SB1f Testing Foods

You Can Test for Sugars Using Benedict's Reagent

PRACTICAL

REDUCING SUGARS — Reducing sugars include simple sugars made from just one unit, e.g. glucose, and a few made from two units joined together, e.g. maltose. Here's how you can test for them:

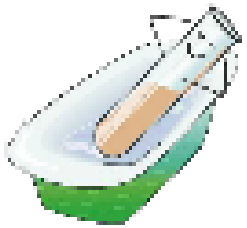
1) Add Benedict's reagent (which is blue) to a sample and heat it in a water bath that's been set at 75 °C. If the test's positive it will form a coloured precipitate (solid particles suspended in the solution).

2) The higher the concentration of reducing sugar, the further the colour change goes — you can use this to compare the amount of reducing sugar in different solutions.

The colour of the precipitate changes from:

blue → green → yellow → orange → brick red

NON-REDUCING SUGARS — If there aren't any reducing sugars in your sample, you can test for non-reducing sugars, e.g. sucrose.



1) Using a new sample of the test solution, add dilute hydrochloric acid and heat in a water bath that's been that's been set at 75 °C.

2) Add sodium hydrogen-carbonate (to neutralise it) then carry out the Benedict's test as above.

3) A coloured precipitate means there are non-reducing sugars present. If the solution stays blue, the test solution didn't contain any sugar at all.

SB1f Testing Foods Questions

- What type of polymer do you get when you join together simple sugars?
- What are the colour changes when using Benedict's Reagent to test for sugar?
- What do the different colours indicate?
- Explain what you need to do to a non reducing sugar initially before you can carry out the Benedict's test.

SB1f Testing Foods 2

Starch is Tested for with Iodine

PRACTICAL

Iodine solution is iodine dissolved in potassium iodide solution.

Just add iodine solution to the test sample.

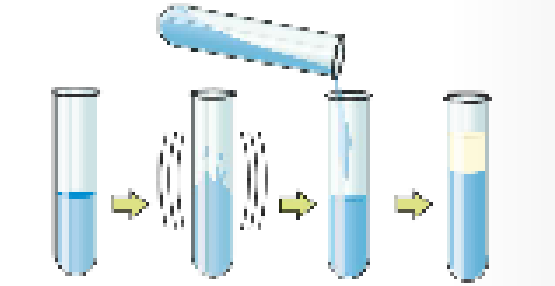
1) If starch is present, the sample changes from browny-orange to a dark, blue-black colour.
2) If there's no starch, it stays browny-orange.

Use the Emulsion Test for Lipids

PRACTICAL

To find out if there are any lipids in a sample:

1) Shake the test substance with ethanol for about a minute until it dissolves, then pour the solution into water.
2) If there are any lipids present, they'll show up as a milky emulsion.
3) The more lipid there is, the more noticeable the milky colour will be.



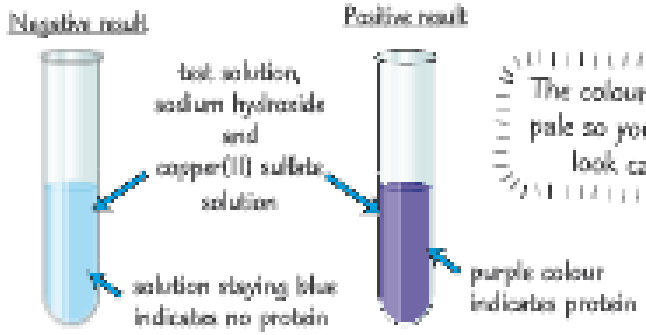
An emulsion is when one liquid doesn't dissolve in another — it just forms little droplets.

The Biuret Test is Used for Proteins

PRACTICAL

If you needed to find out if a substance contained protein you'd use the biuret test.

1) First, add a few drops of sodium hydroxide solution to make the solution alkaline.
2) Then add some copper(II) sulfate solution (which is bright blue).
   - If there's no protein, the solution will stay blue.
   - If protein is present, the solution will turn purple.



The colours are quite pale so you'll need to look carefully.

SB1f Testing Foods 2 Questions

What do the following test results show about substances found in a biscuit?

a) Biuret tests: turned purple.

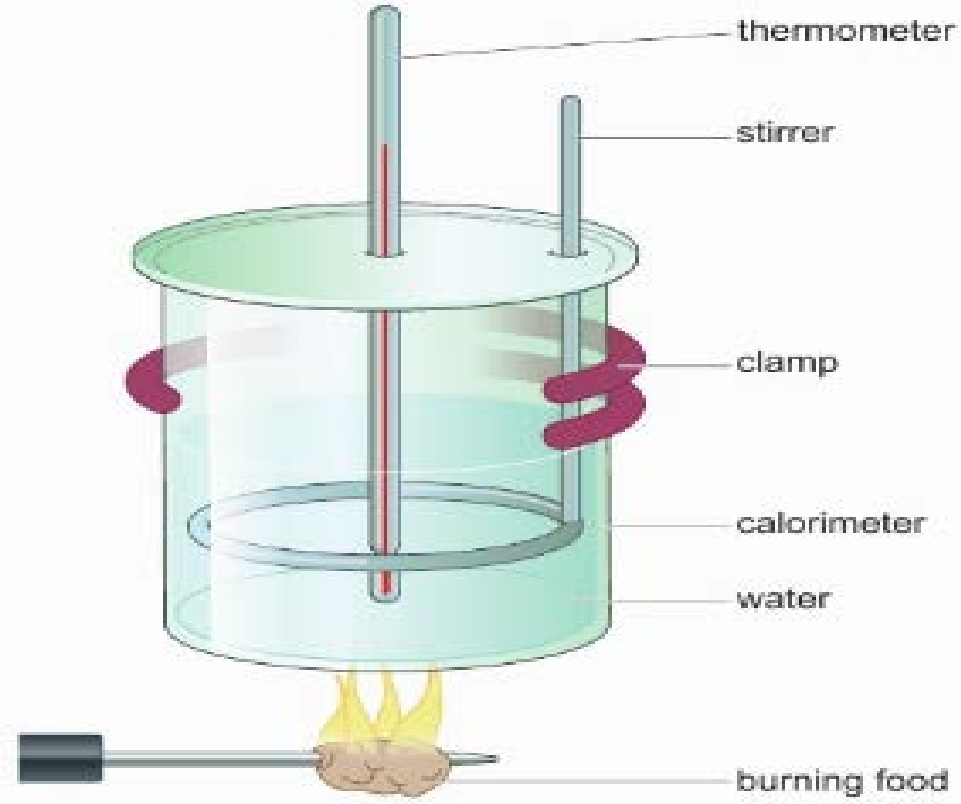
b) Benedict's test : stayed bright blue.

c) Iodine solution test: turned blue/black.

d) Ethanol emulsion test: cloudy emulsion at top of sample.

SB1f Testing Foods 3

Food not only provides us with the nutrients we need but also contains energy that we can transfer to other processes that keep us alive. Foods that contain large amounts of sugars or fats are particularly good sources of energy. We can measure the amount of energy in a food by burning it in a **calorimeter**.



SB1f Testing Foods Questions 3

- Explain how the calorimeter is used to measure the amount of energy in a piece of food.
- Describe how you would use the calorimeter to compare the amount of energy in two different foods. Identify any sources of error that could make the results less accurate.
- Compare what happens when food is burnt in a calorimeter with respiration of food molecules in a cell.

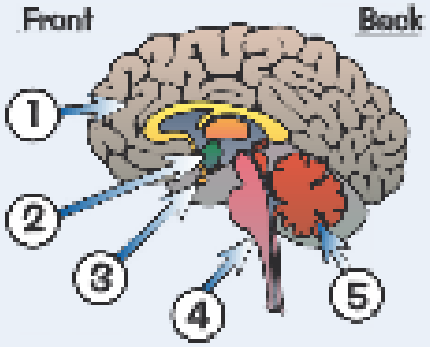
SB2e The Brain

Embryonic stem cells in a human embryo divide to produce more and more stem cells. Once an embryo is 3 weeks old the stem cells in the brain area start to differentiate to produce neurons (nerve cells), which make up most of the brain. An adult brain has about 86 billion neurons, which interconnect with one another and other parts of the body to process information and control the body.

The Brain is Responsible for Complex Behaviours

The brain is made up of billions of interconnected neurones. It controls and coordinates everything you do. We know that different regions of the brain carry out different functions:

1. Cerebrum — This is the outer wrinkly bit. It's responsible for things like consciousness, intelligence, memory and language.
2. Hypothalamus — Involved in maintaining body temperature at the normal level . Also produces hormones that control the pituitary gland.
3. Pituitary — A gland that produces many important hormones, such as some of those involved in the menstrual cycle
4. Medulla — Controls unconscious activities (things you don't have to think about doing) like breathing and your heart rate.
5. Cerebellum — Responsible for muscle coordination.



SB2e The Brain Questions

- Draw a table to summarise the structures and functions of the major parts of the brain.
- Suggest why a professional pianist might have a cerebellum that is larger than usual.
- Suggest why the medulla is sometimes referred to as the automatic pilot of the brain.
- Give a function of the hypothalamus.
- Describe how most of the cells in the brain develop.

