I diabetes mellitus

A healthy pancreas will produce the hormone insulin which is responsible for removing glucose from the bloodstream. The insulin is produced by the beta cells in the pancreas but in diabetes, these cells have been damaged or destroyed by the body's own immune system. The result is that the body cannot lower the amount of glucose in the blood and, if not controlled, this can cause a coma.

Guillain–Barré syndrome

It is not fully understood what triggers Guillain–Barré syndrome, although most people who suffer from it have had an infection in the previous few weeks. It is thought that the immune system's response to the infection causes the autoimmune response. The body's immune cells attack the nerve cells in the body; the nerve cells normally have a protective coating called myelin around them. In Guillain–Barré syndrome this layer of myelin is stripped off, and since our nerves control our muscles this can mean the muscles stop functioning properly. There can be tingling and numbness, even temporary paralysis and if not caught early paralysis of the respiratory muscle can leave the patient unable to breath properly. The patient will probably have a nerve conduction velocity test which tests how quickly the electrical impulses are travelling through the nerves – it slows down in Guillain–Barré syndrome. If the autoimmune response is halted the body is able to repair itself and full recovery is possible.

Rheumatoid arthritis

In rheumatoid arthritis the body's immune system attacks the joints causing pain and swelling and eventually the breakdown of bone and cartilage. In people with rheumatoid arthritis, the white blood cells produce rheumatoid factors which attack the joints..

Anaphylaxis

This extreme allergic reaction occurs when the body's sensitive immune syste material. The antibodies produced by the body bind to other immune system chemicals (like histamines) that can affect the whole body. Swelling of the lip breathing, release of these chemicals beneath the skin cause rashes and blood the blood pressure drops. Adrenaline is a short-term treatment to overcome t symptoms. Drugs to remove the chemical released by the immune system nee help long term recovery, for example, antihistamines.

Task

Describe how doctors could attempt to treat autoimmune diseases.

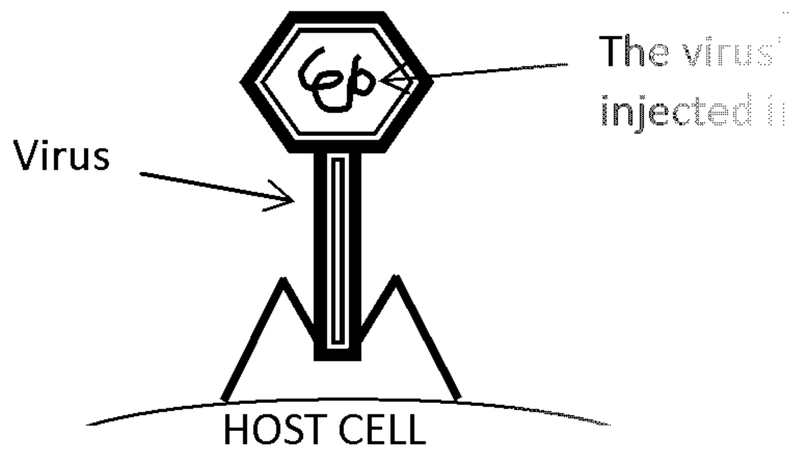
Causes of Disease

A
virus, he
genetic m

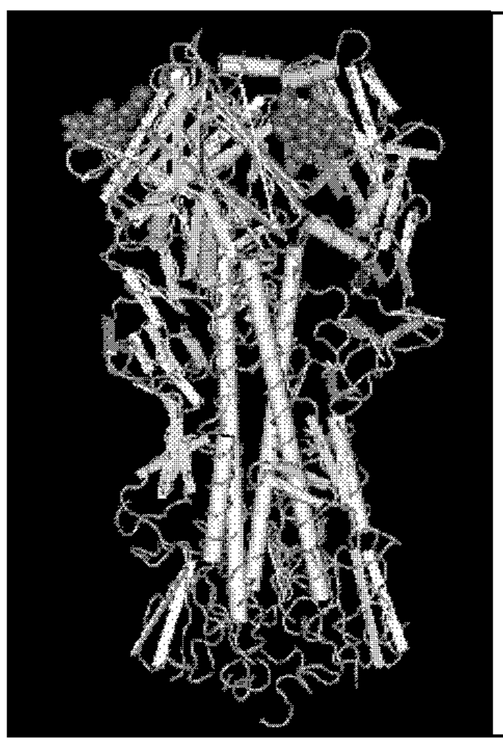
In 1918 up to 50 million people were killed by a pandemic (worldwide outbreak) of Spanish flu – more than any other disease outbreak. It affected up to one billion people, which was half the world's population at the time. This outbreak probably originated in the Far East but it was the Spanish press who first began reporting on it widely so it became known as the Spanish flu.

Influenza is caused by viruses which cause disease by injecting their own genetic material (DNA) into host cells, such as a human or another animal cell. This DNA then tells the host animal cell to make more of the virus, turning the animal cells against their own body. Once the animal cell has made a large number of viruses the cell will burst open and release the viruses to repeat the process with other cells.

Hemagglutinins on the virus recognise specific proteins on the host cell



Viruses have molecules called hemagglutinins on them which recognise speci
viruses will only infect one type of animal. They are able to recognise specific
proteins on their membrane that identify them. Therefore, a virus infecting h
specifically recognise a human cell.



This is an example of a hemagglutinin molecule found on an influenza virus. The long strand is the long protein chain and the other shapes are other molecules that are wrapped up in it. They are very complex molecules!

A process called X-ray crystall
caused the 1918 Spanish flu ha
structure of the virus. This infl
infected birds but developed th
humans. By studying the struct
have found that the hemaggluti
virus infecting humans are very
infecting birds. This meant very
of the virus were needed for it
humans. Much fewer changes
pandemics such as the Asian flu
flu in 1968.

It is thought that the Spanish flu may have been partly responsible for ending
both sides became too ill to fight. Towards the end more soldiers were dying
the unsanitary conditions in the trenches) than were dying from weapons and

Task

Could the Spanish flu pandemic have been a good thing for the growth of the hu
long run?

