CB1a/SB1a Microscopes

Cells are Studied Using Microscopes

1) Microscopes use lenses to magnify images (make them look bigger).
2) They also increase the resolution of an image. This means they increase the detail you can see. Resolution is how well a microscope distinguishes between two points that are close together.
3) Light microscopes were invented in the 1590s. They let us see things like nuclei and chloroplasts.
4) Electron microscopes were invented in the 1930s. They let us see much smaller things in more detail like the internal structure of mitochondria. This has allowed us to have a much greater understanding of sub-cellular structures. Only electron microscopes will let us see things as tiny as plasmids or viruses.
5) Transmission electron microscopes (TEMs) have a higher magnification and resolution than light microscopes but they're not portable, they're expensive and it's a complicated process to prepare specimens for use (which means they can't be used to look at living tissue, unlike light microscopes).

You Need to Know How to Work With Numbers in Standard Form

1) Because microscopes can see such tiny objects sometimes it's useful to write numbers in standard form.
2) This is where you change very big or small numbers with lots of zeros into something more manageable, e.g. 0.017 can be written 1.7×10^{-2}.
3) To do this you just need to move the decimal point left or right.
4) The number of places the decimal point moves is then represented by a power of 10 — this is positive if the decimal point's moved to the left, and negative if it's moved to the right.

EXAMPLE: A mitochondrion is approximately 0.0025 mm long. Write this figure in standard form.

1) The first number needs to be between 1 and 10 so the decimal point needs to move after the '2'. 0.0025
2) Count how many places the decimal point has moved — this is the power of 10. Don't forget the minus sign because the decimal point has moved right. 2.5×10^{-3}

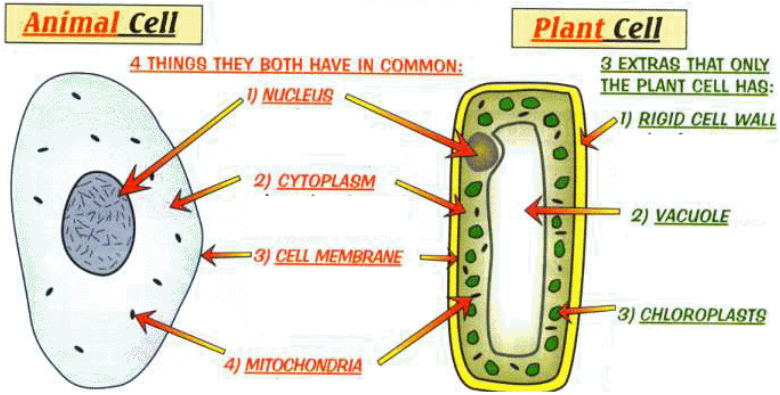
You can put standard form numbers into your calculator using the 'EXP' or the '×10ˣ' button. E.g. enter 2.67×10^{15} by pressing 2.67 then 'EXP' then 15.

CB1a/SB1a Microscopes - questions

- A photo of a water flea says it is magnified by x50. What does this mean?
- A microscope has a x5 eyepiece with x5, x15 and x20 objective lenses. Calculate its three total magnifications.
- State two advantages of using an electron microscope to view cells, rather than a light microscope.

CB1b/SB1b PLANT AND ANIMAL CELLS

The structure of cells can be studied using a light microscope. Image is magnified by lens (made bigger) and the different parts of a cell can be seen.



Plant and animal cells have some features in common:

- *Cell membrane:* separates the contents of the cell and its surroundings
  controls the movement of substances (e.g oxygen, glucose, carbon dioxide) in and out
- *Cytoplasm*: where many of the cell's chemical reactions take place and it contains many organelles (tiny structures that carry out specific jobs)
- *Nucleus*: an organelle that contains DNA (the genetic material) and controls all the activities of the cell
- *Mitochondria:* organelles in which aerobic respiration (i.e respiration in the presence of oxygen) takes place

Plant cells also have some extra structures:

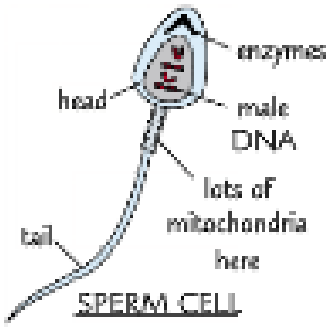
- Cell wall: made of tough cellulose, which supports the cell and gives it shape
- Large permanent vacuole: filled with cell sap - helps support plants by keeping cells turgid (i.e filled with water)
- Chloroplasts: organelles that contain chlorophyll – a green substance that absorbs light energy used for photosynthesis

CB1b/SB1b Questions – Plant and Animal Cells

- What would you use to see the structure of a cell? What part magnifies the cell?
- Name the part of the cell where the chemical reactions occur.
- What is an organelle?
- What does a cell membrane do?
- Name three substances that move in and out of the cell
- What process happens inside mitochondria?
- Name 3 extra structures that a plant cell has that an animal cell doesn't have. What does each structure do?

CB1c/SB1c Specialised Cells

1) Differentiation is the process by which a cell changes to become specialised for its job.
2) In most animal cells, the ability to differentiate is lost at an early stage, but lots of plant cells don't ever lose this ability.
3) Having specialised cells is important — it allows organisms to work more efficiently.
4) Most cells are specialised to carry out a particular job. For example:

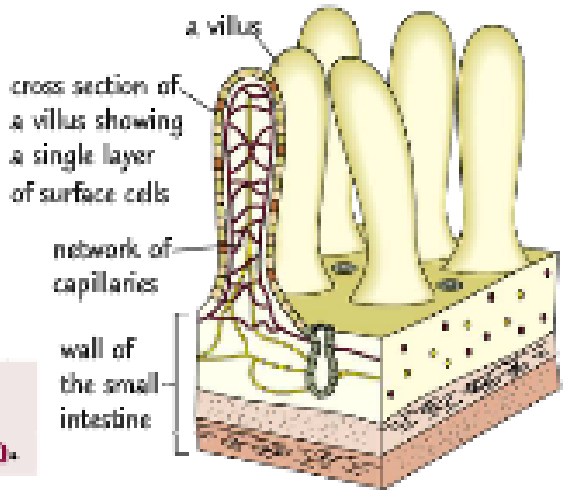


SPERM The function of sperm is basically to get the male DNA to the female DNA during reproduction. Sperm have long tails and streamlined heads to help them swim, they contain lots of mitochondria to provide them with energy, and they have enzymes in their heads to digest through the egg cell membrane.

5) In multicellular organisms, specialised cells are grouped together to form tissues — groups of cells working together to perform a particular function. Different tissues work together to form organs. Different organs make up an organ system.

The Villi Provide a Really Big Surface Area

1) The small intestine is where dissolved food molecules are absorbed out of the digestive system and into the blood.
2) The inside of the small intestine is covered in millions and millions of tiny little projections called villi.
3) They increase the surface area in a big way so that dissolved food molecules are absorbed much more quickly into the blood. They have:
   - A single layer of surface cells.
   - A very good blood supply to assist quick absorption.



CB1c/SB1c Specialised Cells questions

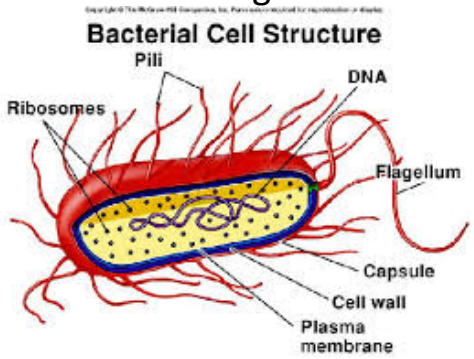
- List 3 specialised human cells and state their function.
- Make a drawing of a human sperm cell and label its parts.
- Explain why a sperm cell needs a tail but an egg cell does not.
- Explain why it is beneficial for the exchange surface of villi to be just one cell thick.

CB1d/SB1d Inside Bacteria

- Light microscopes can magnify more than 1500 times allowing us to see inside bacteria.
- Bacteria are single-celled organisms that are much smaller than animals or plant cells. Bacteria do not have nuclei.
- In the 1930s the electron microscope was invented - this uses a beam of electrons to magnify specimens up to about 2,000,000 times!
- Electron microscopes have shown us more detail about the structure of bacterial cells
- 1. Bacteria cells have two types of DNA
    - Chromosomal DNA – giant loop of DNA containing most of the genetic material
    - Plasmid DNA – comes in small loops and carries extra information

  2. Bacteria Cells have a cell wall
    - It's different to the cell wall in plants – it is not made of cellulose, and it is more flexible
    - However, it does a similar job (i.e provides support and shape)

  3. Some Bacteria cells have flagella on the outside:
    - These are long, whip-like structures that bacteria can use to move themselves along

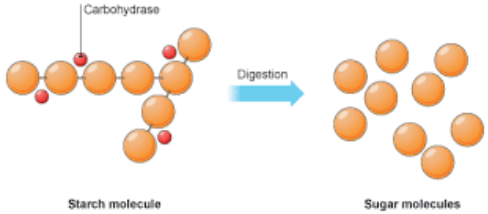


Cb1d/SB1d Questions – Inside Bacteria

- What type of microscope has allowed us to see even more detail of bacteria cells?
- What are the magnifications of a light microscope and of an electron microscope?
- Name the two types of DNA a bacterium cell has and what each types does.
- Give one reason why bacteria cell walls are similar to a plant cell wall and one reason why they are different.
- What is the name given to a ‘whip like’ structure that can make a bacterium cell move.

CB1e/SB1e Enzymes and Nutrition

The chemical breakdown of food (from large insoluble molecules into small soluble molecules) depends on the action of digestive enzymes. Different types of digestive enzymes break down the three main types of food molecules – carbohydrates, proteins and fats. Enzymes are biological catalysts that are proteins



Digesting carbohydrates

Digestive enzymes that break down carbohydrates are called 'carbohydrases' e.g amylase in saliva.

Amylase breaks starch down into sugars. The sugars can then either be absorbed by the small intestine or be broken down into glucose (a 'simple sugar') by other carbohydrases.

Digesting proteins

Protease enzymes break down proteins into shorter polypeptide chains and then into amino acids.

Pepsin is a protease produced in the stomach. The contents of the stomach are acidic so pepsin has an optimum pH of around pH2 or pH3 which means pepsin works best (breaks down proteins fastest) in acidic conditions

Some other proteases are produced by the pancreas and then released into the small intestine. The contents of the small intestine are weakly alkaline proteases that are released into the small intestine have an optimum pH of around pH8.