SB2f Brain and Spinal Cord Problems

There are many things that can go wrong with the brain or other parts of the nervous system, e.g. injuries to the brain or spinal cord, tumours, diseases, etc. These can be difficult to treat successfully:

- It's hard to repair damage to the nervous system — neurones in the CNS don't readily repair themselves and as of yet scientists haven't developed a way to repair nervous tissue in the CNS.
- If a problem occurs in a part of the nervous system that's not easy to access it can be hard to treat, e.g. it's not possible to surgically remove tumours growing in certain parts of the brain.
- Treatment for problems in the nervous system may lead to permanent damage, e.g. surgery to remove a brain tumour may leave surrounding parts of the brain permanently damaged.

Scanning allows scientists to look deeper into the brain than surgery does. It also allows the study of a healthy individual without the risk of damaging the brain.
A CT scan shows the shapes of structures in the brain.
A PET scan shows brain activity.

Spinal Cord Damage

Damage to the spinal cord reduces the flow of information between the brain and parts of the body.

Brain Tumours

Cancer cell soften divide rapidly to form a tumour. A brain tumour may squash parts of the brain and stop them working.

SB2f Brain and Spinal Cord Problems Questions

- State two advantages of CT scanning to investigate brain functions compared with using electrodes during brain surgery.
- Karen's spinal cord was cut in an accident. Explain why the damage means that she will never regain full movement or feeling.

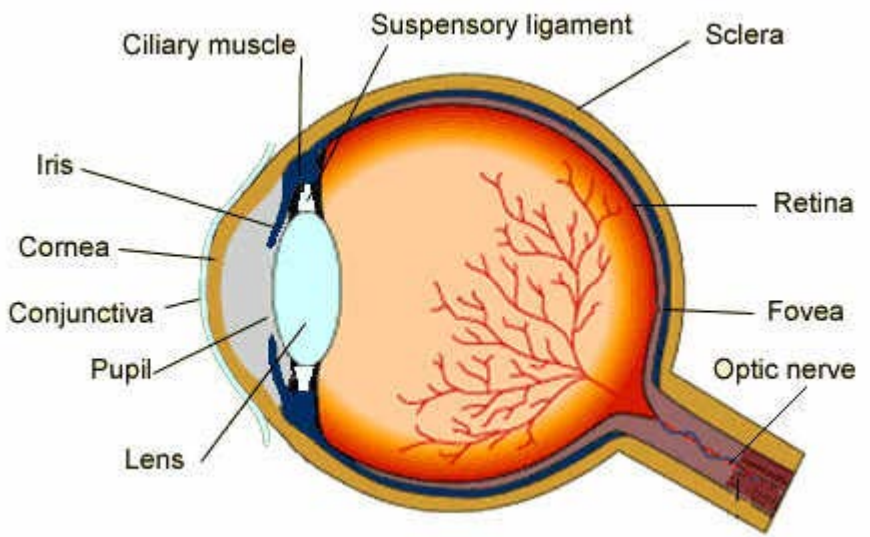
SB2h The Eye

- **Constricted pupil – small to reduce light entering**
- **Dilated pupil – larger to allow more light to enter**

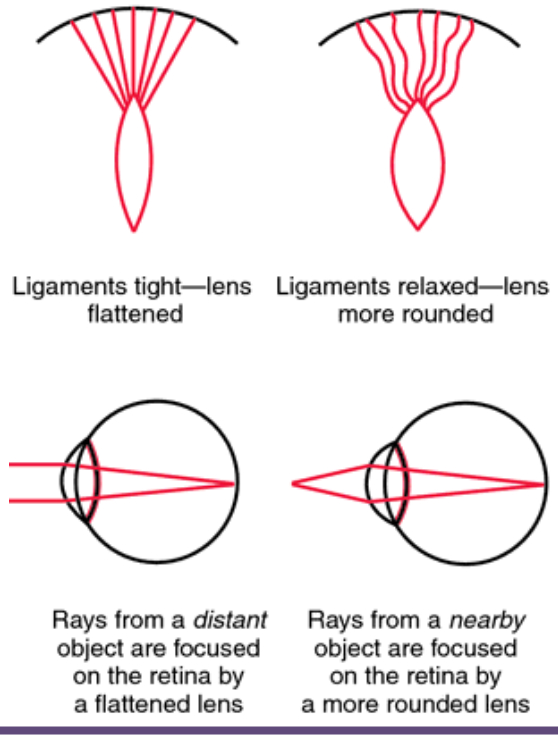
Image formation

- Light **converges** on the retina
- Path of rays is changed by the eye by **refraction** (carried out by cornea and lens)
- **Ciliary muscles** change the shape of the lens to keep image focussed on retina if the distance alters.
  - Contracted ciliary muscles = loose ligament = lens more rounded = focus on nearby objects
  - Relaxed ciliary muscles = taut ligaments = lens flattened = focus on distant objects
- No limit to how far away you can focus – **far point** is at **infinity**
- You near point is approx. **25cms** – nearer and image is **blurred**.

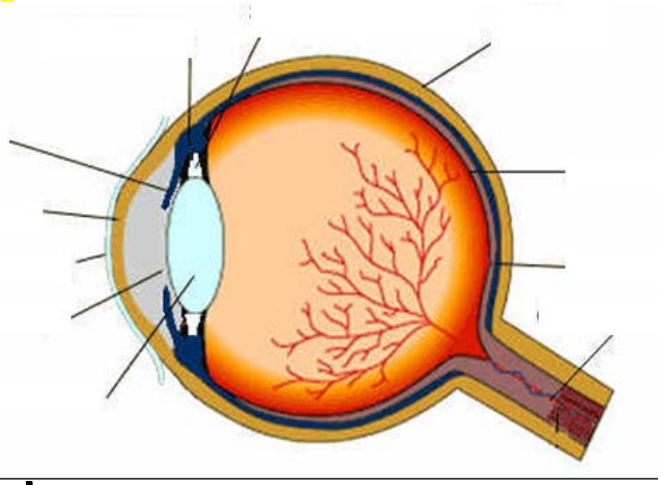
Eye structure diagram



Accommodation/ Focussing



SB2h The Eye Questions



1. What are the main structures of the eye?

2. What controls the amount of light entering the eye?

3. Which medical techniques use harmful, ionising radiation?

4. What distance is your far point when focussing?

5. Why does an image get blurred when it is nearer that 25cm to your eye?

6. What is the job of the ciliary muscle

SB2h The Eye – Eye Problems

Keywords

- **Short Sight**– cannot focus on distant objects as light rays focus on a point in front of the retina
- **Long Sight** – cannot focus on near objects as light rays focussed to a point behind the retina
- **Diverging Lenses** – spreads out light rays
- **Converging Lenses –** brings light rays together

Short and long sightedness

- **Near** objects = lens is shorter and **fatter**
- **Distant** object = lens is **thinner**

Short sighted

- Eyeball **too long** or cornea curved **too sharply**
- Rays focussing **in front** of retina
- **Distant** objects are **blurred**

Long sighted

- Eyeball **too short** or lens **not thick /curved enough.**
- Taut ciliary muscles still **cannot bend** the **light** enough
- **Near** objects are **blurred**

Correcting vision

- **Short** sight corrected by glasses with **diverging** lenses
  - Bends light apart to focus correctly on retina
- **Long** sight corrected by glasses with **converging** lenses
  - Refracts the light more to meet on the retina.

Laser Correction

- Uses a laser beam to **reshape** the front of the cornea
- Lasers make **precise incisions** without damaging surrounding areas
- Changes the way light is refracted by the cornea

SB2h The Eye – Eye Problems Questions

1. A person who is long sighted struggles to focus what objects?

2. What lens shape is needed to correct short sightedness?

3. What lens shape is needed to correct long sightedness?

4. State methods other than glasses that can be used to correct vision problems

5. How can you permanently correct a person's vision? Explain how it works.

SB3a Sexual and Asexual Reproduction

	ASEXUAL REPRODUCTION	SEXUAL REPRODUCTION
ADVANTAGES	• Asexual reproduction can produce lots of offspring very quickly. • For example, bacteria, such as *E. coli*, can divide every half an hour.	• Creates genetic variation within the population. • This means that if the environmental conditions change, its more likely that some individuals will have characteristics that enable them to survive. • Over time this leads to evolution as species become better adapted to their environment.
	• Only one parent is needed — this means organisms can reproduce whenever conditions are favourable without having to wait for a mate. • For example, aphids produce asexually during summer when there is plenty of food.	
DISADVANTAGES	• There's no genetic variation between offspring. • So, if the environment changes and conditions become unfavourable, the whole population can be affected. • For example, Black Sigatoka is a disease that affects banana plants, which reproduce asexually. So, if there's an outbreak of the disease, it's likely that all banana plants in the population will be affected as there are none that are resistant to it.	• Sexual reproduction takes more time and energy than asexual reproduction, so organisms produce fewer offspring in their lifetime. • For example, organisms need to find and attract mates, which takes time and energy. E.g. male bowerbirds build their females an attractive structure and then dance for them.
		• Two parents are needed for sexual reproduction. This can be a problem if individuals are isolated. • For example, polar bears often live alone, so male polar bears may have to walk up to 100 miles to find a mate.