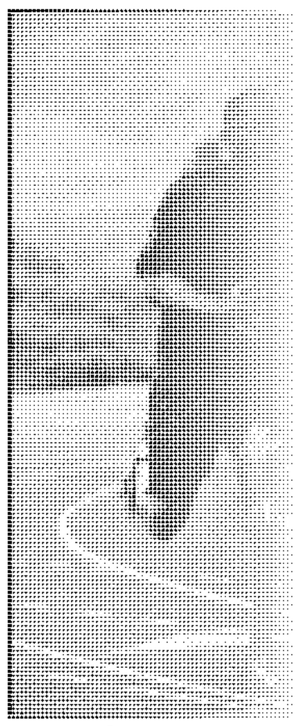
The Human Body – The Skeletal S

Amputees are people who have lost a limb or part of a limb, this can be a congenital defect (from birth) or as a result of trauma, diabetes, vascular disease, cancer, infection or other diseases. The most comm being performed is peripheral arterial disease (which means arteries are narrow reaches the limbs).

pros

In removing the diseased or damaged limb, the surgeon is aiming to meet the balance between removing enough to ensure it heals whilst preserving as muc During the operation the surgeon removes all infected or damaged tissue as c important that the final result is neat. The surgeon may close up the wound (leave it open (open flap amputation). By leaving it open, the surgeon allows r carefully for a few days – this is done if there is a particular risk of the wound days of keeping the stump clean and if they are sure it is free from infection, l follow-up care after an amputation is particularly important – physiotherapy t practising use of an artificial limb are absolutely necessary. Patients sometimes pain, where they feel pain in the lost limb – this can be dealt with by counsell

Amputees often opt to have an artificial replacement (a prosthesis) which has such a way that allows the individual to control and use the limb. There is on improve these artificial limbs.



Most prosthetics at the moment are strapped onto the human body, however, this often means the prosthetic can be uncomfortable at the point where it is strapped to the body. The wearer can have blisters and sores that can become infected. Scientists have been working on a way to attach the prosthetic to the human body more permanently but there are a number of problems. Primarily, the weight of the prosthetic means that it would have to be attached to bone which means there has to be an opening into the body and human tissue will not heal around the prosthetic leaving it open to infection.

Scientists have developed a new technique c Transcutaneous Amputation Prosthesis (ITA from nature – the scientists were studying ho through their skin without bacteria getting in antlers come out of the skin. They have desi metal that could sit under the skin to allow t creating a seal and preventing the skin rippin

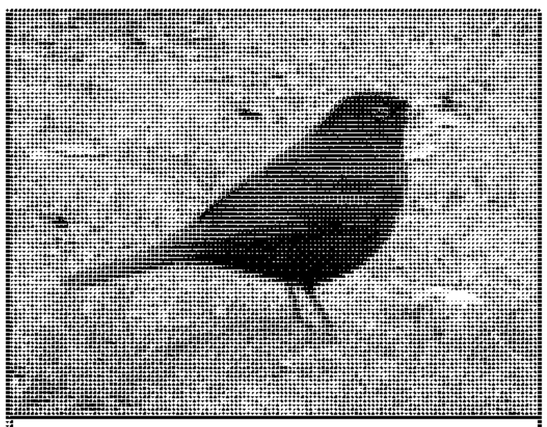
A lot of money is being put into researching amputations and prosthetics and is advancing rapidly as scientists attempt to improve peoples' quality of life aft look to nature for ideas as matching technology to the human body is a tricky business.

Task

Can you think of other examples where science and technology have taken ideas

Sampling Techniques

The RSPB (Royal Society for the Protection of Birds) carries out national surveys using the general public to help provide a large sample that makes the results more reliable.



A male blackbird

For the last 30 years they have carried out the Big
has clocked up more than 3 million hours of bird
years!). It is carried out in the winter because the
the garden and people are asked to spend one hou
birds in their garden. They only ask for an hour in
people to take part. This makes it a more reliable
to spot patterns over time to identify any populati
declining, for example, the number of house spar
quarters of the starling population has been lost. In
part to count 8.5 million birds of 73 different speci

2009 Results:

Rank	Species	Average seen per garden	% of gar spe
1	House sparrow	3.70	
2	Starling	3.21	
3	Blackbird	2.84	
4	Blue tit	2.45	
5	Chaffinch	2.01	
6	Wood pigeon	1.85	
7	Collared dove	1.44	
8	Great tit	1.40	
9	Robin	1.36	
10	Long tailed tit	1.34	
11	Goldfinch	1.26	
12	Greenfinch	1.07	
13	Dunnock	1.04	
14	Magpie	0.86	
15	Coal tit	0.75	

The one you are most likely to see in your garden is the blackbird even thou
of the rankings. However, if you have house sparrows present in your garden
more of these than any other bird.

You can even spot foxes in your back garden

In 2009 the RSPB began another new national s
Nature Count. This is a full wildlife count (not j
part during the week of 8th–14th June. They are
up this data to allow them to spot trends. They d
likely to spot a fox in urban areas (38%) than in
rural dwellers are more likely to see hedgehogs
(15%).

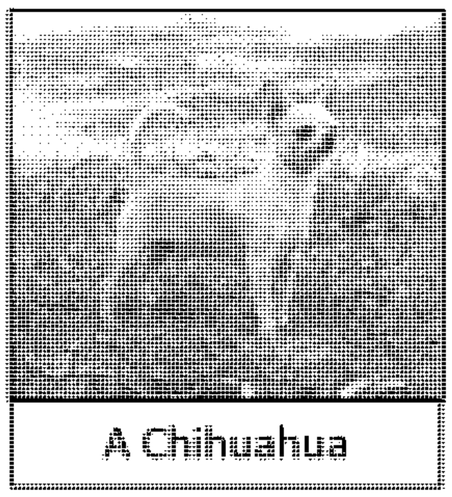
Task

What other conclusions can you draw from the table of results?