Digesting fats

Lipases are enzymes that break down fat molecules into fatty acids and glycerol. However, fats are insoluble and form large globules in the watery digestive juices. Large globules have a small surface area to volume ratio and lipases would only be able to break down the fat molecules very slowly

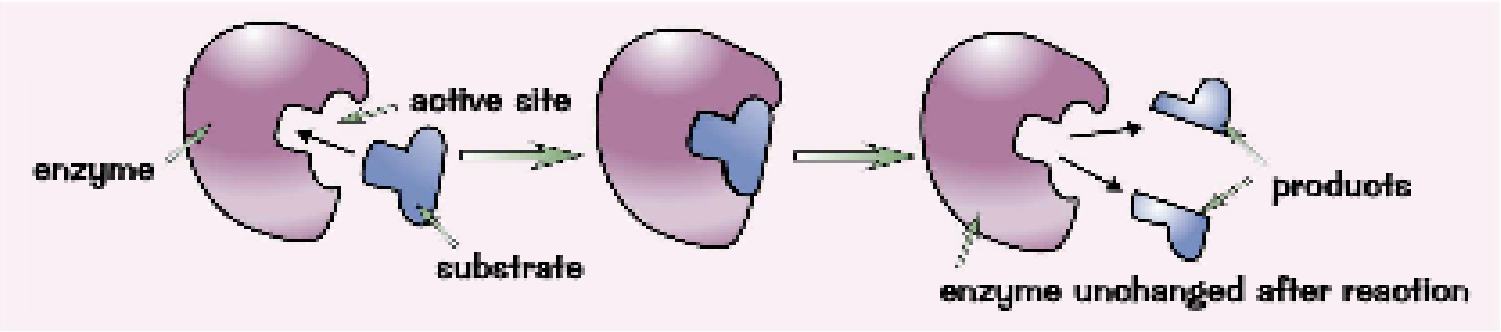
CB1e/SB1e Questions on Enzymes and Nutrition

- What does carbohydrase do?
- Name the enzyme that breaks down proteins and fats.
- Name a protease enzyme and explain what its optimum pH is.
- Explain why the role of enzymes as catalysts in digestion is important for life.

CB1f/SB1g Enzyme Action

Enzymes are *Very Specific*

1) Chemical reactions usually involve things either being split apart or joined together.
2) The substrate is the molecule changed in the reaction.
3) Every enzyme has an active site — the part where it joins on to its substrate to catalyse the reaction.
4) Enzymes are really picky — they usually only work with one substrate. The posh way of saying this is that enzymes have a high specificity for their substrate.
5) This is because, for the enzyme to work, the substrate has to fit into the active site. If the substrate's shape doesn't match the active site's shape, then the reaction won't be catalysed. This is called the 'lock and key' hypothesis, because the substrate fits into the enzyme just like a key fits into a lock.



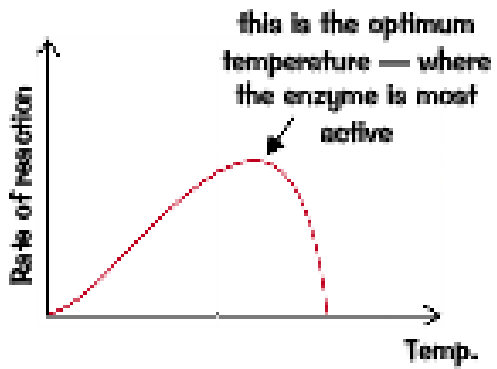
Changes in pH or temperature can affect how the protein folds up and so can affect the shape of the active site. If the shape of the active site changes too much, the substrate will no longer fit neatly in it and the enzyme will no longer catalyse the reaction. We say that the enzyme has been denatured.

CB1f/SB1g Enzyme Action Questions

- What is the active site of an enzyme?
- Why is the active site a different shape in different enzymes?
- What is meant by enzyme specificity?
- Use the lock and key model to suggest how an amylase enzyme catalyses the breakdown of starch to small sugar molecules.

CB1g/ SB1h Enzyme Activity

Enzymes Like it Warm but Not Too Hot



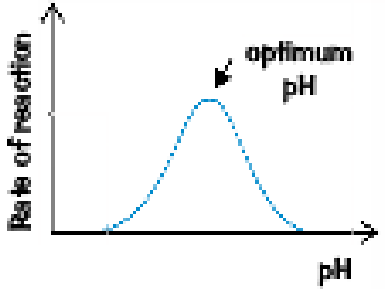
1) Changing the temperature changes the rate of an enzyme-controlled reaction.

2) Like with any reaction, a higher temperature increases the rate at first. The enzymes and the substrate move about more, so they're more likely to meet up and react. But if it gets too hot, some of the bonds holding the enzyme together break. This makes the enzyme become denatured — it loses its shape and the substrate doesn't fit the active site any more. This means the enzyme can't catalyse the reaction and the reaction stops.

The enzyme is denatured irreversibly — it won't go back to its normal shape if things cool down again.

3) Each enzyme has its own optimum temperature when the reaction goes fastest. This is the temperature just before it gets too hot and starts to denature. The optimum temperature for the most important human enzymes is about 37 °C — the same temperature as our bodies. Lucky for us.

Enzymes Like it the Right pH Too



1) The pH also has an effect on enzymes. If it's too high or too low, it interferes with the bonds holding the enzyme together. This changes the shape of the active site and can irreversibly denature the enzyme.

2) All enzymes have an optimum pH that they work best at. It's often neutral pH 7, but not always. For example, pepsin is an enzyme used to break down proteins in the stomach. It works best at pH 2, which means it's well-suited to the acidic conditions in the stomach.

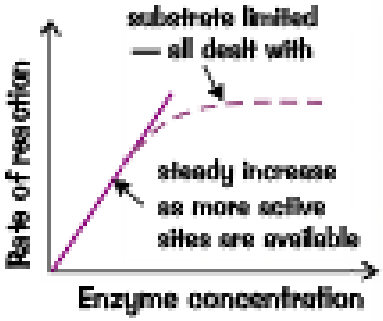
CB1g/ SB1h Enzyme Activity Questions

- Explain why enzymes work more slowly when the temperature is below the optimum and also above the optimum.
- The enzyme pepsin digests proteins. Pepsin is denatured at pH8. Explain what this means.
- Sketch a graph to show the effect of pH on the enzyme pepsin which has an optimum pH of 2.

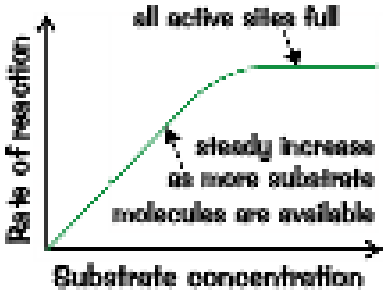
CB1g/ SB1h Enzyme Activity 2

Enzyme Concentration Affects the Rate of Reaction

1) The more enzyme molecules there are in a solution, the more likely a substrate molecule will meet up with one and join with it. So increasing the concentration of the enzyme increases the rate of reaction.
2) But, if the amount of substrate is limited, there comes a point when there are more than enough enzyme molecules to deal with all the available substrate, so adding more enzyme has no further effect.



Substrate Concentration Affects the Rate Up to a Point



1) The higher the substrate concentration, the faster the reaction — it's more likely the enzyme will meet up and react with a substrate molecule.
2) This is only true up to a point though. After that, there are so many substrate molecules that the enzymes have about as much as they can cope with (all the active sites are full), and adding more makes no difference.

CB1g/ SB1h Enzyme Activity 2 Questions

- Explain the effect of substrate concentration and the rate of an enzyme controlled reaction.
- Draw a graph to show how substrate concentration affects the rate of an enzyme controlled reaction.
- Give 2 things that you could measure when investigating the rate of an enzyme controlled reaction.

CB1h/SB1i Transporting Substances.

Diffusion is the Movement of Particles from Higher to Lower Concentration

1) Diffusion is simple. It's just the gradual movement of particles from places where there are lots of them to places where there are fewer of them. That's all it is — just the natural tendency for stuff to spread out. Here's the fancy definition:

Diffusion is the net (overall) movement of particles from an area of higher concentration to an area of lower concentration.

If something moves from an area of higher concentration to an area of lower concentration it is said to have moved down its concentration gradient.

2) Diffusion happens in both liquids and gases — that's because the particles in these substances are free to move about randomly.

Active Transport is the Opposite of Diffusion

Active transport is the movement of particles across a membrane against a concentration gradient (i.e. from an area of lower to an area of higher concentration) using ATP released during respiration.

Osmosis is a Special Case of Diffusion, That's All

Osmosis is the net movement of water molecules across a partially permeable membrane from a region of higher water concentration to a region of lower water concentration.

CB1h/ /SB1i Transporting Substances Questions

- Define the 3 terms diffusion, active transport and osmosis.
- A dish of perfume is put at the front of a lab. Explain why the smell spreads.
- Explain why a slice of potato will decrease in mass if it is placed in a concentration sugar solution.

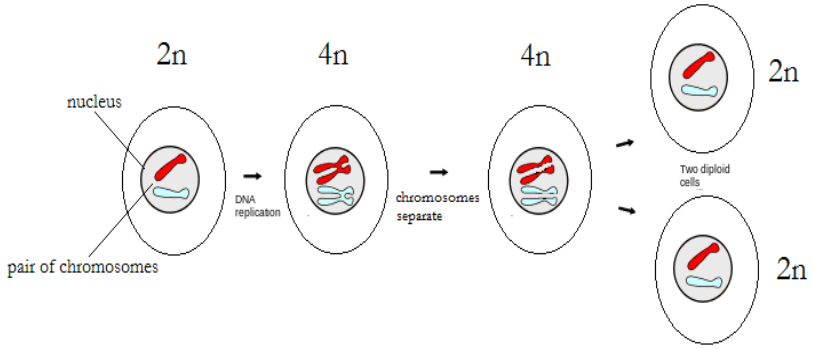
CB2a/SB2a Mitosis

Mitosis: All human body cells (i.e all cells except sperm and egg cells) contain two sets of 23 chromosomes (=46 in total) in their nucleus. One set of 23 chromosomes comes from the father and the other set of 23 chromosomes comes from the mother . The human body cells contain two copies of each chromosome = 'diploid'

To make more cells during growth and/or to repair damaged cells, body cells divide by a process called mitosis:

1. Chromosomes first make copies of themselves - DNA replication
2. The copies of the chromosomes separate and the cell divides
3. This division produces two daughter cells, which are diploid and genetically identical.

- Note: <u>n = 23 chromosomes in nucleus</u>…→2n = 46 , 4n = 92



- Diploid cell has 46 chromosomes→2n
- 1st stage: diploid cell replicates→46x2 = 92 chromosomes→4n
- 2nd stage: chromosomes separate but no further division occurs→still 4n
- 3rd stage: cell divides to form two diploid daughter cells, each containing 46 chromosomes (2n)

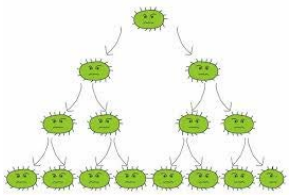
CB2a/SB2a Questions on Mitosis

- How many pairs of chromosomes does every human cell contain?
- What two processes occur by mitosis?
- What do diploid and haploid mean?
- Describe the 3 stages of mitosis.