SB3a Sexual and Asexual Reproduction Questions

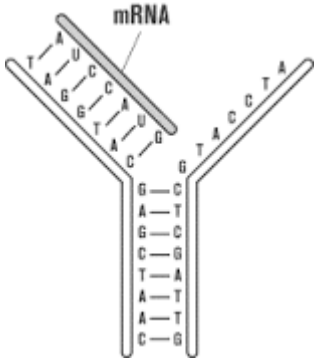
- Strawberry plants can reproduce asexually. Discuss the advantages and disadvantages of this form of reproduction.
- Why does asexual reproduction produce offspring that are genetically identical?
- State with a reason, whether humans reproduce sexually or asexually.

SB3d PROTEIN SYNTHESIS

Protein synthesis takes place in two stages – transcription and translation…

Transcription:

- Transcription takes place inside the nucleus
- The DNA is first unzipped by breaking the weak hydrogen bonds between the bases in the double helix – this separates the two strands of DNA
- One of the DNA strands then acts as a template…:
  - RNA bases that are complementary (i.e. that match) to the bases on the DNA strand link together
  - This forms a strand of messenger RNA (mRNA) that is complementary to the DNA template strand - see diagram below
- RNA vs DNA:
  - RNA only has one strand (not two like DNA has)
  - RNA has a base called uracil (U) instead of thymine (T)…→
    - in RNA: adenine (A) bases pair with uracil (U) bases
    - in DNA: adenine (A) bases pair with thymine (T) bases
    - In the diagram an adenine (A) base on the strand of DNA is matched by a complementary uracil (U) base on the mRNA strand
    - a thymine (T) base on the strand of DNA is matched by a complementary adenine (A) base on the mRNA strand



SB3d Questions on Protein Synthesis

- Name the two processes in protein manufacture
- Where does transcription occur?
- What bonds break when the DNA breaks apart?
- What do we call the strand that is made that joins to the single strand of DNA?
- What is the difference in coding in the mRNA?

SB3d DNA DISCOVERY

- In the 1950s,Rosalind Franklin was investigating the structure of DNA. She directed beams of x-rays at purified DNA and used photos to record how the DNA molecules scattered the x-rays
- At the same time, Watson and Crick were trying to build a 3D molecular model of DNA, using data obtained by other scientists. The detailed x-ray images from Franklin gave Watson and Crick the clues they needed to come up with their double helix model
- Watson and Crick published their findings and Franklin was barely mentioned
- Eventually, though, it became clear that all 3 scientists (i.e not just Watson and Crick) were key to the discovery of the structure of DNA and they were all (except for Franklin, who died beforehand) awarded Nobel Prizes

SB3d Questions – DNA Discovery

- In which decade was the structure of DNA discovered?
- Who discovered DNA structure and what particle was used?
- What were Watson and Crick using to build a 3D model of DNA?
- Who published their findings first?
- Who got awarded a Nobel prize?

SB3e Genetic Variants and Phenotypes

Mutations

A change in the bases of a gene creates a genetic variant or **mutation**. It can be caused when DNA is not copied properly in cell division. Environmental factors can also cause mutations. Some mutations change an organism's **phenotype** (observable characteristics).

Mutations are the reason that genes exist in different forms, called **alleles**. One gene can have many alleles, caused by different mutations. Your characteristics are shaped by the alleles you inherit.

Most genetic variants have very little or no effect on the protein the gene codes for. Some will change it to such a small extent that its function is unaffected.
This means that most mutations have no effect on an organism's phenotype.

Some variants have a small influence on the organism's phenotype — they alter the individual's characteristics but only slightly. For example:

> Some characteristics, e.g. eye colour, are controlled by more than one gene. A mutation in one of the genes may change the eye colour a bit, but the difference might not be huge.

SB3e Genetic Variants and Phenotypes Questions

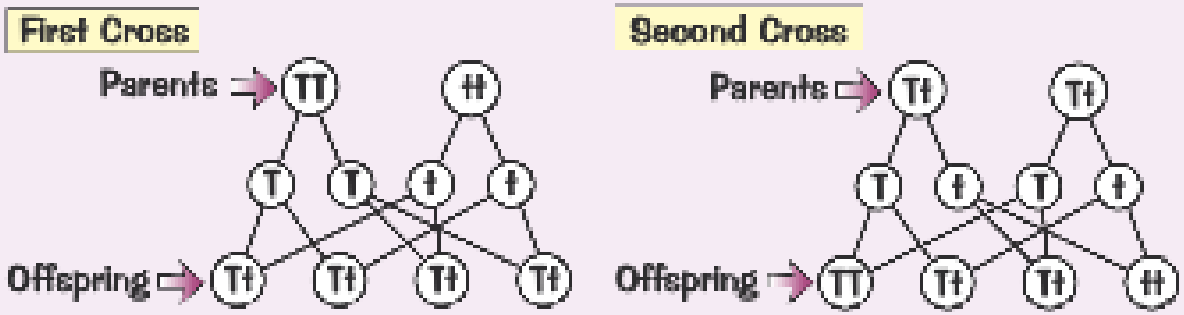
- Describe what is meant by the term phenotype.
- How likely is it that a variant will have a really big effect on an organisms phenotype?
- Explain how a mutation leads to the formation of a genetic variant.

SB3f Mendel

Mendel Helped Us Understand Genetics

Gregor Mendel was a monk who was alive in the 1800s. On his garden plot, he noted how characteristics in plants were passed on from one generation to the next. The results of his research were published in 1866 and eventually became the foundation of modern genetics. He carried out crosses for height in pea plants:

1) Mendel crossed a tall pea plant with a dwarf pea plant. All the offspring were tall.
2) So, Mendel took two of the tall plants from the first set of offspring and crossed them. This time, 75% of the offspring were tall but 25% were dwarf plants.
3) This is explained nicely by a genetic diagram:



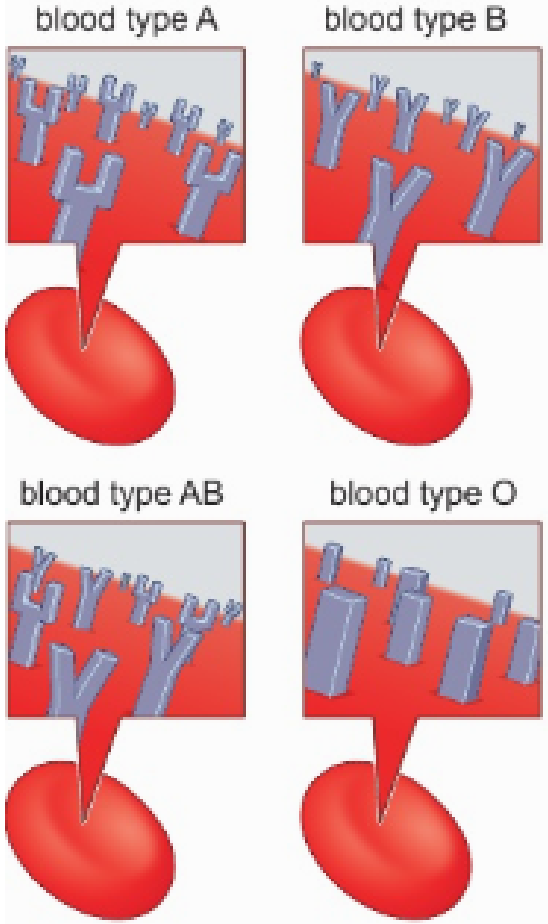
4) Mendel had shown that the height characteristic in pea plants was determined by separate "inherited factors" passed on from each parent. The ratios of tall and dwarf plants in the offspring showed that the factor for tall plants, T, was dominant over the factor for dwarf plants, t.

We now know that the "inherited factors" are of course genes. But back then nobody knew anything about DNA. It wasn't until a long time after Mendel's death that other scientists linked his inherited factors with genes and chromosomes — and realised the significance of his work.

SB3f Mendel Questions

- Suggest why Mendel put his pollinated flowers in bags.
- What do we call Mendel's factors today?
- Describe how the work of Mendel contributed to our understanding of genetics.

SB3i Multiple and Missing Alleles



A People with different blood types have different markers on their red blood cells.

If a person loses a lot of blood, such as in an accident or operation, they must be given more blood to help them survive. The blood they are given must be of the right type otherwise the red blood cells in it will clump together, which can kill.

One way of classifying different types of blood is the **ABO blood group** system. In this system, everyone's blood is in one of four groups: A, B, AB and O. Which blood group you have is determined by whether you have certain 'marker molecules' on the outside of your red blood cells. There are three main types of these markers, which we refer to as A, B and O.

1 Use diagram A to identify the marker molecules on the red blood cells of people with each of the four ABO blood groups.

The gene that is responsible for the markers in the ABO system has three alleles, written as I^A, I^B and I^o. Everyone has two copies of the gene, so may be homozygous for any of the three alleles or heterozygous for any two of the three alleles. I^o is recessive to both I^A and I^B. However, a person with genotype I^AI^B shows the effect of both alleles and has the blood group AB. When both alleles for a gene affect the phenotype, we say they are **codominant**.