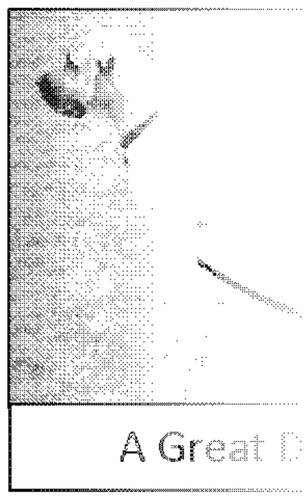
Selective Breeding and Natural Sel

For thousands of years humans have selectively bred dogs to get a particular look or behaviour that suits us. The result is one of the most diverse species, in particular with relation to size – a Great Dane is 100 times bigger than a Chihuahua.

Ke
gene, chro
phenotype



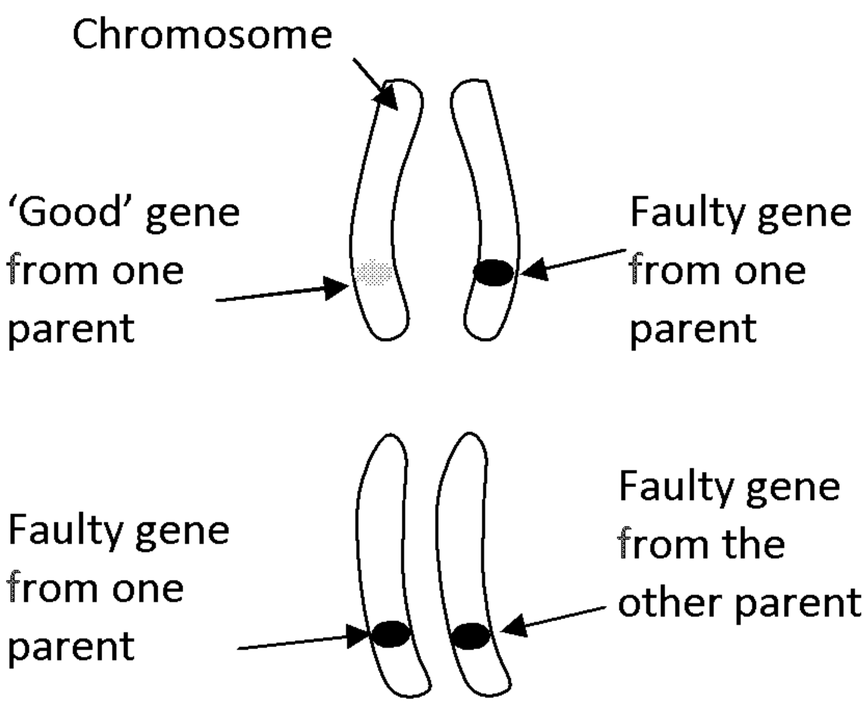
A Chihuahua



A Great D

Nearly all domestic dogs are selectively bred and a large number of them are t
where relatives are bred together. This is because close relatives are very likel
and to have the desired genetic information.

All dogs (like other animals) carry defective genes that are usually recessive. T
dominant, gene that overrides the faulty one. It is a bit like having two sets of
job but one is incomplete or damaged – it does not matter because there is an
are given two incorrect sets of instructions the job cannot be completed prop
genes could mean nothing, but it could lead to a defect at birth, or a defect th



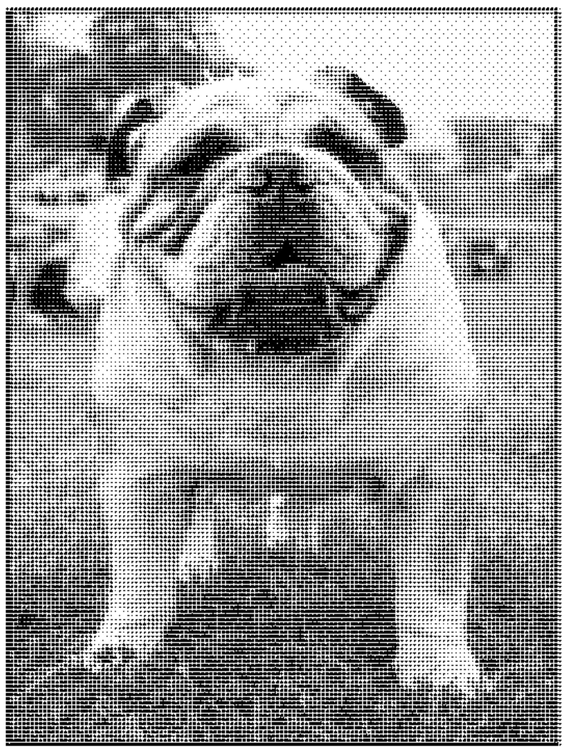
In this pair of chromo
'good' gene and one f
The faulty one is 'over

In this pair of chromo
have provided a faulty
has no instructions to
protein.

So selective breeding of dogs can lead to unintended defects, particularly whe
better if phenotype breeding is carried out – this involves selecting dogs for th
(phenotype), and not ones closely related.

As well as these unintended consequences, humans have been selecting dogs
especially for entering them into competitions. These features are not always
for example:

Irish Wolfhounds are bred to be very large and suffer hip problems and arthritis in later life (they only live about 9 years).



Bulldogs have been bred to have such large heads that they do not fit through the female's pelvis and they all have to be born by caesarean section.

However, it is also worth noting that nearly all animals that have been bred f looked after and enjoy the attention and excitement of the competition. It is people to be able to make reliable predictions about temperament and requir suitable home for dogs as pets. For example, a young family needs to know t to be good with children.