CB2a/SB2a Mitosis 2

Asexual reproduction (A means without)

- As well as in growth and repair, cell division by mitosis also occurs in asexual reproduction. Asexual reproduction is when organisms reproduce by themselves (i.e. without a partner)
- Bacterial cells often reproduce asexually by splitting in half
- Some plants can also reproduce asexually



Sexual reproduction:

- Sex cells (i.e. sperm cells and egg cells) are called 'gametes' which are different to body cells as they only contain one set of chromosomes in their nucleus (so have a total of 23 chromosomes). Gametes are ***haploid*** cells – they have **ha**lf the number of chromosomes.
- When a sperm cell fertilises an egg cell, the gametes fuse to produce a **di**ploid body cell (d for double -with 46 chromosomes – two sets of 23) called the zygote.
- The zygote develops into a ball of cells called the embryo, which then develops to form a new individual

CB2a/SB2a Mitosis Questions

- What does asexual mean?
- Name three processes that use mitosis
- Give two organisms that reproduce asexually
- What is the collective name for sex cells?
- Gametes are haploid …explain
- Zygotes are diploid….explain
- What is the common name for a zygote?

CB2b/SB2b/Growth in Animals

Growth is an increase in size, length or mass.

Percentiles can be used to compare a certain characteristic (e.g mass) against the total population

- The 20th percentile indicates that 20% of the data points are the same or lower than this value
- The 50th percentile indicates that 50% of the data points are the same or lower than this value and the 50th percentile is the **median** value of the sample

New Cells are Needed for Growth and Repair

The cells of your body divide to produce more cells, so your body can grow and replace damaged cells. Cells grow and divide over and over again — this is called the cell cycle. Of course, cell division doesn't just happen in humans — animals and plants do it too.

Growth in animals also involves cell division but unlike plants, animals stop growing when they become adults

In an animal, cells that can differentiate to form many different types of specialised cells are called stem cells:

- Embryonic stem cells can differentiate and form almost any type of cell in the body
- However, adult stem cells can only develop into a limited range of cells. This is why most animals can't re-grow a damaged limb or body part, but plants can grow new shoots, roots and leaves.

CB2b/SB2b/Growth in Animals Questions

- Define growth.
- What would the 40th percentile line mean?
- Suggest how you could measure the growth of a kitten. Explain your answer.
- Your mass increases when you take in food and drink. Is this an example of growth? Explain your answer.
- Explain why percentile curves are used to measure the growth of babies.

CB2c/SB2c Growth In Plants

Plants have special areas called 'meristems' found on the tips of roots and shoots – these are the sites of plant growth

Stages in Plant Growth

Cell division: cells in meristems keep dividing constantly (each division doubles the number of cells)

Elongation: once the cells have divided, they get longer – this is called 'elongation'

Differentiation: as a plant continues to grow, the older meristem cells start to develop into specialised cells – this process is called 'differentiation'. A meristem can differentiate (develop) into any type of plant cell (so they're like the equivalent of embryonic stem cells in animals) e.g. a meristem cell in the root can develop into a specialised root hair cell.

Meristems Contain *Plant Stem Cells*

1) In plants, the only cells that divide by mitosis are found in plant tissues called meristems.
2) Meristem tissue is found in the areas of a plant that are growing — such as the roots and shoots.
3) Meristems produce unspecialised cells that are able to divide and form any cell type in the plant — they act like embryonic stem cells. But unlike human stem cells, these cells can divide to generate any type of cell for as long as the plant lives.
4) The unspecialised cells can become specialised and form tissues like xylem and phloem

CB2c/SB2c Growth In Plants Questions

- In plants what is a meristem?
- Name the three stages in plant growth.
- How is growth in animals different from growth in plants?
- Explain why plants can grow new shoots but animals can’t grow new limbs?

CB2d/SB2d Stem Cells

Stem cells are cells that have not specialised yet. There are two types of stem cells: :Embryonic stem cells – these can develop into nearly all types of cells and adult stem cells - these can develop into only a few types of cells

The ability of embryonic stem cells (in particular) to develop into lots of different types of cells means they could be used to treat many medical problems...

Two steps: 1. Embryonic stem cells first need to be extracted (see below for problems associated with this) 2. They are then put wherever in the body they are needed so that they can develop into the appropriate specialised cell

General risks of using stem cells:

- If stem cells are put into the body, they could produce the wrong kind of cells or even create cancer cells therefore more research is needed to make sure stem cells are safe
- People may try to use embryonic stem cells to produce human clones – this is illegal

Problems associated with extracting embryonic stem cells

One way of extracting embryonic stem cells is to use leftover embryos created for couples having fertility treatment however, extracting the embryonic stem cells kills the embryo. This is controversial because some people think that because embryos go on to develop into people, destroying embryos is the same as murder

Two ways scientists are trying to solve this issue: **1.** Use adult stem cells to make cloned embryos - the embryonic stem cells could then be extracted from the clones without any natural embryos having to be killed **2.** Turn specialised body cells into stem cells by reprogramming them – if this works, it will help to completely avoid the ethical problem of using embryos

Treating leukaemia:

Due to the ethical issues associated with extracting embryonic stem cells, most established methods use adult stem cells, which are easier to extract

e.g adult stem cells are used in bone marrow transplants to treat leukaemia (a cancer of white blood vessels)

Adult stem cells can't develop into as many different types of cells so the number of diseases they can treat is limited.

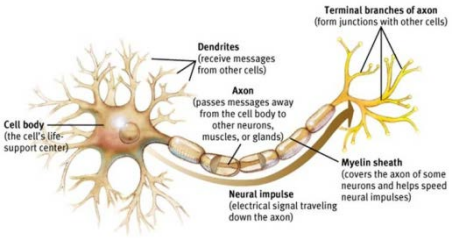
CB2d/SB2d Stem Cells Questions

- What are stem cells?
- What two types of stem cells are there?
- Describe the two steps to turn a stem cell into a specialised cell.
- What risks are there for using stem cells?
- What problems are associated with extracting stem cells?
- Give two ways that scientists are trying to solve the problems above.

CB2e/SB2g The Nervous System

- Electrical impulses travel along bundles of nerves called <u>neurones</u>

- There are three different types of neurones:
  Sensory neurone (fig. B below) carries signals from receptor cells to the central nervous system
  Relay neurone
  Motor neurone (fig. A below) carries signals from central nervous system to effectors



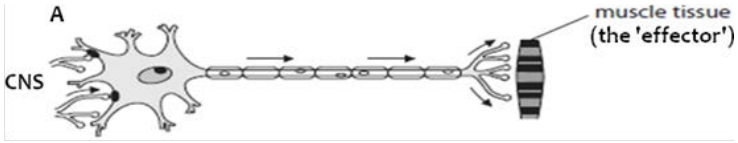
Neurotransmission – how impulses travel along neurones

- Dendrites receive impulses from receptor cells or other neurones
- Impulses move along the dendron, past the cell body and to the axon
- When impulses reach axon endings ('terminals'), chemicals called neurotransmitters are released across the gap ('synapse')
- This causes the electrical impulse to be passed on to other neurones
- Many neurones have a fatty layer surrounding the axon – this is called the myelin sheath and it helps to insulate the axon from surrounding tissue causing impulses to travel faster.

Responding to stimuli (co-ordinated/conscious responses)

- Sense organs in the body contain 'receptor cells', which detect stimuli. Anything the body is sensitive to is called a stimulus.
- When a stimulus is detected, receptor cells create electrical signals – called <u>impulses</u> – which travel along sensory neurones (Fig.B) in the spinal cord to the brain ('central nervous system' – CNS)

- Brain processes the information and electrical impulses are then sent along motor neurones (Fig.A) to effectors (e.g muscles, glands), which carry out the response

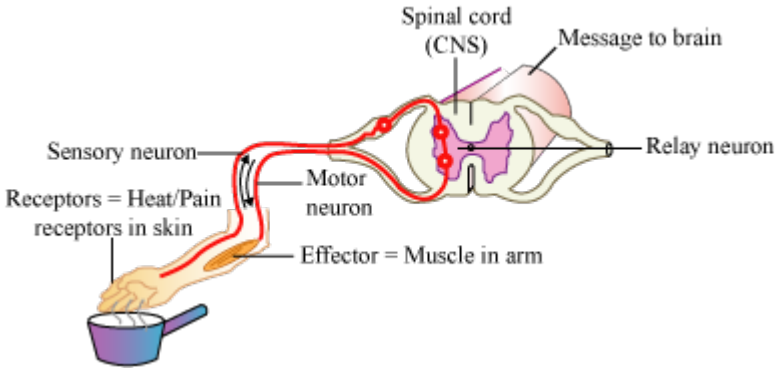


CB2e/SB2g Questions The Nervous System

- What is a neurone?
- How many types of neurone are there and what do they do?
- Where do dendrites receive impulses from?
- How do impulses travel across the gaps between nerve endings – synapses?
- What is the myelin sheath and how does it speed up the impulse?

CB2f/SB2i Neurotransmission Speeds

- Reflex actions are responses that are *automatic*, *extremely quick* and *protect* the body from injury (e.g. moving finger away from hot object prevents burning)
- Reflexes use neurone pathways called reflex arcs:
  - Receptor cells detect the stimulus (e.g. hot object) and cause electrical impulses to travel along a sensory neurone
  - Sensory neurone synapses with a relay neurone in the spinal cord
  - Impulse then travels from a relay neurone to a motor neurone
  - Motor neurone carries impulse to the effector (muscle or glands)
  - Muscle contracts and finger is pulled away from the hot object
- Reflex arcs don't pass by the brain (only pass by the spinal cord) so reflex responses don't require conscious thought.
- Reflex responses are quicker than coordinated responses (e.g kicking of a football...or...shivering), which instead do involve conscious thought



CB2f/SB2i Neurotransmission Speeds Questions

- What is a reflex response and how is it different from a normal response?
- Explain which part of the central nervous system is missed out during a reflex response.
- What are the two types of effector?
- Give two examples of where a reflex response would be needed.

CB3a/SB3b Meiosis

Meiosis is the form of cell division needed to make gametes.