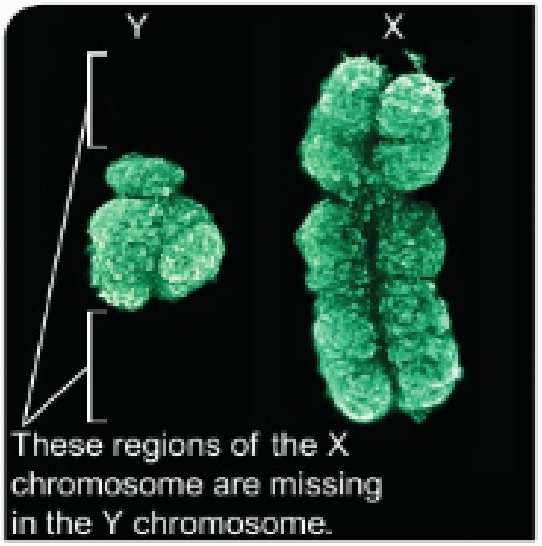
2 Explain why ABO blood groups show codominance.

3 Write down the possible genotypes of the following blood groups.

a AB **b** O **c** A **d** B

SB3i Multiple and Missing Alleles with questions

H



B The human Y and X chromosomes.

Sex-linked genetic disorders

Chromosomes in diploid cells come in pairs. In most pairs, the chromosomes have the same genes. However, the human Y sex chromosome is missing some of the genes found on the X chromosome. This means a man (XY) will have only one allele for some genes on the X chromosome (because those genes are missing on the Y chromosome). If the allele for one of these X chromosome genes causes a genetic disorder, then a man will develop that disorder.

If a woman (XX) inherits the 'disorder' allele, she may have a 'healthy' allele on her other X chromosome. If the 'disorder' allele is recessive, she will not get the disorder. If she inherits two recessive 'disorder' alleles, she will develop the disorder. However, the probability of a woman getting the disorder is much less than that of a man developing it. Disorders that show a different pattern of inheritance in men and women are called **sex-linked genetic disorders**.

68

Using a Punnett square, explain why a mother with blood group A and a father with blood group B could have a child with any of the four blood groups.

Explain how ABO blood group alleles illustrate dominance, recessiveness and codominance.

SB4c Development of Darwin's Theory

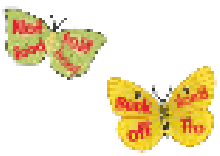
Darwin Came up With The Theory of Evolution by Natural Selection...

1) Charles Darwin was the guy that came up with the theory of evolution by natural selection.
2) Darwin spent 5 years on a voyage around the world studying plants and animals.
3) He noticed that there was variation in members of the same species and that those with characteristics most suited to the environment were more likely to survive. He also noticed that characteristics could be passed on to offspring.
4) He wrote his theory of evolution by natural selection to explain his observations.

Charles Darwin

... and Wallace Contributed Too

1) Alfred Russel Wallace was a scientist working at the same time as Darwin.
2) He also came up with the idea of natural selection and worked with Darwin on it.
3) Wallace's observations provided evidence to help support the theory of evolution by natural selection. E.g. he realised that warning colours are used by some species (e.g. butterflies) to deter predators from eating them — an example of an advantageous adaptation that had evolved by natural selection.
4) But, it was Darwin's famous book 'On the Origin of Species' that made other scientists pay attention to the theory so Darwin is usually better remembered than Wallace.

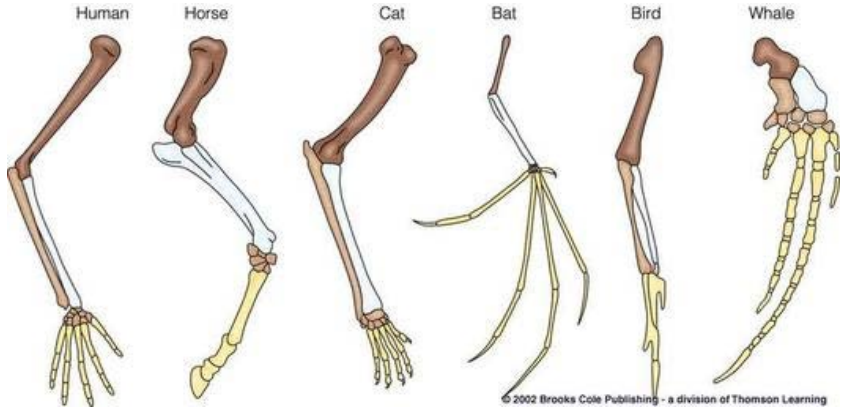


Ideas About Evolution have Influenced Modern Biology

The theory of evolution by natural selection is still relevant today — we now understand that all life changes through the process of evolution and we have all descended from a common ancestor. This has affected lots of different areas of biology including:

- classification — this is now much more based on evolutionary relationships
- antibiotic resistance — we now understand the importance of finishing a course of antibiotics to prevent resistant bacteria spreading and we know we need to constantly develop new antibiotics to fight newly-evolved resistant bacteria (see previous page).
- conservation — we now understand the importance of genetic variation and how it helps populations adapt to changing environments. This has led to conservation projects to protect species

SB4c Development of Darwin's Theory with questions



All vertebrates have the same five-fingered 'pentadactyl' limb structure

From fossils, we know that even limbless vertebrates living on Earth millions of years ago had a pentadactyl limb structure

This suggests that all vertebrates evolved from one common ancestor hundreds of millions of years ago

- The pentadactyl limb has evolved differently in different vertebrates, to adapt to different ways of living and moving
- How do we know that vertebrates had the same feature millions of years ago?
- Why has this feature evolved differently in different vertebrates?

SB4f Tissue Culture

Tissue culture is the growing of cells or tissues in a liquid containing nutrients or on a solid medium (such as nutrient agar). This is a useful way to grow many identical cells. These may form a callus(a clump of undifferentiated cells). Sometimes the cells are then treated to make them differentiate (become specialised).

Tissue culture is used to produce new plants of very rare species which are at risk of extinction. It is also used to produce new individuals of plant species that may be difficult to grow from seed , such as orchids. The technique is also use to produce clones of GM plants.

SB4f Tissue Culture questions

- Give one example of how tissue culture is used in medicine.
- Explain why all the cells in a plant callus are genetically identical.
- Give one example of how tissue culture is used in plant breeding.
- Describe one advantage of using tissue culture in plant breeding and one advantage of using tissue culture in medicine.

SB4h GM and Agriculture

1) Plants can be genetically modified to make them resistant to insect pests.
2) There's a bacterium called *Bacillus thuringiensis* (Bt) which produces a toxin (poison) that kills many of the insect larvae that are harmful to crops.
3) The gene for the Bt toxin is inserted into crops, like corn and cotton, which then produce the toxin in their stems and leaves — making them resistant to the insect pests.
4) The toxin is specific to insect pests — it's harmless to humans, animals and other insects.
5) A good thing about Bt crops is that farmers need to apply less pesticide (because the crops already have it built into them). This avoids the negative impacts of pesticide use
6) There's a drawback to Bt crops though. There's a danger that insects might develop resistance to the toxin and no longer be killed by it.

Genetic engineering can also be used to combat certain deficiency diseases. For example:

In some parts of the world, the population relies heavily on rice for food. In these areas, vitamin A deficiency can be a problem, because rice doesn't contain much of this vitamin, and other sources are scarce. Genetic engineering has allowed scientists to take a gene that controls beta-carotene production from carrot plants, and put it into rice plants. Humans can then change the beta-carotene into vitamin A. Problem solved.

SB4h GM and Agriculture Questions

- Explain why some insects are a problem in agriculture.
- Suggest how plants were genetically modified to produce Bt toxin.
- Explain how growing GM crops that are insect resistant could a) benefit the environment or b) harm the environment.
- Give two potential risks of growing genetically engineered cloths.

SB4i Fertilisers and Biological Control

Fertilisers Are Used to Ensure Crops Have Enough Nutrients

1) Plants need certain elements, e.g. nitrogen, potassium and phosphorus, so they can make important compounds like proteins.
2) If plants don't get enough of these elements, their growth and life processes are affected. Sometimes these elements are missing from the soil because they've been used up by a previous crop planted in the same soil.
3) Farmers use fertilisers to replace these missing elements or provide more of them. This helps to increase the crop yield by boosting plant growth.

4) However, fertilisers can cause environmental problems. Excess fertiliser can run off fields and end up in ponds, rivers and lakes, which can result in the death of organisms living in the water.