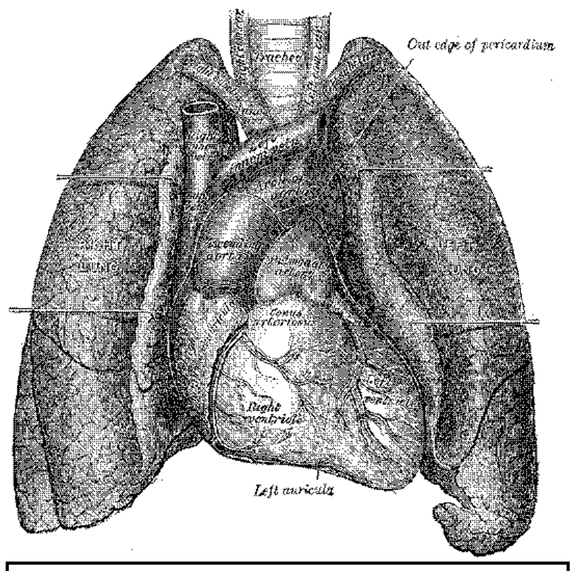
Task

What do you think about selectively breeding dogs?

Cloning

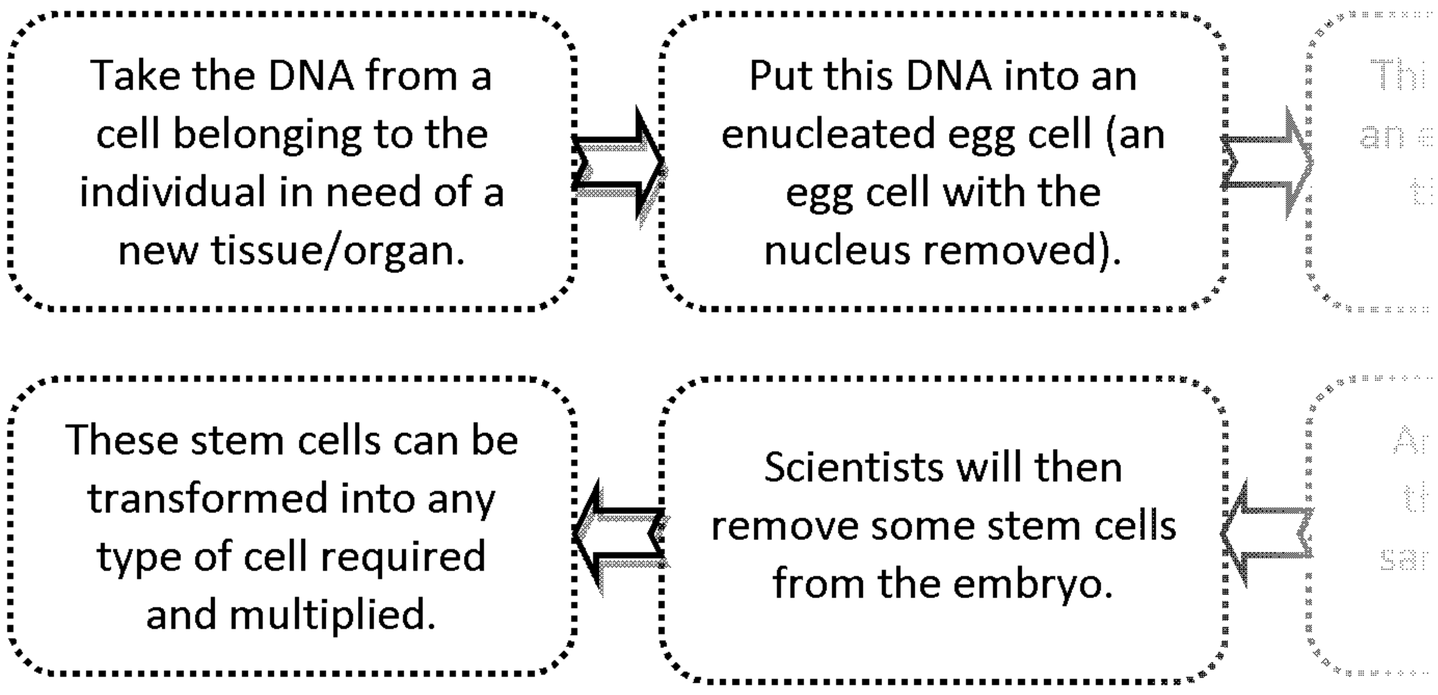
Key words
therapeutic, DNA, enucleated, stem cells

The cloning of a whole hum
the technology is simply not
cloned human embryos do
nearer possibility is cloning individual organs fo
always a need for organ donors because there is
need a new liver, kidney, heart or other organ.
has to be carefully matched between the donor
recipient's body will reject it. The use of therap
tissues has the potential to reduce or eliminate t
eradicate the risks of organ rejection when orga

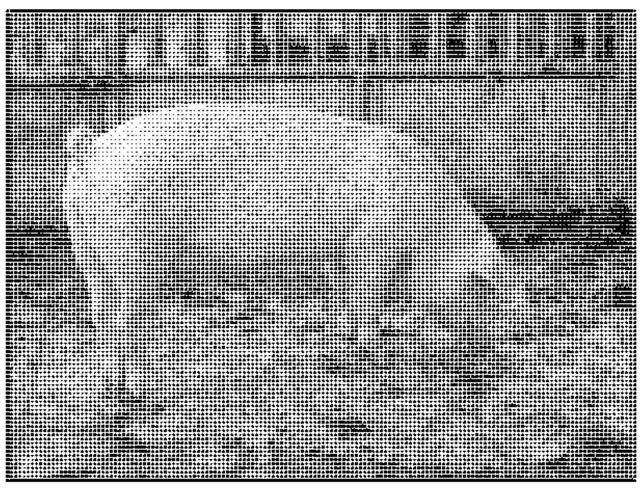


Eventually you may be able to have a spare heart and lungs made up for you!

In theory, scientists could be able to use a perso
(their DNA) to create a new tissue or organ tha
so that their immune system would not reject it
cells that are extremely useful cells that can turn
in the body – muscle cells, nerve cells, skin cell



However, there will need to be significant advances in the technological proc
become full reality. Currently scientists cannot reliably produce cloned huma
of stem cells is also a tricky business.