1. First step is DNA replication (this first step is the same as in mitosis)
2. This is followed by two cell divisions - i.e the cell is first divided into two and then divided again into four
3. This produces 4 haploid daughter cells, each containing one set of (23) chromosomes

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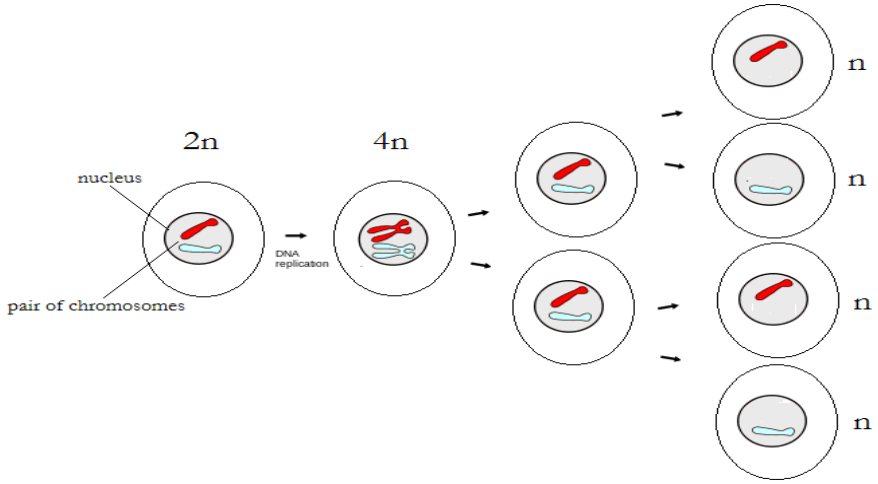
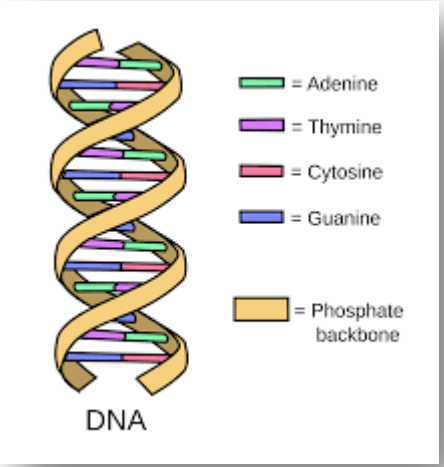


CB3a/SB3b Questions on Meiosis

- What is meiosis?
- What is first step of meiosis?
- How many cell divisions follow?
- Why is this different from mitosis?
- If you start with one cell, after meiosis how many daughter cells are there?
- Is the daughter cell haploid or diploid?
- Why are the daughter cells genetically different?

CB3b/SB3c DNA



Chromosomes

Inside nuclei (plural of 'nucleus') chromosomes contain the genetic material made of DNA

- Sections of DNA are called genes:
  - Each gene codes (i.e. carries instructions) for a specific protein
  - Often, genes work together to produce what is needed for a particular feature: e.g. eye colour is determined by lots of different proteins that are coded by several different genes

The structure of DNA:

- A DNA molecule consists of two strands that are coiled together to form a spiral known as a 'double helix'
- The two strands of DNA are linked together at regular intervals by chemicals called 'bases'
- Bases always pair up in the same way because they have complementary (i.e matching) shapes:
  - Adenine (A) always pairs with thymine (T)
  - Guanine (G) always pairs with cytosine (C)
  - The matching bases are known as 'complementary base pairs'
- Base pairs are joined together by weak hydrogen bonds
- The order of the bases in DNA (i.e the 'DNA sequence') determines the proteins that are made in the body
- We each have a slightly different order of bases in our DNA/genes as all of us are made from slightly different proteins – this is what makes us all different

CB3b/SB3c Questions – DNA

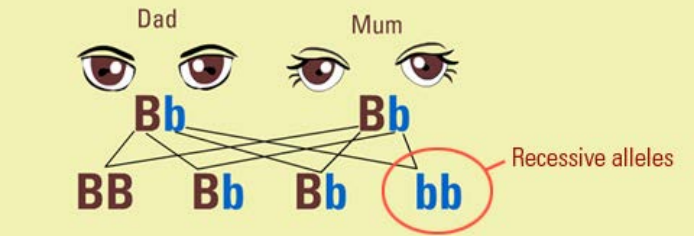
- Name the organelle found in a nucleus that contains the genetic material.
- What is a gene?
- What does ‘a gene codes for’ mean?
- What does a double helix look like?
- How are the strands held together?
- Which bases pair up? Why are they complementary?
- What type of bonding holds the bases together?
- What is the ‘DNA sequence?’ Why is it important?
- Why are we all different?

CB3c / SB3g Alleles

- Animal cells have a cell membrane, cytoplasm and a nucleus
- Inside the nucleus are long strands of a substance called DNA
- Each strand of DNA forms a structure called a chromosome and human body cells contain 23 pairs of chromosomes (=46 in total) in their nuclei.
- Each chromosome carries a large number of genes
- Each gene does a particular job. Many genes control variations in our characteristics e.g. how we look. Other genes contain information about how likely we are to get certain diseases.
- Variation caused by genes is called inherited variation because genes are inherited from our parents

Alleles

- There are two copies of every chromosome (23 pairs) in a body cell nucleus so there are two copies of every gene
- These gene pairs may contain slightly different instructions for the same characteristic e.g. may code for brown eye colour instead of for blue eye colour
- These different forms of the same gene are called alleles.
- Each of us can inherit a different set of alleles from our parents which gives each of us slightly different characteristics (this explains why twins can sometimes be very different).



CB3c/SB3g Questions on Alleles

- Give three features of animal cells.
- Where is the DNA found in an animal cell?
- How many pairs of chromosomes does each human body cell have?
- What do chromosomes carry?
- What do they control?
- What is an allele?
- Why do we have slightly different characteristics from our parents?

CB3c/SB3g Alleles 2

- Plants and animal cells produce gametes (sex cells). Male gametes – sperm in animals, pollen grains in plants. Female gametes – egg cells in both animals and plants
- Gametes are different from other body cells because they only have one copy of each chromosome (i.e. 23 chromosomes in their nucleus not 46). Gametes only have one allele for each gene.
- In sexual reproduction the male and female gametes fuse together and the organism formed has 46 chromosomes (23 pairs) in their body cells, with two alleles for each gene (one from the male parent, one from the female parent).

Inheritance Terminology

- Dominant alleles - have an effect even if there is just one copy of it. A dominant characteristic is seen even if just one allele is dominant
- Recessive alleles - need to be present as a pair to have an effect. A recessive characteristic is only seen if both alleles are recessive
- This can be shown by drawing a punnett square (see below):
  - A dominant allele is shown by a capital letter (e.g. T)
  - The recessive allele has the lower case version of the same letter (e.g. if dominant allele is 'T', then recessive allele is 't')
- The alleles in an organism are its ***genotype***
- What an organism looks like is its ***phenotype***
- If both alleles in an organism are the same, the organism is

homozygous (e.g. TT)

- If the alleles are different, the organism is heterozygous (e.g. Tt)

CB3c/SB3g Alleles 2 Questions

- What is a gamete?
- Give an example of a male gamete and a female gamete.
- Why are gametes different from every other body cell?
- Define dominant and recessive alleles.
- A tall plant has alleles Tt. What is the genotype and what is the phenotype of this plant?

CB3d /SB3h Inheritance

- Possible genotypes produced when two organisms breed can also be shown in a Punnett square. Let T be the allele for a tall offspring.
- Parents have the ***genotype Tt*** (one dominant allele and one recessive allele) so they are heterozygous dominant)
- T is dominant so both parents are tall (***phenotype is tall)***
- When gametes fuse, alleles can come together in different combinations:
  - 25% TT (genotype - homozygous dominant, phenotype - tall)
  - 50% Tt (genotype - heterozygous dominant, phenotype - tall)
  - 25% tt (genotype - homozygous recessive, phenotype - short)

So there's a 3 in 4 chance (75%) that offspring will be tall (TT, Tt, tT)
And there's a 1 in 4 chance (25%) that offspring will be Short (tt)

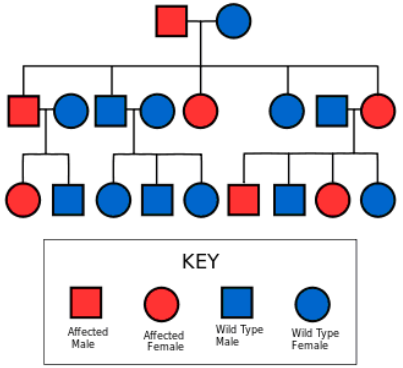
	T	t
T	TT	Tt
t	Tt	tt

CB3d /SB3h Questions on Inheritance

- Two parents Bb and Bb have four offspring: Bb, BB, bb, Bb – which of these are heterozygous offspring and which are homozygous offspring?
- What percentage of offspring will exhibit the characteristic if B is a dominant allele?
- What percentage of the offspring will not exhibit the characteristic?
- How will the percentages of offspring be different if the parents are BB and Bb?

CB3d/ SB3h Inheritance 2

Family pedigree charts show how a genetic disorder is passed on in a family. Doctors can use family pedigree charts to work out the probability of a person inheriting a genetic disorder from their parents – this is pedigree analysis.



Carriers

Carriers are individuals who don't have the disease themselves but can pass it on to their offspring if their partner is also a carrier for the same disease:

> e.g. a person who is Cc is a carrier for cystic fibrosis because they have a copy of the faulty allele. They don't have the disease, though, because cystic fibrosis is recessive (both recessive alleles need to be present - cc)

If both parents are carriers (can find this out by genetic screening), doctors can help couples decide whether to try for a baby or not.

CB3d/SB3h Questions on Inheritance 2

- Why would doctors use a pedigree chart?
- What is meant by a carrier?
- Why might you want genetic screening if you wanted to have a baby?
- If two people have the genotype Cc for cystic fibrosis what is the chance that their offspring will have the disease?

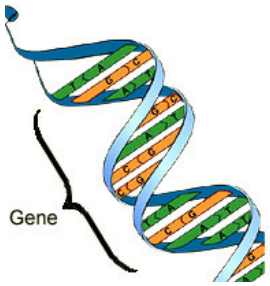
CB3e/ SB3j Gene Mutation

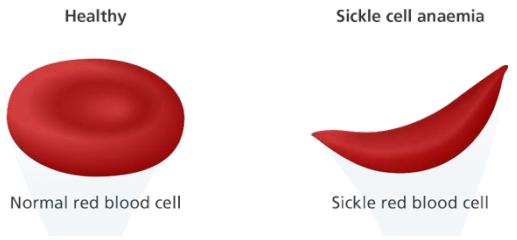
Each protein is made up of a different sequence (number and order) of amino acids.

This sequence affects the way the polypeptide chain folds up, giving the protein its specific 3D shape. Some proteins form long fibrous molecules (e.g. keratin – found in human hair and nails), and others have a round 'globular' shape (eg. insulin, haemoglobin, enzymes)

The shape helps the proteins with their function e.g. round haemoglobin helps it move around the body easily. E.g. enzymes are specific to one reaction, and their shape determines which reaction this is.

A mutation is a change in the sequence of bases in the genetic code of DNA. Some mutations have no effect on the amino acid sequence so the shape of the protein is not affected. Other mutations result in one amino acid being replaced by another so the protein folds up differently so affects the shape and the way proteins work. E.g. Sickle cell anaemia – mutations in the gene that produces haemoglobin causes red blood cells to become pointy, reducing the oxygen carrying capabilities of the cell.