Biological control

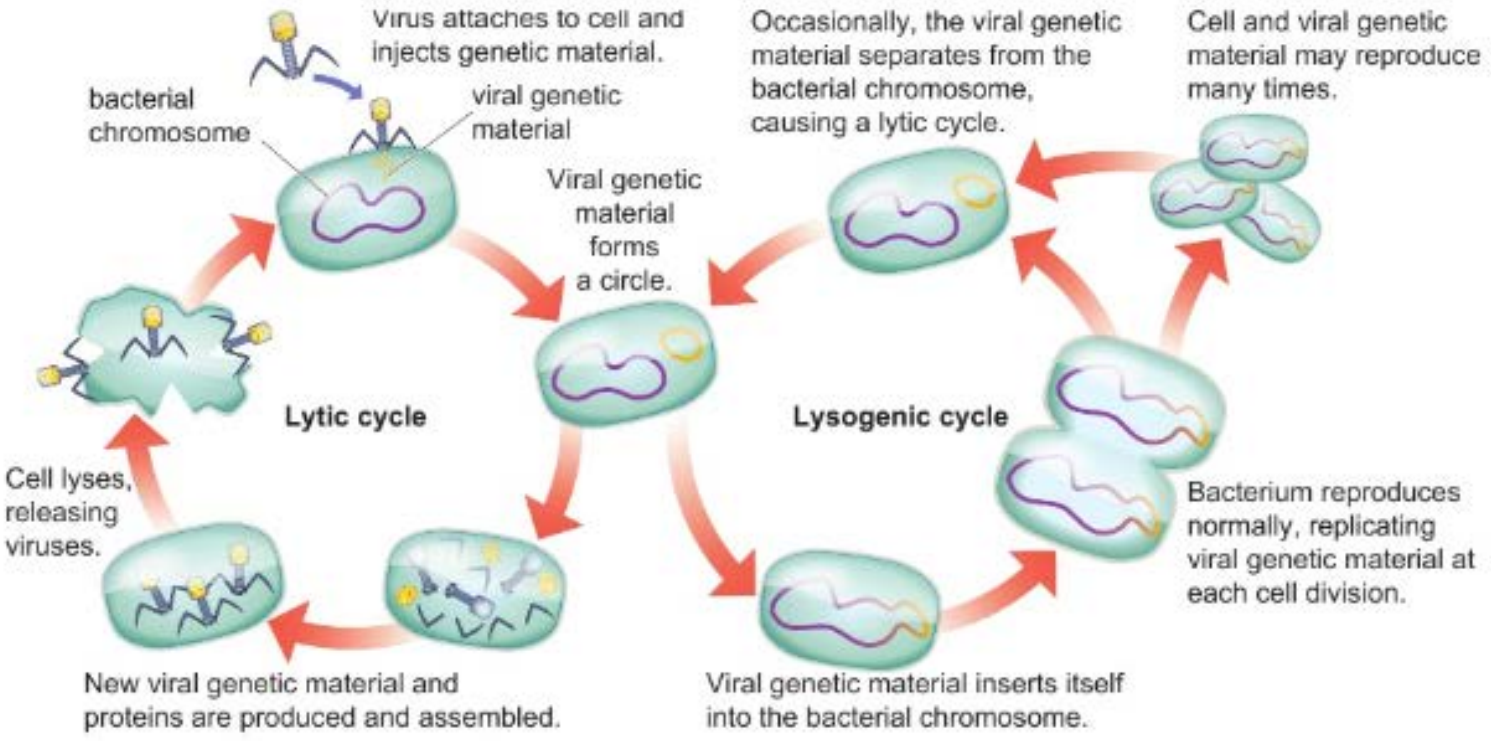
1) Biological control is an alternative to using pesticides. It involves using other organisms to reduce the numbers of pests. This is done by encouraging wild organisms or adding new ones.
2) The helpful organisms could be predators (e.g. ladybirds eat aphids), parasites (e.g. some flies lay their eggs on slugs, eventually killing them), or disease-causing (e.g. bacteria that affect caterpillars).
3) Biological control can have a longer-lasting effect than spraying pesticides, and be less harmful to wildlife. But introducing new organisms can cause problems — e.g. cane toads were introduced to Australia to eat beetles, but they're now a major pest themselves because they poison the native species that eat them.
4) Biological control can be considered a safer alternative to pesticides. This is because no chemicals are used, so there's less pollution, risk to people eating the food and no passing of chemicals along food chains.

SB4i Fertilisers and Biological Control Questions

- Explain how biological controls can increase agricultural yields.
- Explain why adding fertiliser affects the yield of crop plants.
- Explain why more fertiliser must be added to a field with each new crop.

SB5f Virus Life Cycles

Viruses are not cells. They're really tiny, about 1/100th the size of bacterium. They replicate themselves inside the infected organism cells. These cells then burst releasing the viruses.



SB5f Virus Life Cycles

- What is a virus?
- Explain why viruses cannot replicate outside a living cell.
- Compare the lytic and lysogenic pathways in a viruses life cycle.

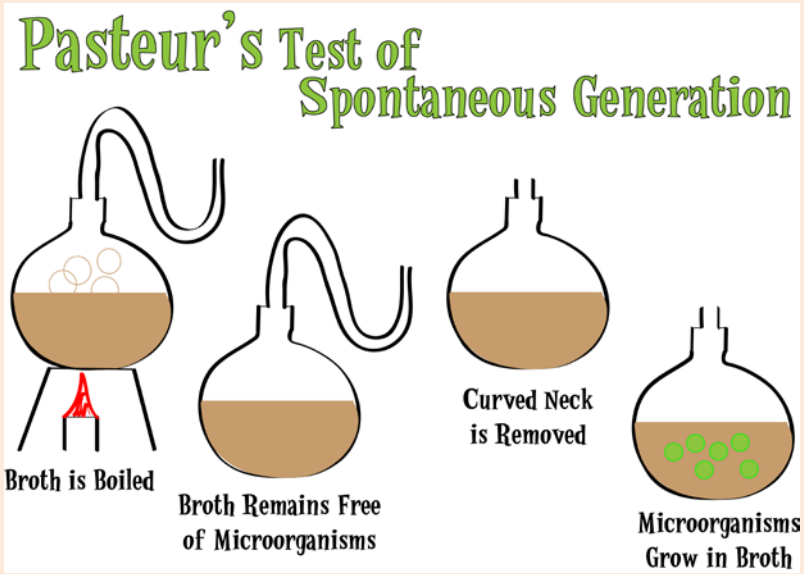
SB3g Plant Defences

Plants can protect themselves by producing chemicals. Some of these can be used by humans to prevent disease or relieve symptoms.

1. Some leaves contain poisonous chemicals to stop pests eating them e.g. lupins
2. Some plants produce chemicals to kill pathogens e.g. some potatoes are resistant to potato blight (fungus)

Humans exploit this by…

a. Digoxin from foxgloves can be used to treat heart disorders.
b. Quinine from cinchona trees can be used to treat malaria.
c. Aspirin from willow tree bark is used as pain and fever relief.



Pasteur showed that microorganisms were responsible for some foods going off and for some diseases. By using the swan necked flask, microbes were unable to get into the broth so it did not spoil.

Plants attacked by pathogens can disrupt the human food supply. Lack of food can cause economic loss for farmers and lack of food e.g. Potato blight was responsible for the famine in Ireland that led to 1million deaths.

SB5g Plant Defences Questions

1. Describe Louis Pasteur's work in aseptic techniques.
2. What do plants do to protect themselves?
3. Name three plant poisons we use as drugs.
4. What is a pathogen?
5. What effect does plant attack by pests have on the human food supply?

SB5h Plant Diseases

Diseases Can be Detected in the Field and in the Lab

1) In the field, plant diseases are usually detected by observations. Scientists can recognise the symptoms of different plant diseases.

Growths might indicate crown gall disease or mottling of leaves might mean that the plant has tobacco mosaic disease.

Plant diseases may also be identified by touch (e.g. a soft or squashy feeling may indicate rot) or by smell (e.g. some bacterial diseases have a particular smell).

Sometimes a microscope is needed to observe smaller features, e.g. to distinguish between different types of fungi that look similar to the naked eye.

2) Pathogens can also be identified in the lab. The ELISA test and the Polymerase Chain Reaction (PCR) are two methods that are commonly used:

ELISA test

- Antigens are unique molecules on the surface of cells. They can be detected using antibodies — proteins that bind to a specific antigen.
- Antigens from a pathogen will be present in a plant infected with that pathogen.
- In an ELISA test, antibodies for the pathogens' antigens are used. These antibodies have enzymes attached to them, which can react with a substrate causing a colour change.
- The antibodies are added to the sample being tested, and are then washed off — but, if the antibodies bind to antigens they will remain in the sample. If there's a colour change when the substrate is added, it demonstrates that the antigen (and so the pathogen) is present.

PCR

- You can see if the DNA of the pathogen is present in your plant sample.
- Parts of the DNA strand complementary to that of the pathogen are used as primers (a sort of template). Any DNA that matches is copied over and over again. If the pathogen is present, lots of its DNA will be made and this will show up on images of the DNA.

SB5h Plant Diseases with questions

1) Regulating movement of plant material — this makes sure that infected plants don't come into contact with healthy plants, e.g. plant nurseries are not allowed to sell plants which have crown gall disease.
2) Destroying infected plants — this stops them being sources of infection.
3) Crop rotation — many pathogens are specific to a particular plant. Changing the type of plants that are grown stops the pathogens becoming established in an area.
4) Chemical control — for example, fungicides can be used to kill fungal pathogens or used as a preventative method by coating the bulbs or seeds before they're planted.
5) Biological control — e.g. crown gall disease can be prevented by dipping roots of plants into a suspension of a similar bacterium before they are planted in infected soils. This bacteria doesn't infect the plants — instead, it produces an antibiotic that prevents *Agrobacterium tumefaciens* from reproducing.

- Suggest why crop plants that have diseases may give a reduced yield.
- Describe 3 ways in which plant diseases may be identified.
- Give 2 physical methods that plants use to defend themselves against pathogens.