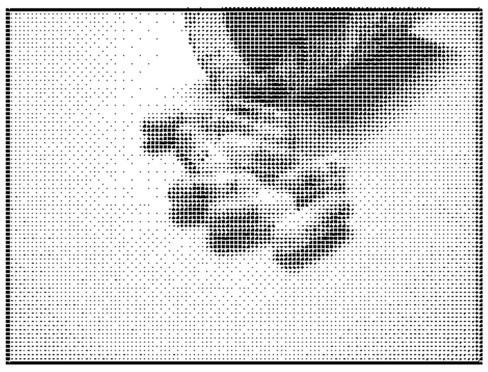


It is also possible that scientists may use generi
chosen because their tissues and organs are mo
other animals. Humans will normally reject a p
they reject many human organ transplants – th
it as 'foreign' and attacks. Scientists can create
genes that cause human beings to reject the or
would mean that cloned pigs could potentially
humans that would not be rejected.

Task

The use of stem cells in any scientific research is source of great debate – here w
they can be used to save lives, but it involves creating a potential new life then d

Drugs and Their Effects



The most commonly used range of drugs are painkillers. There are many types of painkillers, they have slightly different effects on the human body and some are stronger than others. The most well-known painkillers fall into steroidal anti-inflammatory drugs or NSAIDs (pronou

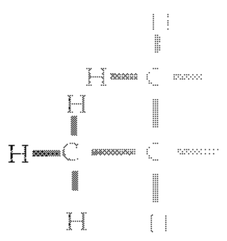
NSAIDS have three effects on the human body:
1. Analgesic – makes the person feel slightly sleepy
2. Antipyretic – reduces a fever (high temperature)
3. Anti-inflammatory – reduces swelling

Each of these effects can range from strong to weak and it is important to use will depend on what is causing the pain – a twisted ankle or a headache cause be best treated with different painkillers. The three most common 'over the c ibuprofen and paracetamol. Aspirin and ibuprofen are both NSAIDS and have paracetamol has such a limited anti-inflammatory effect that it is sometimes n NSAID.

A lot of pain is caused by swelling of damaged tissues, this swelling occurs bec normal in that area, for example, fluid around a twisted ankle or around the t These painkillers work by reducing the levels of chemicals called prostaglandi blood vessels to dilate (get wider) so that there is more fluid in the area. Thes amount of swelling in an area and relieve pain.

Ibuprofen

Ibuprofen is usually used as a mild anti-inflammatory drug. It can cause bleeding in the digestive system, particularly in the stomach, so is best taken with food.



Aspirin

Aspirin used to just be the first drug to be prescribed when anti-inflammatory properties were needed but recently it has been found to have many other beneficial effects such as positive effects on the cardiovascular system. It can also have side effects on the digestive system.

Paracetamol

The chemical name is para-acetyl-amino-phenol.
Even though paracetamol does not have much of an anti-inflammatory effect it is excellent for the reduction of fevers and has very few side effects. It is, however, very toxic at doses just 2–3 times the maximum advised dose. It can cause nausea and vomiting and eventually liver damage.

The World Health Organisation has a 'pain ladder' that doctors use to prescr painkiller. This allows doctors to work their way 'up' the level of painkillers very strong ones that make people drowsy.

1. Non-opioids such as aspirin and paracetamol
2. If pain persists or increases: mild opioids such as codeine
3. If pain still persists or increases: strong opioids such as morphine

Task

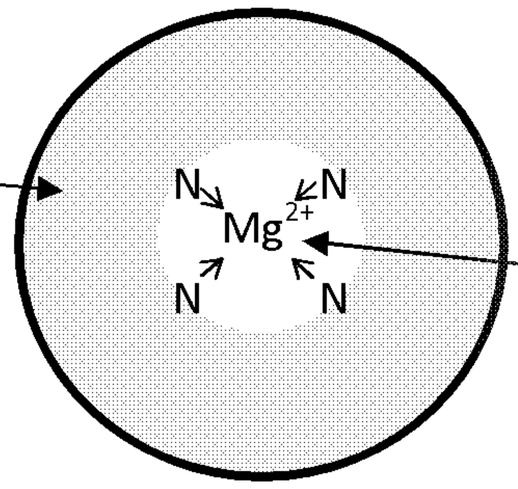
Why is it important that doctors do not prescribe the strong painkillers unnecess

Photosynthesis

Key words
chlorophyll, pigment, molecule, carotene, anthocyanin

Chlorophyll is the pigment found in [illegible] is responsible for the absorption of [illegible] oxygen from carbon dioxide and wa[illegible] very complex molecule ($C_{55}H_{72}MgN$[illegible] photoreceptor because it absorbs visible light. In fact, chlorophyll absorbs all [illegible] which it reflects into our eyes, which is why leaves appear green.

The shaded area represents the complicated chlorophyll molecule (minus the Mg): $C_{55}H_{72}MgN_4O_5$



The [illegible] in th[illegible] chlo[illegible]

However, there is more than that one typ[illegible] leaves, but chlorophyll has such an intens[illegible] masks the colour of other pigments. Two [illegible] present are carotene and anthocyanin.

Carotene acts as a 'helper' for chlorophyll in the process of photosynthesis. It [illegible] pigment that is responsible for the orange colour of many fruit and vegetables

Anthocyanin is a red-coloured pigment also found in leaves. It is a pH-sensiti[illegible] molecule (much like indicators for acids and alkalis), in very acidic saps it is cr[illegible] red colour but in less acidic saps it is a dark purple colour. Anthocyanins caus[illegible] skins to be red. These molecules are only produced when there is sunlight pr[illegible] explains why apples are often red on one side but green on the other: as the a[illegible] half is in sunlight but half is in the shade.

As the temperature begins to drop in the aut[illegible] chlorophyll molecules to decay (break down[illegible] stable as other molecules. This means that th[illegible] masks the other colours gradually disappears [illegible] carotene and/or anthocyanins to show throu[illegible] produces the range of beautiful autumn colo[illegible]

Task

Describe how the chemicals in different leaves change in the autumn to show th[illegible] see. What might be different about evergreen plants?