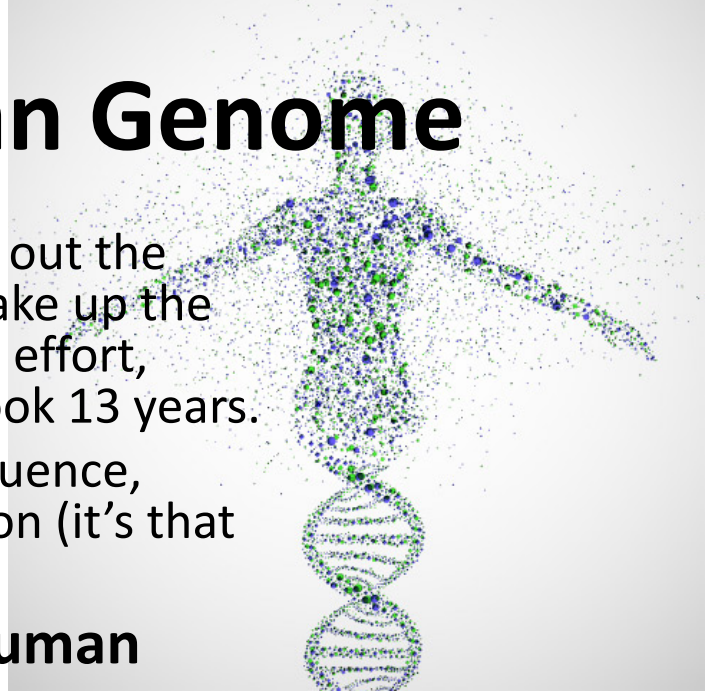




CB3e / SB3j Questions on Gene Mutation

- What is a protein?
- Why is the sequence of proteins significant?
- Why is the shape of a protein important?
- What is a mutation?
- Describe an example of a common mutation of red blood cells.

CB3e / SB3j The Human Genome



The human genome project (HGP) involved finding out the sequence (order) of the 3 billion base pairs that make up the human genome. The HGP was a huge international effort, involving scientists in 18 different countries and took 13 years.

Although each human being has a unique DNA sequence, everyone has at least 99.9% of their DNA in common (it's that 0.01% that makes us different)

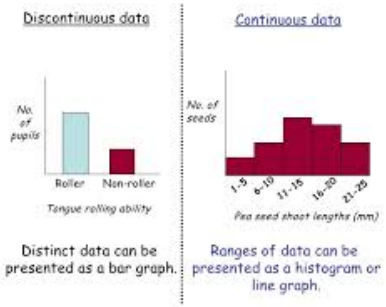
What can we do with the results of the Human Genome project?

- We can find new ways of finding genes that may increase the risk of certain diseases
- We can find new treatments and cures for disorders e.g gene therapy, where scientists try to replace faulty genes that cause a disorder with normal genes
- We can find new ways of looking at changes in the genome over time – i.e. how humans have evolved
- We can personalise medicines - find medicines that work best (i.e. are more effective and have fewer side-effects) on certain people

CB3e / SB3j.Questions – The Human Genome Project

- What is the HGP?
- How many base pairs make up a human being?
- How many countries worked together and for how long?
- What percentage of our DNA is the same as everyone else's? What percentage is different?
- Name four applications of the results of the Human genome project.

CB3f / SB3k Variation



Differences in characteristics are called variation

Discontinuous variation

- Take a fixed set of values – categories (e.g. shoe size, blood group, gender)
- Discontinuous variation is usually caused by instructions within cells and is called **genetic variation**
- Discontinuous data is plotted on a bar graph

Continuous variation:

- Values can be any number within a certain range (e.g. height, weight)
- Characteristics that show continuous variation are often controlled by both genes and the environment…e.g.:
  - You may inherit a tendency for being tall from parents
  - But diet and lifestyle are also important in determining height
- Characteristics influenced by the environment (i.e. diet/disease/ lifestyle) are known as 'acquired characteristics' – called '**environmental variation'**
- Continuous data can be plotted on a line graph (usually gives a normal distribution of values – i.e bell-shaped curve)

Biodiversity

- Biodiversity is a measure of the total number of different species in an area
- Areas of greater biodiversity ('biodiversity hotspots') need to be protected because they contain a large variety of species within them

CB3f/ SB3k Questions on Variation

- Define variation.
- What is the difference between continuous and discontinuous variation?
- Give an example of each type of variation.
- How would the graphs of continuous and discontinuous data be different?
- What is an area of biodiversity and why does it need protecting?

CB4a / SB4a Evidence For Human Evolution

Evolution is a gradual change in the characteristics of a species over time. Scientists use fossils to find out about human evolution. They work out how old the fossils are and put them in age order.

Fossils are the preserved remains of organisms that lived on the Earth thousands or millions of years ago
The collection of fossils from different periods in the Earth's history is known as the 'fossil record'
Studying the fossil record can reveal details about how organisms have changed gradually through time (i.e. how they have evolved) and the fossil record is one of the strongest pieces of evidence in support of evolution

Gaps in the fossil record:
The fossil record has many gaps in it for 3 main reasons

1. Soft-bodied organisms leave little fossil evidence behind because soft tissues decay (→don't usually form fossils)
2. Sometimes, the hard parts of organisms are destroyed and fossils don't form
3. Many fossils are buried deep in the earth and have not yet been found

The gaps in the fossil record mean that scientists must interpret how organisms changed over time from incomplete data.
The same set of data could be interpreted differently by different scientists
As more fossils are discovered, scientists can predict more accurately how an organism may have looked like and how it may have evolved
Computers can now be used to model how the organism may have looked

CB4a / SB4a Evidence For Human Evolution Questions

- What is a fossil
- What do we call the collection of fossils from different periods in the Earth's history?
- How does the fossil record support the theory of evolution?
- Suggest 3 reasons why the fossil record has gaps in it.
- Why is the gap in fossil records a problem for scientists?

CB4a/SB4a Evidence for Human Evolution 2

Evidence based on the Fossil Record and Stone tools

Key Fossils:

Ardi 4.4mya No stone tools found with Ardi	Human like female fossil Must have come from an extinct species 120cm tall, 50kg Walked upright Long arms and big toes for grabbing branches Small brain
Lucy 3.2mya No stone tools found with Lucy	Human like female fossil 107cm tall May not have walked completely upright Small brain
Leakey's discovery 1.6mya Stone tools found	Human like fossil More closely related to modern humans so given the genus 'Homo' Walked upright Short with longer arms Larger brain

Stone Tools

Initially stones were blunt and just used for pounding.

Tools become more sophisticated with cutting edges for hunting and preparing meat.

Tools can be dated by the layers of rock they are found in. Assume they are the same age as the layer they are found in.

CB4a/SB4a Evidence for Human Evolution

1. What happened to arm length during human evolution?
2. What happened to brain size during human evolution?
3. How are stone tools dated?
4. What features of mtDNA makes it suitable for providing evidence for human evolution?

Ext: research human migration during interglacial periods

CB4b/SB4b Darwin's Theory

Darwin's Theory of Evolution by Natural Selection

Organisms produce more offspring than the environment can support because there are limited resources (e.g limited food and space) so competition for survival occurs between individuals. Most offspring die before reaching adulthood.

Even within the same species, organisms show variation in their characteristics because individuals who are well adapted to their environment are more likely to survive, breed, and pass on their genes to their offspring. Individuals who are less well adapted to their environment are more likely to die and less likely to breed and pass on their genes to their offspring.

Over generations, there is a gradual shift in the variation of characteristics in a species which is called evolution e.g. if an environment becomes drier, then individuals better suited to drier conditions survive and over time, species becomes better suited to the drier conditions. This process is called 'survival of the fittest' or 'natural selection'

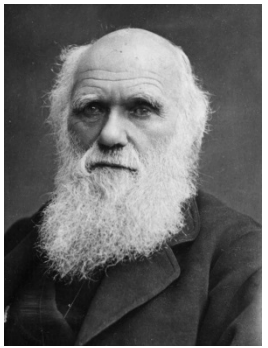
If the environment changes too rapidly and no individuals have adaptations that help them survive, they all die and the species may become extinct

New evidence for Darwin's theory

Resistant organisms: In the 1940s and 1950s, warfarin was used to poison rats, however, within 10 years, most rats were resistant to warfarin (i.e rats were not affected by the poison)

Explanation using Darwin's theory: As a result of variation, there were a few rats that by chance had always been resistant to warfarin poison. As non-resistant rats were killed by poison, the only ones left to breed were the warfarin resistant rats and their warfarin resistance characteristic was passed on to their offspring which over some years made most rats became resistant.

Also DNA research has shown how characteristics are passed on to offspring and this also supports Darwin's theory of natural selection



CB4b/SB4b Questions on Darwin's theory

- Why is there competition for survival amongst all living things?
- What would make an organism more likely to survive? What is natural selection?
- How does the effect of warfarin on rats support Darwin's theory on evolution?
- Name a modern analytical technique that supports Darwin's theory of natural selection.

CB4c/SB4d CLASSIFICATION

Classification is the sorting of organisms into groups based on their characteristics (i.e according to how closely they are related to one another).

Organisms are classified into one of five 'kingdoms' with the following characteristics:

Animalia (the 'animal kingdom'):

- Multicellular (made of many cells)
- Heterotrophic feeders - i.e animals get their food by eating and digesting other organisms
- No cell walls, complex cell structure with nucleus

Plantae (the 'plant kingdom'):

- Multicellular
- Autotrophic feeders – i.e plants make their own food through photosynthesis
- Cell walls made of cellulose (to provide support to plants)
- Complex cell structure with nucleus

Fungi:

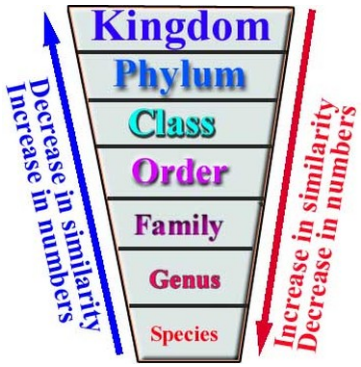
- Multicellular, cell walls not made of cellulose
- Saprophytic feeders – i.e fungi get their food from dead or decaying matter
- Complex cell structure with nucleus

Protoctista:

- unicellular (made of one cell), complex cell structure with nucleus

Prokaryotae:

- unicellular, simple cell structure with no nucleus



- Viruses do not have a kingdom because they are *non-living* and they're not made up of cells and can only exist inside 'host' cells (e.g inside human cells)
- Living organisms in kingdoms are further divided into 6 sub-categories:Phylum, Class, Order, Family, Genus and Species. As you progress from kingdom→phylum→class→order→family→genus →species, the groups are smaller and the organisms share more and more characteristics in common (i.e organisms are more and more alike).

CB4c/SB4d Classification Questions

- Name the 5 kingdoms.
- Which 3 kingdoms are multicellular and what does this mean?
- Give two differences between the animal and plant kingdoms.
- What is the difference between heterotrophic, autotrophic and saprophytic feeders?
- Which kingdom do viruses belong to?
- Name the next 6 sub-categories that Kingdoms are divided into.