SB5l Monoclonal Antibodies

- **<u>Uses of Monoclonal Antibodies</u>**
- **Pregnancy Testing**
- Used to detect the hormone hGC.
- This hormone is found in the urine of pregnant women.
- If hGC is in the urine it binds to the monoclonal antibodies on the test stick and changes colour.
- **Diagnosis and treatment of cancer and blood clots,**
- Monoclonal antibodies can be made slightly radioactive.
- They can bind to antigens on the surface of cancer cells or platelets in blood clots.
- Radioactive monoclonal antibodies are injected into the patient and they are scanned to show where the radioactive monoclonal antibodies have stuck.
- Some chemotherapy drugs can be bound to the monoclonal antibody.
- When these are injected into the body the monoclonal antibody sticks to the tumour and the drug affects only the cells that it is bound to.
- Less drugs are needed as their action is targeted.
- Less side effects are noticed.
- Less drug is wasted so it is cheaper.

SB5l Monoclonal Antibodies Questions

1. How are monoclonal antibodies formed? Draw a diagram

2. State three uses of monoclonal antibodies.

3. Describe how a pregnancy test works

SB6e Plant Adaptations

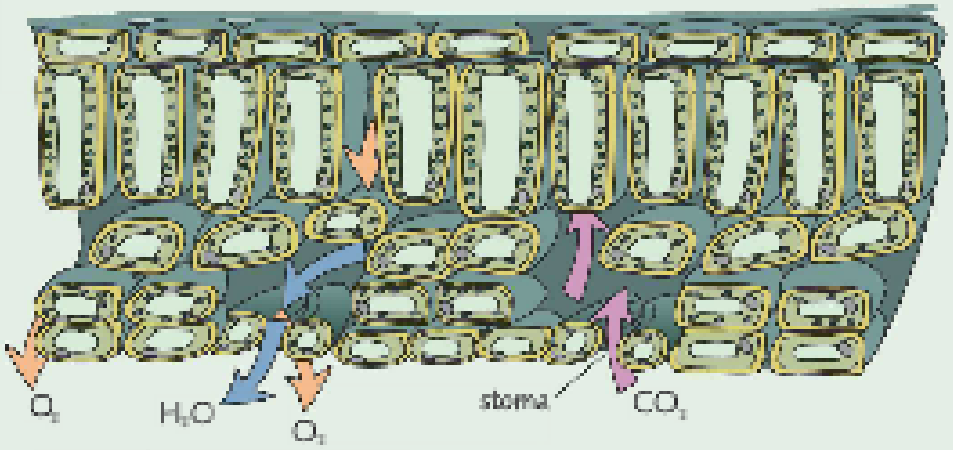
Leaves are Adapted for Efficient Gas Exchange

When plants photosynthesise they use up CO_2 from the atmosphere and produce oxygen as a waste product. When plants respire they use up oxygen and produce CO_2 as a waste product. So there are lots of gases moving to and fro in plants, and this movement happens by diffusion.

E.g. when the plant is photosynthesising it uses up lots of CO_2, so there's hardly any inside the leaf. This makes more CO_2 move into the leaf by diffusion (from an area of higher concentration to an area of lower concentration).

Leaves are specialised to maximise the diffusion of O_2 and CO_2:

1) Leaves are broad, so there's a large surface area for diffusion.
2) They're also thin, which means gases only have to travel a short distance



Oxygen (O_2) and water vapour (H_2O) diffuse out of the leaf.

Carbon dioxide (CO_2) diffuses into the leaf.

3) There are air spaces inside the leaf. This lets gases like CO_2 and O_2 move easily between cells. It also increases the surface area for gas exchange.
4) The lower surface is full of little holes called stomata. They're there to let gases like CO_2 and O_2 diffuse in and out. They also allow water to escape — which is known as transpiration

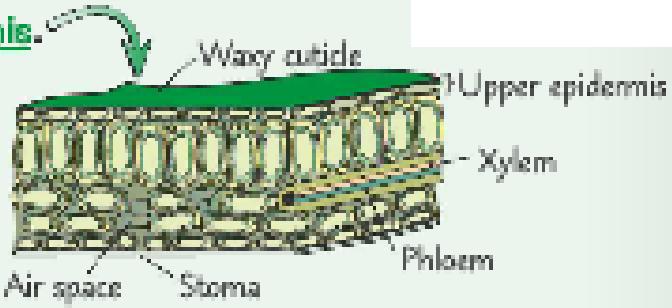
SB6e Plant Adaptations with questions

So plants have adaptations to help reduce water loss from their leaves:

1) Leaves usually have a waxy cuticle covering the upper epidermis. This helps make the upper surface of the leaf waterproof.

2) Most stomata are found on the lower surface of a leaf where it's darker and cooler. This helps slow down diffusion of water out of the leaf.

3) The bigger the stomata and the more stomata a leaf has, the more water the plant will lose. Plants in hot climates really need to conserve water, so they have fewer and smaller stomata on the underside of the leaf and no stomata on the upper epidermis.



- Give 3 ways that leaves are specialised to maximise the diffusion of oxygen and carbon dioxide.
- How are plant roots adapted to be able to absorb lots of water and mineral ions from the soil?
- Mamzanita bushes live in deserts. They have small leaves that have a very thick cuticle. Explain the functions of these features of the plant.

SB6f Plant Hormones

Tropisms

Responding to a stimulus by growing towards or away from it is called a tropism A tropism caused by light is called a phototropism. A tropism caused by gravity is called a gravitropism.

A tropism away from a stimulus is a negative tropism and tropism towards a stimulus is a positive tropism.

Auxins and positive phototropism in shoots

Plant shoots grow towards sunlight – 'positive phototropism' because they need sunlight for photosynthesis. This positive phototropism in shoots is caused by plant hormones called auxins.

Auxins are produced in the tips of shoots, where they cause elongation of cells. If a shoot is grown with light coming from only one direction, auxins move to the shaded side of the shoot. The presence of auxins makes the cells on the shaded side elongate more and cause the shoot to grow upwards towards the light. Auxins are only present at the tips of shoots and if the tips are cut then auxins are removed and shoots will not grow towards the light source.

Auxins and positive gravitropism in roots

Root tips grow downwards in the direction of gravity – 'positive gravitropism' because it helps them anchor the plant in place and reach moisture underground (important because water is needed for photosynthesis). Positive gravitropism in roots is also caused by auxins. In root tips, auxins have the opposite effect to that in shoots (i.e. they inhibit cell elongation instead of promoting it. Auxins accumulate on the bottom side of root tips and stop these cells elongating which causes the root to bend downwards in the direction gravity is acting.

Gibberellins stimulate growth of seeds

When a seed germinates, roots and a shoot start to grow. Some seeds need periods of darkness or cold before they will germinate and once this period is completed, the seed releases plant hormones called gibberellins.

Gibberellins cause starch stored in a seed to be turned into sugars that the seed uses as energy to grow. Gibberellins also stimulate flower and fruit production in some plant species.

SB6f Plant Hormones Questions

- Define the word tropism.
- What are the tropisms caused by light and by gravity?
- What is the difference between a negative and positive tropism?
- Describe the action of auxins in shoots.
- How is the action of auxins in roots different from in shoots?
- What does gibberellin do?

SB6g Uses of Plant Hormones

USES OF PLANT HORMONES

Selective weedkillers: In the Vietnam War, a weedkiller containing artificial auxins called Agent Orange was used to destroy the jungle so that the Americans could see enemy movements

Artificial auxin is still used as a selective weedkiller because it only makes plants with broad leaves (e.g daisies) grow out of control and die - plants with narrow leaves (e.g. wheat and grass) are unaffected hence farmers can kill all the weeds in a field without affecting their crop.

Rooting powder: Artificial auxins are also used in rooting powders. Dipping plant cuttings (parts of plants) in rooting powder gives a much faster root growth compared to growing plants from seed

Seedless fruit: Some seedless fruits are produced using plant hormones. Other plants, like some varieties of grape, are naturally seedless but have small fruits so the fruits are sprayed with gibberellins to increase their size.

Fruit ripening: Plant hormones naturally control the ripening of fruits so farmers can use plant hormones to control when and how ripening occurs. Plant hormones are sprayed onto Fruit trees to stop the fruit falling off. This stops fruits falling and becoming damaged and also allows the fruit to grow bigger. Plant hormones sprayed onto Fruit trees also speed up ripening so that all the fruit ripens together and can be picked off the trees all in one go. Plant hormones are sprayed onto unripe fruit to make them ripe.

SB6g Uses of Plant Hormones Questions.

- Describe three uses of plant hormones.
- Cuttings can develop roots without rooting powder. What is the advantage of using rooting powder?
- Explain how the use of selective weedkiller allows weeds on a playing field to be killed off without affecting the grass.

SB7g Thermoregulation

The control of body temperature is called thermoregulation. Body temperature must be maintained at 37°C because enzymes that help many chemical reactions to occur work best at this temperature. At too high temperatures, enzymes become denatured (lose their shape and stop working)

A small part of the brain called the hypothalamus constantly monitors body temperature. It receives information from nerve endings in the dermis of the skin about the temperature outside the body and it receives information about the temperature inside the body from the blood.