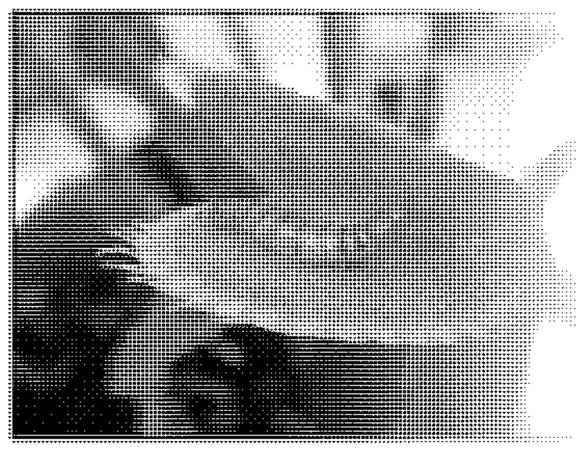
Plant Organs – Leaves and Ro

Key
carnivorous, a

Plants are able to grow and thrive in virtually any climate on earth. There are plants adapted to survive the cold of Antarctica to the heat of the Sahara desert. In many places the soil does not provide enough nutrients for the plant to thrive, plants have adapted to be carnivorous – to gain additional nutrients from digest known of these is the Venus fly trap (Latin name: *Dionea muscipula*) which is similar plant found underwater called the Waterwheel plant (Latin name: *Aldr* plants actually actively hunt their food, there are many other carnivorous plants producing sticky substances that the insects become stuck to so the plant can di

The Venus fly trap

The Venus fly trap has very specially adapted leaves that contain a small amount of sweet sap at the base, this entices the insects into the trap. When the insect enters the trap it knocks against 'trigger hairs' found within the leaves and this causes the plant to close the trap.



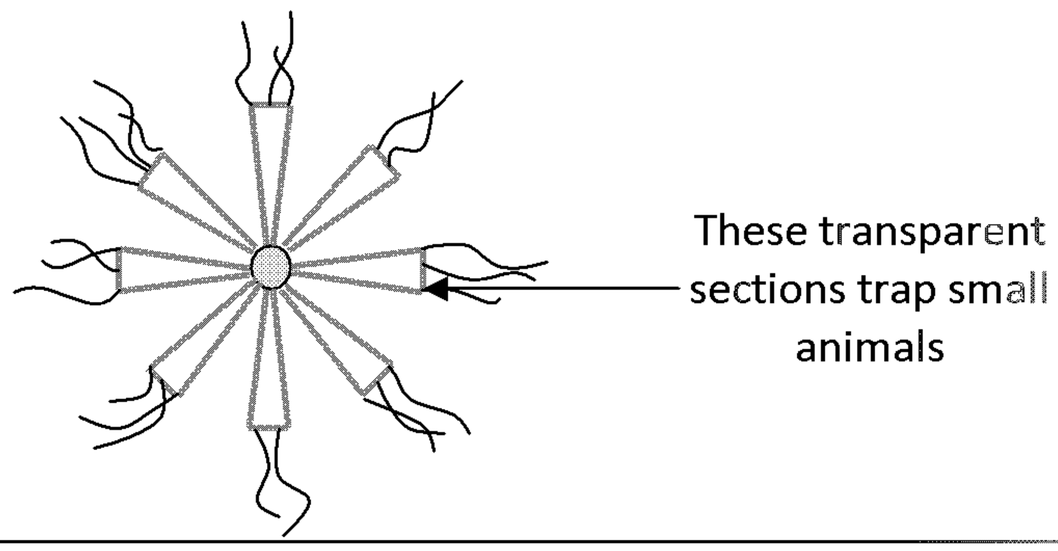
It is important to note that the Venus fly trap does not have a 'brain', it does not it to make decisions about its prey, it simply responds to chemical signals released touched. In fact, it requires more than one trigger hair to be knocked (or one to ensure that only live food is trapped. It requires a lot of energy to close the trap so closing the trap unnecessarily. If a small twig or stone falls into the trap it will only this happens the plant will only partially close the trap and after a few hours will re

The trap closes in less than half a second and the insect finds itself trapped, the projections (they look a little like teeth but do not actually do any chewing!) plant then secretes acidic digestive juices onto the insect that breaks the food not all that dissimilar to the process that begins in our stomachs.

The waterwheel plant

The waterwheel plant works in a similar way but instead of enticing the prey in with a sweet sap the small animals swim into the traps which are transparent. It catches small invertebrate sea creatures and once they swim into the plant it snaps shut to stop the prey escaping.

The waterwheel plant



Task

Describe how carnivorous plants might have evolved. When and where might an been an advantage that means these plants were more likely to survive and prod

Fertilisers, Herbicides and Pestic

Key words

aerobic, actinomycetes, mesophilic, thermophilic, microscopic, bacteria, fungi

Composting is an important p
carry out in their back garden
going into landfill sites. It inv
(from plant and animal matter
allow useful compost to be produced that can be used to help plants grow succes
the action of micro-organisms – both fungi and bacteria have a role to play in the
put into the composter.

It is not possible (or safe) to compost all organic matter and there is a lot of scienc
mixture to ensure maximum production of compost. All organic matter contains
between these two elements in the material is important in working out the best
include in the composter. The ideal ratio of carbon to nitrogen is 30 grams to 1 g
a combination of different materials.

Organic material	Approximate carbon: nitrogen ratio in gr
Autumn leaves	55:1
Mixed paper	175:1
Vegetable scraps	18:1
Grass cuttings	20:1
Manure	15:1

In general approximately two thirds 'greens' (including vegetable scraps) and
'browns' (shredded newspapers, thick woody stems, pet droppings – but only
are vegetarian) is a good combination.