CB4c SB4d Classification 2

An organism's scientific name has two Latin words, made up of the **genus** and **species** name. Using the last two sub-categories of classification is called the binomial system.

e.g. humans are *Homo Sapiens* – 'Homo' is the genus, 'sapiens' is the species

The binomial naming system is in Latin because common names given to organisms can sometimes be misleading and so that scientists all over the world can communicate clearly, whatever their language.

- E.g robins in America (turdus migratorius) and robins in the UK (erithacus rubecula) are different species

CB4c SB4d Classification 2 Questions

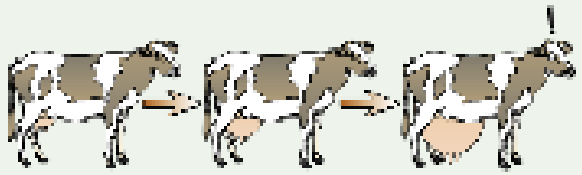
- What is the binomial system?
- Which two sub-categories are used for naming?
- Give two reasons why scientists all over the world use the binomial method of naming.
- A cat is named Felis domestica – what is the genus of the cat? What is the species?

Cb4d/SB4e Breeds and Varieties

Selective Breeding is Mating the Best Organisms to Get Good Offspring

Organisms are selectively bred to develop the best features according to what we want from them. This includes things like:

- Maximum yield of meat, milk, grain, etc. — this means that food production is as high as possible, which is important for helping make sure there's enough food for people to eat.
- Good health and disease resistance.
- In animals, other qualities like temperament, speed, fertility, good mothering skills, etc.
- In plants, other qualities like attractive flowers, nice smell, etc.



This is the basic process involved in selective breeding:

1) The parent organisms with the best characteristics are selected, e.g. the largest sheep and rams — those with the highest meat yield.
2) They're bred with each other.
3) The best of the offspring are selected and bred.
4) This process is repeated over several generations to develop the desired traits, e.g. to produce sheep with very large meat yields.

Selective breeding is also known as artificial selection.

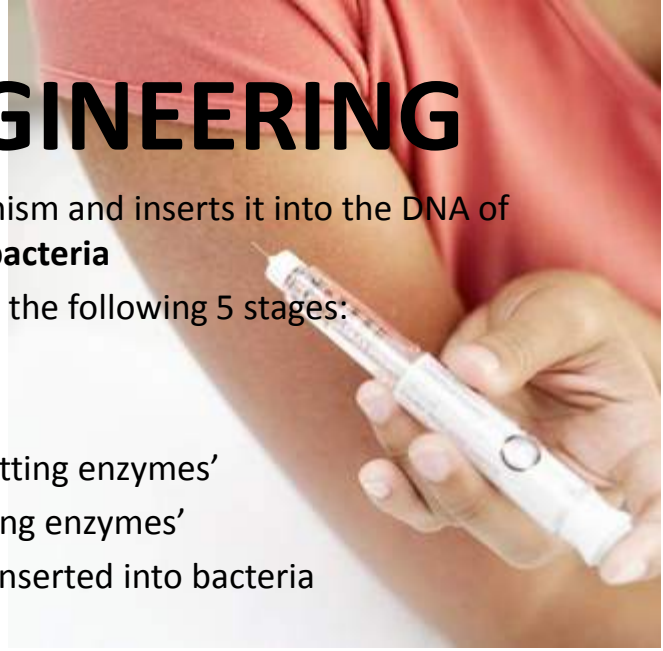
Selective breeding can also be used to combine two different desirable characteristics:

1) Tall wheat plants have a good grain yield but are easily damaged by wind and rain. Dwarf wheat plants can resist wind and rain but have a lower grain yield.
2) These two types of wheat plant were cross-bred, and the best resulting wheat plants were cross-bred again. This resulted in a new variety of wheat combining the good characteristics — dwarf wheat plants which could resist bad weather and had a high grain yield.

Cb4d/SB4e Breeds and Varieties Questions

- Suggest two characteristics a cattle breeder might select for.
- Explain how a goat that produces more milk could be selectively bred.
- Suggest two characteristics a wheat breeder might select .

Cb4d/SB4e **GENETIC ENGINEERING**



- **Genetic engineering' occurs** when a scientist removes a gene from one organism and inserts it into the DNA of another organism **e.g production of human insulin by genetically modified bacteria**
- Scientists can insert the gene for human insulin into bacterial plasmid DNA in the following 5 stages:
  1. Bacterial plasmid DNA is removed from bacteria
  2. Bacterial plasmid DNA is cut by 'cutting enzymes'
  3. Bit of the chromosome that contains the human insulin gene is cut by 'cutting enzymes'
  4. The human insulin gene is stuck onto the bacterial plasmid DNA by 'sticking enzymes'
  5. The bacterial plasmid DNA, with the additional human insulin gene, is reinserted into bacteria

- The genetically modified (GM) bacteria now have the human insulin gene in their plasmid DNA and can make human insulin, which is used by people with diabetes. These bacteria are now called GMO – genetically modified organisms

How was Human Insulin made in the past?

insulin used to be extracted from dead cattle and pigs and though similar is not the same as human insulin. The supply of the animal insulin could be affected by animal diseases or by the numbers of animals slaughtered.

What are the advantages of making Human insulin by GM Bacteria?:

- It is the same as the insulin produced by body cells in the pancreas
- It can be used by vegans (vegans don't eat any animal products and would not take animal insulin
- It can be made in vast quantities and more cheaply

What are the disadvantages? o

Different bacteria produce insulin slightly differently and this may not suit everyone

Cb4d/SB4e Questions – Genetic Engineering

- What is genetic engineering?
- Describe the 5 stages for inserting the gene for human insulin into bacterial DNA.
- What is a GMO?
- Give three advantages of using genetically modified bacteria to make human insulin.
- Give one disadvantage.

CB4e / SB4g Genes In Agriculture and Medicine

1) The main problem with selective breeding is that it reduces the gene pool — the number of different alleles (forms of a gene) in a population. This is because the farmer keeps breeding from the "best" animals or plants — which are all closely related. This is known as inbreeding.
2) Inbreeding can cause health problems because there's more chance of the organisms developing harmful genetic disorders when the gene pool is limited.
3) There can also be serious problems if a new disease appears, because there's not much variation in the population. All the stock are closely related to each other, so if one of them is going to be killed by a new disease, the others are also likely to succumb to it.

There are concerns about growing genetically modified crops...

1) Transplanted genes may get out into the environment. E.g. a herbicide resistance gene may be picked up by weeds, creating new 'superweeds'.
2) Another concern is that genetically modified crops could adversely affect food chains — or even human health.
3) Some people are against genetic engineering altogether. They worry that changing an organism's genes might create unforeseen problems — which would then get passed on to future generations. For example, the long-term effects of exposure to Bt crops (see above) aren't yet known.
4) Some people say that growing genetically modified crops will affect the number of weeds and flowers (and therefore wildlife) that usually live in and around the crops — reducing farmland biodiversity (number of species in an ecosystem).

People in developed countries, e.g. those in Europe, tend to be more concerned about the potential risks because food shortages are not as big an issue as in developing countries.

CB4e / SB4g Genes In Agriculture and Medicine Questions

- Give two disadvantages of selectively breeding animals.
- A farmer who grows green beans lives in an area that experiences a lot of drought. Explain how he could use selective breeding to improve the chances of his bean plants surviving the droughts.
- Describe the advantages of making insulin using genetically modified bacteria rather than extracting it from animals.

CB5a/SB5a Health and Disease.

- The World Health Organization (WHO) is responsible for coordinating health across the world. According to the organization good health means more than simply feeling well: it is a state of 'complete physical, social and mental wellbeing'.

Diseases Can be Communicable or Non-Communicable

1) A pathogen is a type of microorganism (microbe) that causes disease. Types of pathogen include bacteria, viruses, protists and fungi (
2) A communicable disease is a disease that can spread between organisms. They are caused by pathogens infecting the organism, e.g. malaria is caused by a protist, and tobacco mosaic disease in plants is caused by a virus. Communicable diseases are also known as infectious diseases.
3) Non-communicable diseases cannot be passed from one organism to another, e.g. cardiovascular and respiratory diseases, cancers and diabetes. They generally last for a long time and progress slowly. They are often linked to unhealthy lifestyles

Sometimes one disease can make it more likely that you will suffer from another disease. For example :

1) HPV (human papillomavirus) is a virus that can infect the reproductive system. One way that it's transmitted is in body fluids (see next page), usually through sexual activity.
2) An infection by the virus doesn't always cause symptoms and often clears up on its own within a couple of months.
3) However, some HPV infections can cause cell changes resulting in the development of certain types of cancer. It's thought that nearly all cervical cancer cases result from HPV infections.

CB5a/SB5a Health and Disease Questions

- Use your own words to define the term ‘good health’.
- Suggest how exercising regularly as part of a group can improve your physical, social and mental well being.
- Suggest why somebody infected with the HIV virus is more likely than people without the virus to get other communicable diseases.

CB5b/SB5b Non-communicable diseases

- **Non- communicable diseases** cannot be passed from one organism to another e.g cancers, diabetes and malnutrition. They generally last for a long time and progress slowly and are often linked to unhealthy lifestyle.
- **Long-term effects of alcohol**

1. Cirrhosis of the liver where Liver tissue is destroyed and the liver can't function properly which can lead to death.

2. Brain damage – alcohol affects learning and memory or can cause a blood clot in the brain

3. Alcoholism -Alcohol can be addictive and people who

become dependent on alcohol are called alcoholics.

Genetic disorders such as sickle cell disease is another type of non communicable disease. Genetic disorders can be passed to offspring but not to any other person

CB5b/SB5b Non-communicable diseases questions

- What is a non-communicable disease?
- Explain how exercising can reduce the risk of obesity.
- Explain why sickle cell disease is a non-communicable disease.
- Give one reason why too much alcohol over a long time is a problem for each of the following.
- A) the person who drinks it
- B) their family
- C) the society they live in.

CB5c/ SB5c Cardiovascular Disease

Cardiovascular Disease Affects The Heart and Blood Vessels

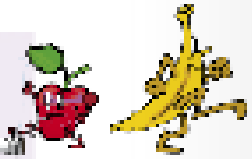
Cardiovascular disease (CVD) are diseases to do with your heart and blood vessels. E.g.

1) High blood pressure and lots of LDL cholesterol can lead to the build up of fatty deposits inside arteries, narrowing them. Over time the fatty deposits harden, forming atheromas. CORONARY HEART DISEASE is when the coronary arteries have lots of atheromas in them, which restricts blood flow to the heart.
2) Sometimes bits of atheromas can break off or damage the blood vessel, causing a blood clot. Complete blockage of an artery by atheromas or blood clots can lead to a HEART ATTACK, where part of the cardiac muscle is deprived of oxygen. If the blockage occurs in the brain, it can cause a STROKE.