If the body temperature goes <u>below</u> 37°C the body will use the following mechanisms to raise temperature:

1. Shivering: The hypothalamus causes muscles to shiver **-** shivering releases heat which warms you up

2. Hairs stand on end: The hypothalamus causes erector muscles in the dermis to contract and the body hairs stand upright. This traps more air next to the skin, providing insulation

3. Vasoconstriction: Hypothalamus causes blood vessels to narrow ('vasoconstriction') so blood flow to the surface of the skin is reduced and therefore less heat is lost.

If the body temperature goes <u>above</u> 37°C the body will use the following mechanisms to raise temperature:

1. Sweating: The hypothalamus causes sweating. As sweat evaporates it transfers heat energy from the skin to the surroundings and the skin cools down

2. Hairs lie flat: The hypothalamus causes erector muscles in the dermis to relax sot hey lie flat and no heat is trapped between hairs which cools us down

3. Vasodilation: Hypothalamus causes blood vessels to widen ('vasodilation') and blood flow to the surface of the skin is increased so more heat is lost.

Hot	Cold
Vasodilation Arterioles dilate (enlarge) so more blood enters skin capillaries and heat is lost.	**Vasoconstriction** Arterioles get smaller to reduce blood going to skin: keeping core warm.
Sweating Sudorific glands secrete sweat which removes heat when water changes state.	**Shivering** Rapid contraction and relaxing of skeletal muscles. Heat produced by respiration.
Pilorelaxation This means the hairs flatten.	**Piloerection** Hairs on skin stand up.
Stretching Out By opening up, the body was a larger surface area.	**Curling Up** Making yourself smaller so smaller surface area.

Thermoregulation is an example of <u>negative feedback</u> which means that as a change to the body happens in one direction, mechanisms in the body work to make it change in the opposite direction. e.g if we get too hot, mechanisms in the body help us to cool down.

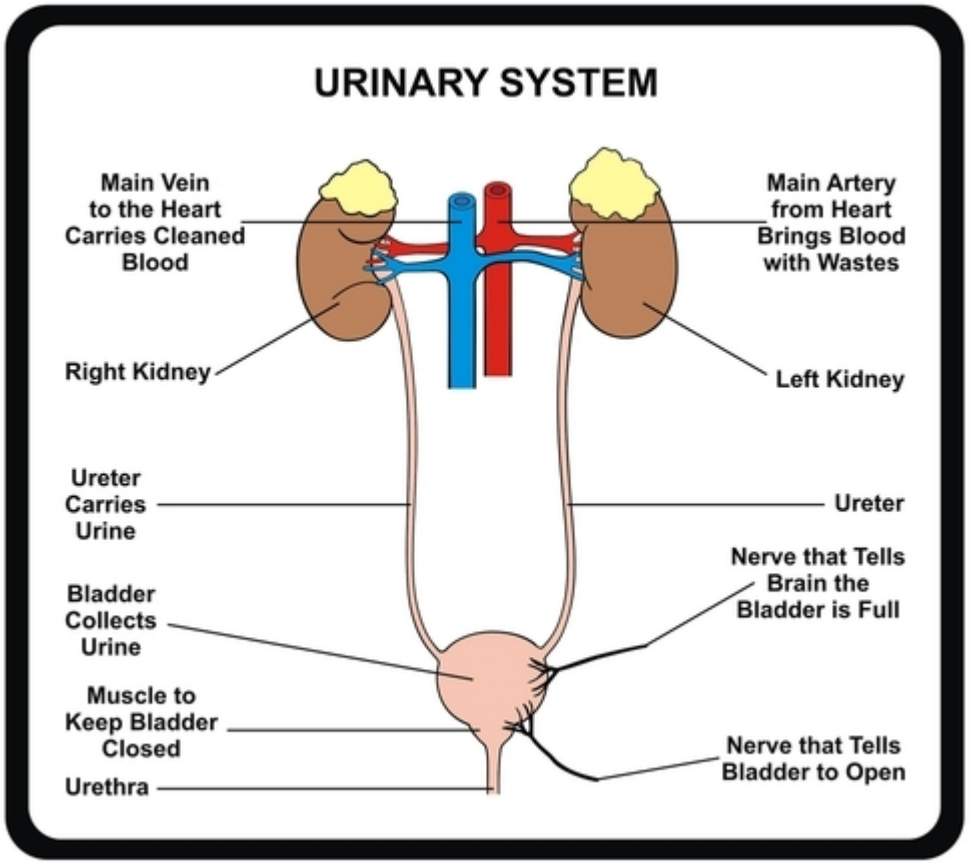
SB7g Thermoregulation Questions

- What is thermoregulation?
- Why is it important that body temperature remains at $37^{o}C$?
- What is the name of the part of the brain that maintains body temperature?
- Name two ways that the body can increase its temperature?
- Name two ways that the body can decrease its temperature?
- How does sweating bring the body temperature down?
- What is vasoconstriction and vasodilation?
- What is negative feedback?

SB7h&i Osmoregulation & the Kidneys

Cell metabolism leads to a build up of waste products such as UREA and CO_2. These need to be removed.

Urea is produced from the breakdown of excess AMINO ACIDS and is removed by the KIDNEYS.



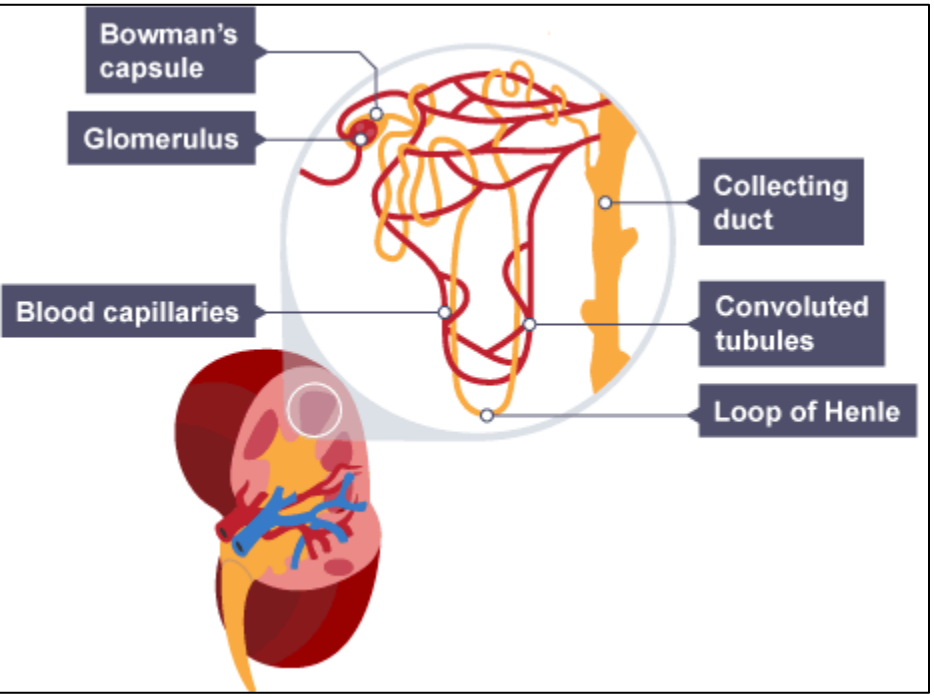
Treatments for kidney failure

1. Dialysis – a machine that removes waste products from the blood. They are expensive and dialysis takes a long time.
2. Kidney Transplant – Requires a donor with similar antigens to the recipient or the transplanted kidney will be rejected. Even with a good match, lifelong medication is required to prevent rejection.

SB7h&i Osmoregulation & the Kidneys questions

1. Name three waste products of cell metabolism.
2. What is urea formed from?
3. What are the main organs in the urinary system?
4. State the three treatments for kidney disease.
5. State two disadvantages of dialysis.

SB7h&i Osmoregulation & the Kidneys 2



Anything left in the nephron after the collecting duct is now urine which passes to the bladder for excretion.

Glomerulus – Network of capillaries into which blood from the renal artery flows. High pressure causes small molecules such as water, salt, urea and glucose to be filtered out – ULTRAFILTRATION.

Bowmans Capsule – Collects the water, urea, salt and glucose as the pass from the blood into the nephron.

Convoluted tubule – Selective reabsorption of some water, some salt and all glucose occurs here.

Loop of Henle – Water is reabsorbed here – OSMOREGULATION.