The process requires oxygen so it is also a good idea to 'fork over' the compo
occasionally to allow oxygen in to the heap of compost. The fungi and bacte
present need the oxygen for aerobic respiration, if there is no oxygen present
becomes anaerobic respiration which can cause the compost heap to smell ba

Once the compost heap has been made of the correct organic material and ox
present, the composting process will begin. There are three phases to compos

1. The mesophilic phase, moderate temperature, a couple of days long
2. The thermophilic phase, high temperature, a few days to a few months
3. T

In the first phase fungi and a special type of bacteria called actinomycetes begin br
material; the 'woody' bits of the plant material that the bacteria cannot begin to w
example). The mesophilic bacteria then begin to break down the molecules of pr
have been released. This break-down process causes the temperature to rise to a p
bacteria will not work anymore. Then the thermophillic bacteria take over the br
very little left to break down, the heap cools back down and mesophilic bacteria

This process produces a mixture of molecules that is an extremely good fertil
providing them with exactly the correct combination of nutrients needed for

Task

How could people be helped to compost effectively?
How would you encourage people to compost?

Answers

Microscopes

- ☑ Both electron microscopes and light microscopes involve something passing through a
- ☑ Both allow magnification of a very tiny object.
- ☑ In both types of microscopy, the reason we see an image is because the light/electrons
  and are changed by it.

- ☑ In light microscopy it is visible light passing through the sample, in electron microscopy
  radiation that travels as waves whereas electrons are very tiny particles.
- ☑ Light microscopy will magnify up to 1,500 times, electron microscopy by up to 2,000
- ☑ Light microscopes were developed much earlier than electron microscopes.
- ☑ In light microscopes it is our eyes interpreting the image formed, but in electron micro

With additional research pupils may find:

- ☑ Both light and electron microscopy use staining to improve the image formed in some
- ☑ Phase contrast microscopy is a type of light microscopy that is often used to make an im
- ☑ The image produced in light microscopy is in colour but in electron microscopy it is no
  visible light in light microscopy. However, colour may be added by computer afterwar

Cells

- ☑ Movement – the amoeba can move due to their pseudopodia, their cytoplasm can chan
  substance that allows the amoeba to pull itself along
- ☑ Reproduction – amoeba reproduce by simple division to create new organisms
- ☑ Sensitivity – their movement is in response to chemical stimuli, if it senses food it will m
  chemical indicates a threat it will move away
- ☑ Growth – the giant amoeba will grow up to 3mm in size
- ☑ Respiration – they respire in order to release energy from the food they take in, this all
- ☑ Excretion – any waste material is disposed of by emptying vesicles out of the main cell
- ☑ Nutrition – the prey that amoeba take in provide the cell with nutrients required to ca
  functions

Organs, Tissues and Growth

Pupils may come up with their own ideas but some considerations might be:

It is likely to be an expensive procedure (at least initially), so who should get it? Children in
limbs due to unexploded mines left in their countries? War veterans? Car accident victims (s
dangerous driving)? Only younger people? Who decides who is entitled to it? Who pays? Is i
to be able to buy it?

There are usually risks involved with any medical treatment but for those who have lost a lim
of life is huge. However, if there is a limited pot of money to pay for treatment (e.g. the NH
limb regeneration be paid for ahead of other treatments that may save lives? What if the othe
success rate for saving a life?

What about those who decide they do not want treatment and those who are (for one reason
treatment? What could happen to society's view on those with missing limbs?

People with missing limbs currently compete in many international sporting events that are c
Would people with regenerated limbs compete in a separate category within these events? C
bodied athletes?

Reproductive Cells and Organs

Seahorses	☑	have all the advantages of internal fertilisation (much greater chan successfully, offspring have better chance of survival through their looks after the offspring in his brood pouch further increasing the regulating the salt the offspring are exposed to and slowly increasi adapted to the conditions they will be born into.
Duck-billed platypus	☑	also have advantages of internal fertilisation. The eggs develop fo and she only incubates them for 10 days outside her body. The in dangerous time as mother defends her unborn offspring and so the time.
Snail	☑	have the advantages of internal fertilisation as well. They lay abou chances of survival of some of their offspring and therefore survivi the couple are fertilised which further increases the potential popu chance of survival.

Development of Baby

In non-identical twins there are two eggs fertilised by two different sperm. The egg will alw
because the mother only has X chromosomes so this is all she can pass onto her children. If
sexes the two eggs must have been fertilised by one sperm containing an X chromosome (to
containing a Y chromosomes (to form XY = a boy).

Puberty and Menstrual Cycle

In male dogs the testes produce testosterone, so after neutering, the levels of testosterone in
dogs the ovaries produce oestrogen, so after neutering, the levels of this hormone will also d
dog will no longer produce any sperm and without ovaries the female dog will no longer pr
have children.
With some further research pupils may come across chemical castration, which is used when
surgery for some reason. In chemical castration the level of testosterone is reduced without

Adaptation and Habitats

Our whole bodies could have evolved in a different way – there is no 'right answer' here bu
maybe we would have been able to survive very different temperature ranges. Obviously, ou
structures as well, but if the enzymes worked, evolution could have taken us a long a very di
potential survival on different planets?

Feeding Relationships

Humans have a variety of teeth of different shapes and sizes and with different functions in th
our mouths are for grinding up vegetation that is difficult to break up. The plant cells have t
grinding process in the mouth. This is also indicated by the fact that we can move our jaw h
can only open and close their mouths. However, we do have some sharper teeth towards the
canines. These are present in most mammals and some non-mammals and indicate that we n
consumption. Although a knife and fork have reduced the need for these teeth and our 'cani
dogs and cats).

Variation

Pupils could come up with a variety of responses relating to meat and fruit/vegetable farming
are:

- ☑ This already happens to some degree with artificial selection but cross-pollination/fertil
  similar organisms.
- ☑ The definition of a species is animals/plants that are able to mate together to produce f
  increasingly plausible for animals and plants considered to be different species to produ
  may have to be rethought.
- ☑ The food types available to us may increase dramatically as farmers are able to produce
- ☑ Food availability may be less dependent on seasons as farmers could combine the hardi
  with the taste of another to produce it all year round.
- ☑ Pupils may suggest animals or plants that could be produced.