There are Different Ways of Treating CVD

Healthy Lifestyle

1) Making changes to your lifestyle can reduce the risk of CVD, even if you've already had problems, e.g. a heart attack. People at risk of CVD are encouraged to eat a healthy diet that is low in saturated fat, exercise regularly and stop smoking.
2) Lifestyle changes can also help other forms of treatment (see below) be more effective.



CB5c/ SB5c Cardiovascular Disease

Drugs

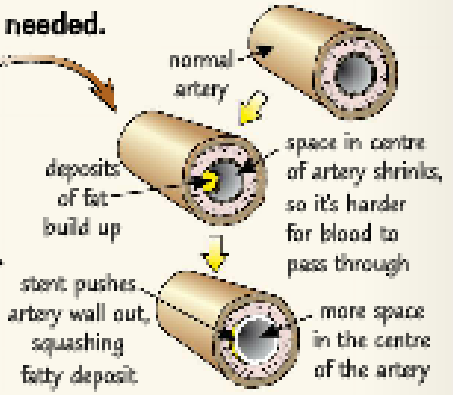
Sometimes drugs are needed to help control the effects of CVD. For example:

1) Statins can reduce the amount of cholesterol present in the bloodstream. This slows down the rate of fatty deposits forming, reducing the risk of CVD. However, statins can sometimes cause negative side effects, e.g. aching muscles. Some of these side effects can be serious, e.g. kidney failure, liver damage and memory problems.
2) Anticoagulants are drugs which make blood clots less likely to form. However, this can cause excessive bleeding if the person is hurt in an accident.
3) Antihypertensives reduce blood pressure. This reduces the risk of atheromas and blood clots forming. Their side effects can include headaches or fainting.

Surgical Procedures

If the heart or blood vessels are too badly damaged then surgery may be needed.

1) Stents are tubes that are inserted inside arteries. They keep them open, making sure blood can pass through to the cardiac muscle. Stents are a way of lowering the risk of a heart attack in people with coronary heart disease. But over time, the artery can narrow again as stents can irritate the artery and make scar tissue grow. The patient also has to take drugs to stop blood clotting on the stent.
2) If part of a blood vessel is blocked, a piece of healthy vessel taken from elsewhere can be used to bypass the blocked section. This is known as coronary bypass surgery.



3) The whole heart can be replaced with a donor heart. However, the new heart does not always start pumping properly. The new heart can also be rejected because the body's immune system recognises it as 'foreign'. Drugs have to be taken to prevent this from happening, and these can have side effects, e.g. making you more vulnerable to infections.

Heart surgery is a major procedure and, as with all surgeries, there is risk of bleeding, clots and infection.

CB5d-e/SB5d-e Pathogens

Pathogens and disease

Diseases that are passed from an infected person to someone who is not infected are called 'infectious diseases'. Infectious diseases are caused/spread by microorganisms called 'pathogens'.

There are several types of pathogens - viruses, bacteria, fungi and protoctists.

Different pathogens spread different diseases:

- Infectious diseases like cholera, food poisoning, dysentery and tuberculosis (TB) are caused by **bacteria**
- Infectious diseases like influenza (flu), mumps, measles and AIDS are caused by **viruses**
- **Fungi** cause athlete's foot
- Protozoan (a type of **protoctist**) causes malaria

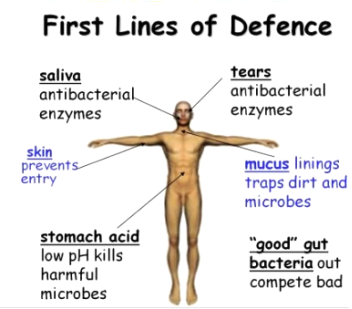
How pathogens pass between people

- In contaminated water – e.g. cholera
- Airborne (e.g by coughing) – influenza virus and TB
- By exchange of body fluids – e.g. HIV
- By direct contact – e.g. athlete's foot
- By food – e.g. salmonella bacteria
- Sometimes pathogens pass from one person to another by animal vectors (carriers) such as by
  - Mosquitoes – e.g anopheles mosquito can transfer protozoan into human blood causing malaria
  - Houseflies – can carry dysentery bacteria from human faeces to food

CB5d-e/SB5d-e Pathogens questions

- Define infectious diseases.
- Define pathogens.
- Name 4 types of pathogen.
- Give an example of a disease caused by a virus.
- What type of pathogen causes athlete's foot?
- Give 5 ways that diseases can pass between people.
- What is a vector and name a disease passed by one.

CB5f/SB5i Physical and Chemical Barriers



Defence against invasion

Animals, including humans, have many different ways to protect themselves against attack from pathogens:

Physical barriers stop pathogens getting into the body:

- Skin – forms a protective barrier
- Mucus – traps microorganisms
- Cilia – these are tiny hairs in the windpipe that sweep mucus and microorganisms trapped in it upwards so they can be coughed

out

Chemical defences help kill pathogens before they can harm us:

- Hydrochloric acid in the stomach kills harmful microorganisms in food
- Tears (liquid is produced by tear glands) contain enzymes called lysozymes that kill microorganisms

Using antiseptics

Chemical substances called antiseptics can kill pathogens outside the body and can be applied to the surface of an open wound to help prevent pathogens getting into the wound and causing infection.

Using antibiotics

If pathogens enter the body (i.e they manage to pass through the body's physical barriers), we need a way of killing them without killing the patient.

Antibiotics are medicines that kill or prevent the growth of bacteria and some fungi. Antibiotics that only affect bacteria are called antibacterials. Antibiotics that only affect fungi are called antifungals.

Antibiotics don't kill viruses so can't be used to treat diseases caused by viruses such as HIV (AIDS), influenza and mumps

Resistance

Individual bacteria in a population show variation and some will be naturally more resistant to an antibiotic (i.e will be killed much more slowly)

When an antibiotic is first taken, the less resistant bacteria are killed first, the more resistant survive

- If person stops taking antibiotic too early then the resistant bacteria will live to reproduce and pass on their resistant genes to their offspring forming a new colony of resistant bacteria
- Over time, misuse of antibiotics (i.e stopping treatment early) can lead to resistant strains of bacteria – e.g MRSA is resistant to many antibiotics

CB5f/SB5i Physical and Chemical Barriers Questions

- Name 3 physical barriers the body has to defend itself against pathogens.
- Name two chemicals the body uses to defend itself.
- Where would you use an antiseptic cream?
- What is the difference between an antibiotic, an antifungal and an antibacterial?
- Which of the above would you take if you had a viral infection? Why?
- How does antibiotic resistance occur? Why is it important to finish your course of antibiotics?

CB5g/SB5j The Immune System

Key definitions

- Antigen – chemicals on the surface of the pathogen
- Antibody – stick to the antigen to destroy it
- Lymphocyte – WBC that produces antibodies

The process of Immunisation

1. Harmless antigen or pathogen injected
2. Antigens trigger immune response and production of antibodies
3. Antigens trigger production of memory lymphocytes

Advantages of Immunisation	Disadvantages of Immunisation
A child can become immune to a disease without suffering from it	Some mild symptoms of the disease associated with immunisation
Reduces chances of long term harm from dangerous diseases e.g. measles, mumps, rubella	Swelling or redness around the injection site
If enough children are immunised, the disease becomes so rare – herd immunity	Allergic reaction

CB5g/SB5j The Immune System Questions

1. Explain the process of immunisation in three bullet points.

2. State an advantage of immunisation.

3. State a disadvantage of immunisation.

CB5g/SB5j The Immune System 2

Edward Jenner

1. Noticed milk maids don't get smallpox
2. Thought getting cowpox might stop you getting smallpox
3. Took pus from a cowpox blister and rubbed it into a boy - James Phipps aged 8
4. James Phipps showed a slight fever
5. Jenner repeated the process with smallpox blister pus.
6. James did not get smallpox
7. Jenner used the cowpox virus to develop a vaccine for the smallpox virus

CB5g/SB5j The Immune System 2 Questions

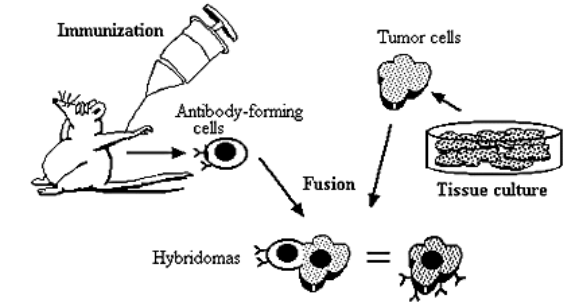
1. Describe Edward Jenner's work on vaccines in 4 bullet points.

2. Explain why being infected with cowpox protects against smallpox infection.

CB5g/SB5j The Immune System 3

The role of memory lymphocytes

1. Remain in blood after primary infection.
2. Should the same pathogen return, the memory lymphocytes produce antibodies more quickly and reduce chances of showing symptoms.
3. This is called the secondary immune response.



Monoclonal Antibody Production

1. Antigen injected into mouse.
2. Mouse make lymphocytes that produce specific antibodies
3. B lymphocyte fused with tumour cells to form hybridoma
4. Hybridoma divides and makes antibodies which can be isolated

CB5g/SB5j The Immune System 3 Questions

1. What is an antigen?

2. What is an antibody?

3. Describe the role of Memory Lymphocytes in the secondary immune response.

CB5h/SB5k Antibiotics

Antibiotics

1) Antibiotics are chemicals that kill bacteria without killing your own body cells. Many are produced naturally by fungi and other microbes, e.g. penicillin is made by a type of mould. Pharmaceutical companies can grow them on a large scale in a lab and extract the antibiotics.
2) They're very useful for clearing up bacterial infections that your body is having trouble with, however they don't kill viruses.
3) Some bacteria are naturally resistant to (not killed by) certain antibiotics. Misuse of antibiotics (e.g. doctors overprescribing them or patients not finishing a course) has increased the rate of development of resistant strains. MRSA (the hospital 'superbug') is the best-known example of an antibiotic-resistant strain.

Remember, not all microbes are harmful. Many are helpful.

A major problem with using antibiotics is that many kinds of bacteria are evolving **resistance** , so they are no longer harmed by the antibiotic.
New antibiotics and other medicines must be developed to help control infection.

New drugs developed to treat any kind of disease need to be thoroughly tested before they can be used to make sure they are safe and they work. New drugs first go through **preclinical** trials which involve testing on animals.
After the drug has been tested on animals, It's tested on humans. This is known as a **clinical trial.**

CB5h/SB5k Antibiotics Questions

- Explain why antibiotics have no affect on diseases such as HIV and flu.
- Why are many bacteria becoming resistant to antibiotics and what can we do to solve this problem?
- Describe two stages of pre-clinical testing in the development of a new antibiotic.