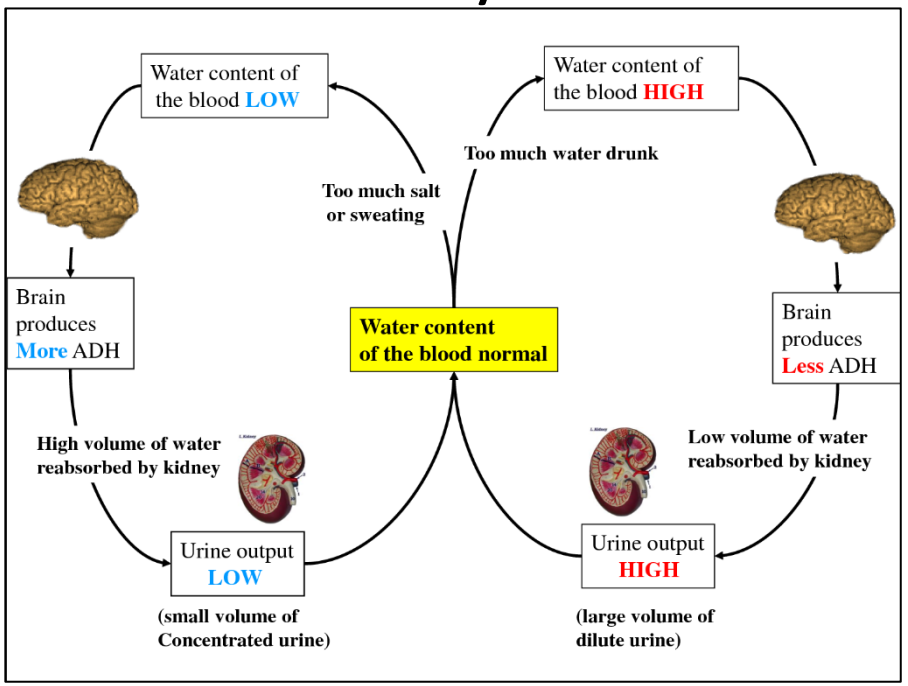
Collecting Duct – The final part of the nephron where water is reabsorbed – OSMOREGULATION.

SB7h&i Osmoregulation & the Kidneys 2 Questions

1. What are the main parts of the nephron?
2. Where do the following processes take place? filtration, selective reabsorption of glucose, reabsorption of water.
3. What does the term ultrafiltration mean?
4. What does the term osmoregulation mean?

SB7h&i Osmoregulation & the Kidneys 3

Water concentration in the blood is regulated by ADH produced by the Pituitary Gland.



ADH production is controlled by NEGATIVE FEEDBACK.

Negative feedback is where a change in a factor leads to the opposite change happening to keep conditions constant.

When water level is too high, the body detects this and reverses the change by secreting less ADH.

SB7h&i Osmoregulation & the Kidneys 3 questions

1. Which hormone regulates water content?
2. Where is it produced and released?
3. What is meant by negative feedback?
4. What effect will an increase in this hormone have on water content of the blood?

SB8b Factors affecting diffusion.

- **The rate of diffusion can be affected by concentration, surface area, distance and temperature.**

Surface area

Small particles can pass through membranes in organisms. If the surface area of a membrane is increased, there is more space through which particles can pass. This means that more particles cross from one place to another in a certain time, and so the overall rate of diffusion increases (but the rate at which particles pass through each unit area of the surface membrane is unchanged).

$$\text{rate of diffusion} \propto \text{surface area}$$

Distance

The further particles have to diffuse, the slower the rate of diffusion. So *increasing* the thickness of a membrane *decreases* the rate of diffusion. This is an **inversely proportional** relationship. As one variable doubles, the other halves.

$$\text{rate of diffusion} \propto \frac{1}{\text{thickness of membrane}}$$

SB8b Factors affecting diffusion with questions

A **concentration** is the amount of a substance in a certain volume. A common unit is g/cm^3 or g cm^{-3}, where the small minus sign shows that g is divided by cm^3. Another common unit is g dm^{-3} (1 dm = 1 litre = 1000 cm^3).

You can calculate the concentration of a solution in g dm^{-3} using this equation:

$$\text{concentration} = \frac{\text{mass of solute in g}}{\text{volume of solution in dm}^3}$$

Fick's law shows the relationship between the variables that affect diffusion:

$$\text{rate of diffusion} \propto \frac{\text{surface area} \times \text{concentration difference}}{\text{thickness of membrane}}$$

- How do surface area and concentration affect the rate of diffusion?
- What is the relationship between the rate of diffusion and diffusion distance?
- What is Fick's law?

SB9b Energy Transfers

Energy Transfers in Food Chains

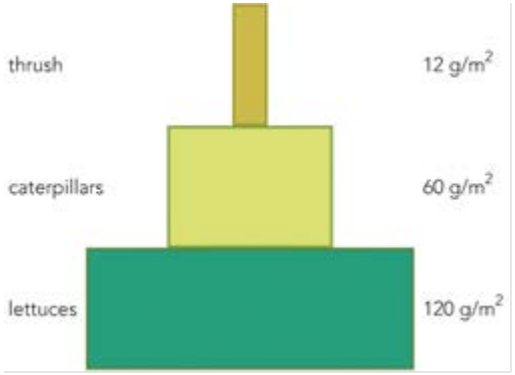
Energy is stored inside each living organism as 'biomass' (the total mass of an organism)

The energy stored in biomass is transferred to the next organism in the food chain when it's eaten. However, some of the energy is lost.

e.g. of the 8,450J in plants, 780J is passed on to rabbits when they eat the plants. The remaining 7,670J is lost.

So at each trophic level of a food chain, there is less and less energy to provide energy for another level and this limits the length of a food chain

- There is less and less energy in the biomass at each trophic level is represented as a 'pyramid of biomass'…i.e:
  - Lots of energy in the biomass at the producer stage shown as a wide base
  - Little energy in the biomass at the secondary consumer level shown as a narrow top
- Energy in biomass can be lost between trophic levels as a result of:
  - Respiration
  - Excretion
  - Regulation of body temperature (energy is lost as heat)
  - Movement/exercise
  - Not all of the organism being eaten



SB9b Energy Transfers Questions

- Identify the energy transfers to and from a herbivore.
- State how energy is transferred to a plant.
- Why is a pyramid of biomass a pyramid?
- Give 4 reasons why energy is lost at each level.

SB9e Assessing Pollution

- Pollution levels can be measured directly. The presence or absence of certain living organisms can also act as an indicator of the amount of pollution. These are known as indicator species.

Air pollution

The most common source of air pollution is the combustion of fossil fuels. This usually happens in vehicle engines and power stations. Sulfur dioxide is released if the fuel contains sulfur compounds. This gas contributes to acid rain. Lichens can be used as air pollution indicators, especially of the concentration of sulfur dioxide in the atmosphere.

Lichens are plants that grow in exposed places such as rocks or tree bark. They need to be very good at absorbing water and nutrients to grow there. Rainwater contains just enough nutrients to keep them alive. Air pollutants dissolved in rainwater, especially sulfur dioxide, can damage lichens and prevent them from growing. This makes lichens natural indicators of air pollution.

Factories can cause air pollution

SB9e Assessing Pollution Questions

Water pollution

Water pollution is caused by the discharge of harmful substances into rivers, lakes and seas. Many aquatic invertebrate animals cannot survive in polluted water, so their presence or absence indicates the extent to which a body of water is polluted.

- Explain what is meant by an indicator species for pollution.
- Why can certain lichen species be used as indicators of nitrogen oxide pollution?
- Explain how black spot fungus on roses can be used as an indicator for air pollution.

SB9i Food Security

Global Food Security – ensuring there is enough food for everyone in a world with an increasing population.

Integrated Pest Management – Reducing the number of pest species using a coordinated treatment of different pest control methods.

Conventional Plant Breeding – Producing new plants by using the natural technique of cross breeding two plants.

How can we ensure we meet the needs of a growing population?

1. Use new varieties of crops produced by conventional plant breeding.
2. Use an Integrated Pest Management System
3. Use Crop Rotation to avoid the build up of diseases
4. Use GM techniques to engineer plants with desired characteristics

Advantages of Biofuels	Disadvantages of Biofuels
Biofuels are renewable	Requires large amount of land
Biofuels are carbon neutral (the Carbon Dioxide they take in during their growth is equal to that they release when burned)	This reduces the amount of land that be used for growing crops

SB9i Food Security

1. What is meant by a 'global food security crisis'?
2. Describe what an integrated pest management system is.
3. If a plant is produced by conventional methods, describe what his means.
4. State two advantages and two disadvantages of the use of biofuels over fossil fuels.

SB9m Rates of Decomposition

Waste products and dead organisms are broken down by decomposers. The main types of decomposers are microorganisms, such as bacteria and fungi.

The rate of decomposition is affected by the following environmental factors:

1) Oxygen Availability

- Many decomposers need oxygen for aerobic respiration so the rate of decomposition increases where there is plenty of oxygen available.
- When there are low oxygen levels, the rate of decomposition is slower. Some decomposers can respire anaerobically (without oxygen - but this transfers less energy, so these decomposers work more slowly.

2) Temperature

Most decomposers work best in warm conditions — the rate of decomposition is highest at around 50 °C. This is because decomposers contain enzymes, which digest the dead/waste material. The rate of enzyme-controlled reactions varies with temperature — at lower temperatures the rate of reaction is slower and above certain temperatures the enzymes become denatured and the reaction stops.

3) Water Content

Decomposers need water to survive, so the rate of decomposition increases in moist conditions. However, waterlogged soils don't contain much oxygen (which many decomposers need to respire — see above) so the rate decreases if there is too much water.

SB9m Rates of Decomposition Questions

- Give examples of two groups of decomposers.
- Explain why the rate of decomposition of food is usually reduced by a) reducing the temperature & b) reducing the oxygen concentration.
- Pickling reduces pH, explain why this helps to preserve food.
- Describe how you would build a compost heap to win a fastest ever compost competition. Explain your design.