Classification of Animals

Pupils could design their own system from scratch based on any number of features, for exam
habitat, etc. They could also decide on a mechanism using DNA for example, all animals tha
considered to be a single species.
They should be encouraged to think about how their system would deal with extinct organis
organisms still to be discovered.

Classification of Plants

The fungi are unable to photosynthesise so they get glucose from the algae. However, algae
and the fungi provide shelter from wind and temperature changes. The fungi also provide on
lichen reproduce, therefore providing additional shelters for more algae.

Food and Food Tests

The key conclusions are as follows:

First graph

- ☑ For all sauces a lot of the content by mass is due to water.
- ☑ Significantly more fat and less water in the pesto green sauce.
- ☑ The four cheese sauce has more carbohydrate than the other sauce
- ☑ The four cheese and carbonara sauces are quite high in fat (although

Second graph

- ☑ Both the spaghetti types have high water content and high carboh
- ☑ There is approximately three times as much fibre in the whole wh
  spaghetti.
- ☑ Both spaghettis are quite low in protein.

Third graph ☑ The pasta cooked in salted water has a lot more sodium and chlor
plain water.

The **Human** Body – The **Digestive** System
The bacterium releases a chemical called an enterotoxin that affects the small intestines. The
the food that travels through it. The large intestines are responsible for absorbing water from
the body. Unfortunately, the amount of water is too much for the large intestines to manage
which causes dehydration. Initially the symptoms are thirstiness, lack of tears and sweating, l
blood around the body as there is less fluid. This can eventually lead to coma and death. How
and cheap to treat dehydration, ready access to saline solution could prevent the extreme sym
prevent the spread of cholera it is necessary to provide clean drinking water and there are ma
challenge.

The **Human** Body – The **Respiratory** System
In the uterus a baby does not use its lungs so they do not fully develop until quite late into th
baby is born their lungs do not contain very much pulmonary surfactant, this means their alv
gaseous exchange. If gas exchange cannot take place the body does not efficiently take in oxy
to release the energy from glucose for cellular processes. If a premature baby is going to survi
them pulmonary surfactant to allow oxygen to enter the bloodstream around the lungs.

The **Human** Body – The **Circulatory** System
This will be down to pupils' own beliefs. There may be religious aspects to their answers and
strong reactions. They should consider the long-term implications for someone with severe le
the implications for the rest of a family, cost to the NHS, difficulties that the individual may
this must be balanced against the 'right to life' argument that actually, there are many people
and live happy lives. Is it really for someone else to decide another individual's right to survi

Respiration
There is a shift from aerobic to anaerobic respiration which is much less efficient (releasing o
This is why muscles get tired – there is less and less energy released from the glucose. After e
paid back to clear the lactic acid that has built up.

The **Human** Body – The **Immune** System
Pupils could come up with their own suggestions or they could research the possible method
Most are treated by treating their symptoms. Pupils might suggest and discuss the possibility
responses (using immunosuppressant drugs) but they should consider the risks of further infec
they consider it to be sensible treatment?

Causes of Disease
Pupils would need to come to their own conclusions about this. They should consider the di
War One might have gone on for longer but, from a historical aspect, other factors will have

The **Human** Body – The **Skeletal** System
Nature has been carrying out her own experiments through evolution for millions of years so
technology would find answers hidden in there. There are many possible examples that pupil
- ☑ The one that pupils are most likely to think of themselves involves drugs. Many drugs h
and have been used or adapted for use as a treatment. For example, the active compone
salicylic acid which is found in the bark of willow trees. Further research will turn up m
pupils look into an area of science called biomimicry.
- ☑ Scientists created a smart fabric that changes its structure according to the temperature
which open in warmer temperatures to release their seeds.
- ☑ Flippers of some marine mammals are being used in the design of wings for supersonic
- ☑ Scientists have created a synthetic version of a glue made by sandcastle worm as a poten
together. At the moment, doctors will pin or even nail broken bones together – if a glu
harm the patient it would be a much less invasive treatment.

Sampling Techniques
There are many possible conclusions for pupils to make from this data, these are some that th
- ☑ The bird that was seen in the fewest gardens was the goldfinch, however, if you do hav
see more of them than you would of greenfinch, dunnocks, magpies and coal tits.
- ☑ Although many people see magpies and consider them a very common bird, they are ac
- ☑ Blue tits and blackbirds are common birds both in the number of gardens they are seen
seen in each garden.
- ☑ Coal tits are very low down on both scales.

Selective Breeding and Natural Selection

Many pupils will have their own pedigree dogs and may well have some of the bree
to reach their own decision based on information provided. They may well find thi
with the need for a more predictable temperament and may have these dogs themse

Cloning

This is another question that will encourage pupils to consider their own viewpoin
weighing up the potential medical benefits of stem cells with the use of 'new life' as
have to come to their own decisions, further research may help.

Drugs and their Effects

1. Patients can become addicted to some of the stronger painkillers and find they
   source of the pain has gone away. These addictions are as potentially damaging
2. Patients can develop tolerance to some painkillers – needing more and more to

In either case there are risks to the patient and doctors need to tread a fine line betwe
allow their patients comfort but without risking addiction of tolerance.

Photosynthesis

The green colour is due to chlorophyll found in leaves and as this is broken down th
through. As there are differing levels of the two pigments, there are various shades f
some trees the presence of anthocyanin, which is red, produces a different spectrum
Different leaves on a tree will begin to change colour over the course of a few days .
However, different trees in different positions will be affected by the temperature ch
neighbouring trees may be the same or different colours at the same time of year.

Plant Organs – Leaves and Roots

The evolution of carnivorous plants is not a particularly well understood area of scie
could have evolved to live where there are few nutrients available in the soil (or in t
carnivorous plants were better able to survive and produce offspring which shared th
consider that perhaps they evolved somewhere with a very high insect population th

Fertilisers, Herbicides and Pesticides

Pupils could design their own campaign but they should consider the accessibility of
the general public to remember information about carbon to nitrogen ratios so pupil
information in a more simplified but still scientifically accurate manner. To extend t
posters or video/radio adverts to provide the general public with information on wh