CB6a/SB6a PHOTOSYNTHESIS

- Plants (like animals) have mitochondria in their cells where respiration occurs
- Plants need a supply of glucose for respiration
- In animals/humans, glucose needed for respiration is obtained from the breakdown of starch
- Unlike animals/humans, plants can make their own glucose by a process called photosynthesis
- Equation for photosynthesis:

$$\text{Carbon Dioxide + Water} \xrightarrow{\text{Light}} \text{Glucose + Oxygen}$$

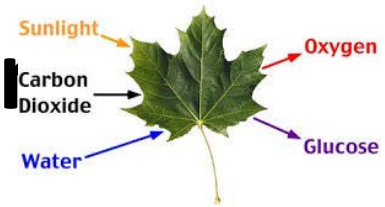
$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{} C_6H_{12}O_6 + 6O_2$$

- Photosynthesis takes place inside plant cell organelles called chloroplasts which contain a green substance called chlorophyll. Plants cannot photosynthesise without chloroplasts.
- Chlorophyll absorbs sunlight, transferring the light energy into stored chemical energy in glucose

CB6a/SB6a Questions on Photosynthesis

- Where does plant respiration occur?
- Where does the glucose come from for plants to respire?
- Write the word equation for photosynthesis
- Write the symbol equation for photosynthesis
- In which organelle does photosynthesis occur?
- Name the chemical that absorbs sunlight

CB6a.SB6a Leaf adaptation



- The leaf is the main plant organ in which photosynthesis occurs.
- Leaves are adapted for photosynthesis as they have chloroplasts containing a substance called chlorophyll that absorbs light energy from the sun. They are broad and flat and therefore have a large surface area to absorb as much light energy as possible
- On the underside of leaves are microscopic pores called stomata where gases enter and leave the leaf
- Air spaces inside the leaf give cells a large surface area to volume ratio – this makes gas exchange through the stomata more efficient

Gas exchange in the stomata

- Carbon dioxide from the atmosphere diffuses into the leaf through the stomata and is used for photosynthesis
- Oxygen produced in photosynthesis diffuses from the inside of the leaf into the atmosphere through the stomata
- Water produced during respiration can evaporate from cells inside a leaf and diffuse out of the leaf through the stomata
- Stomata open when it's light to allow gas exchange and photosynthesis to occur . They close when it's dark
- When it's dark, stomata close for two reasons:
    1. Photosynthesis can't take place so gas exchange is not necessary
    2. Plants still respire in the dark, producing water vapour

Note:

- Water needed for photosynthesis does <u>NOT</u> enter through stomata in the leaf - it is taken up in the roots and then transported to the leaf in xylem vessels

CB6a/SB6a Questions on Leaf Adaptations

- What is the main organ of a plant?
- How is the shape of a leaf adapted for photosynthesis?
- What is the name of the small pores on the underside of a leaf that allow gases in and out?
- What do air spaces inside the leaf do?
- Which gas diffuses into a leaf and why?
- Name two substances that leave the leaf –one by diffusion and one by evaporation.
- Give two reasons why stomata close in the dark

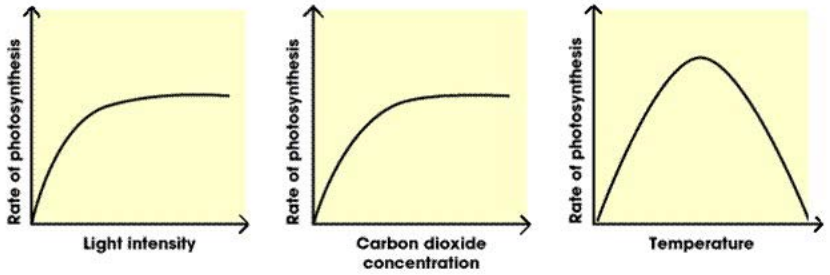
CB6b/SB6b Factors That Affect Photosynthesis

The higher the rate of photosynthesis, the more glucose that is produced which is needed by plants for growth and for respiration

Factors affecting the rate of photosynthesis:

- Concentration of carbon dioxide
- Water
- Light intensity
- Temperature (reactions in photosynthesis are catalysed by enzymes so can also affect the rate of photosynthesis)

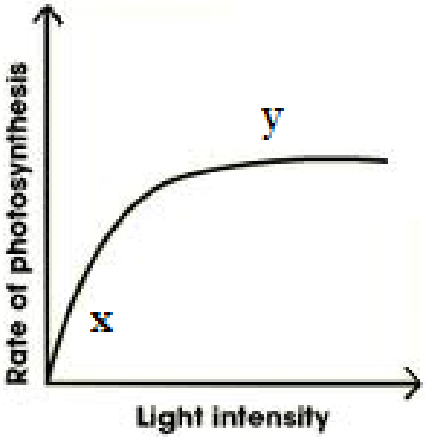
- The process of photosynthesis is affected by several factors so the maximum rate at which the process can occur is controlled by the factor that is in the shortest supply – the factor in the shortest supply is the 'limiting factor' that will slow the rate of photosynthesis down
- If a plant has lots of carbon dioxide, lots of water, is grown at the right temperature but in dim light, it will photosynthesise slowly. Increasing the concentration of carbon dioxide, or giving the plant more water or increasing the temperature will not increase the rate of photosynthesis
- Only increasing the amount of light will increase the rate of photosynthesis so in this example, the limiting factor is light (intensity)



CB6b/SB6b Factors That Affect Photosynthesis Questions

- Name four factors that can affect the rate of photosynthesis
- Explain how temperature can affect the rate of photosynthesis.
- What do we call the factor that is in shortest supply?

CB6b/SB6b Factors That Affect Photosynthesis

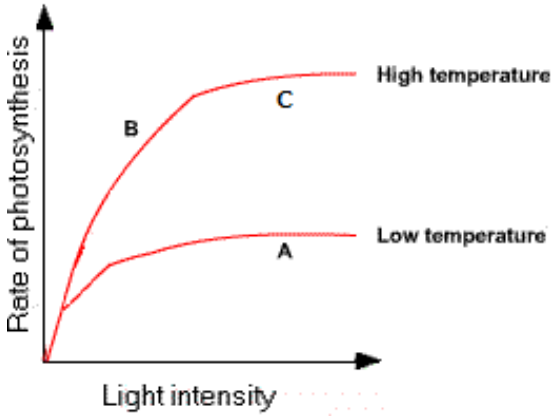


At point x:

Increasing light intensity increases the rate of photosynthesis…
initially light intensity is the limiting factor

At point y:

Increasing light intensity doesn't increase the rate of photosynthesis any further…
another factor (i.e temperature, CO_2 concentration or water) must be limiting the rate of photosynthesis at this point

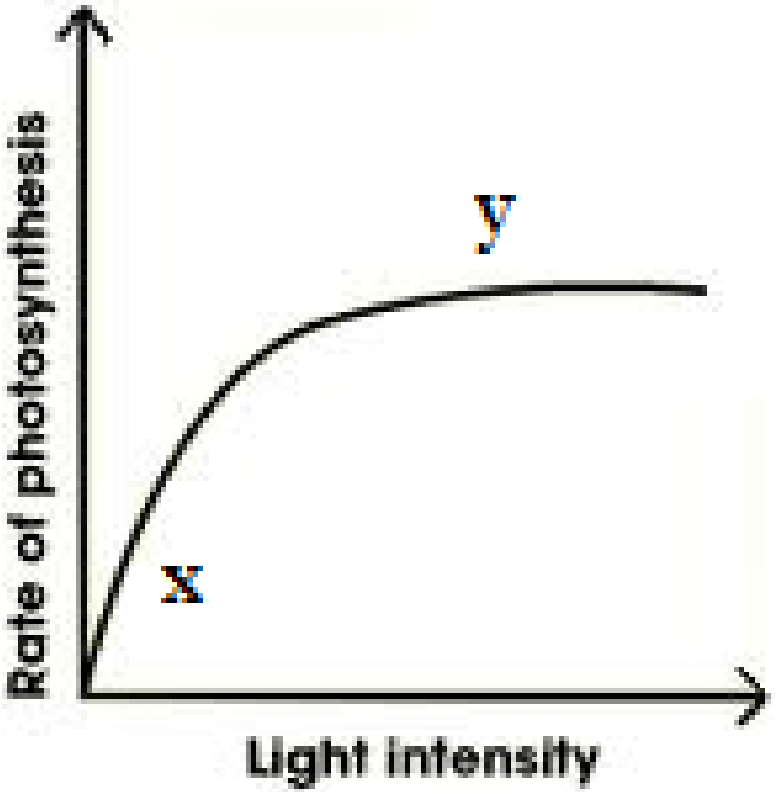


At point **A** – increasing the temperature increases the rate of photosynthesis (the high temperature trace at the same light intensity has a much higher rate of photosynthesis)the limiting factor at this point is temperature

At point **B** – increasing the light intensity increases the rate of photosynthesis - the limiting factor at this point is light intensity

At point **C** – increasing temperature or light intensity doesn't increase the rate of photosynthesis any further - the limiting factor at this point could either be the amount of carbon dioxide or water available to the plant

CB6b/SB6b Factors That Affect Photosynthesis



Explain this graph. What happens when light intensity increases?

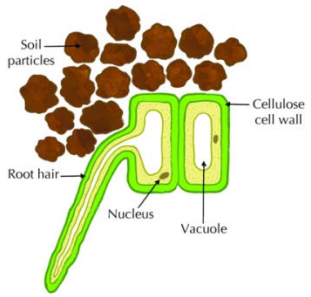
Why doesn't the rate of photosynthesis keep increasing

CB6c/SB6c Absorbing Water & Minerals

- Roots anchor plants to the ground and take up water and mineral salts from the soil
- 'Root hair cells' are present in roots – they have adaptations that help them take up water and minerals from the soil:
  1. long, thin extensions that reach into the surrounding soil
  2. large surface area
- Water enters the root hair cells by osmosis

  Water moves from a region of higher water concentration to a region of lower water concentration until 'equilibrium' is reached (i.e until the water concentration is the same on both sides)

  Sucrose molecules can't move because they are too big to fit through the gaps in the partially permeable membrane



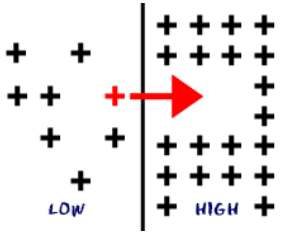
CB6c/SB6c Absorbing Water & Minerals Questions

- Describe two jobs of plant roots.
- Describe two adaptations of root hair cells
- Name the process that allows water to move into root hair cells.
- Why don’t sucrose molecules move into the root hair cell?

CB6c&d/SB6c&d Transpiration & Translocation

The concentration of minerals dissolved in soil water is very low compared to the concentration of minerals in the plant. For minerals dissolved in soil water to be taken up into the roots, they must be absorbed against the concentration gradient –from an area of lower concentration to an area of higher concentration. Minerals help plants grow.

- Absorbing particles against a concentration gradient is called 'active transport' which requires energy from respiration.



- Once water and minerals have entered the root cells, they need to get to all the plant's tissues
- Xylem vessels transport the water needed for photosynthesis and dissolved mineral salts
- The glucose made in the leaves during photosynthesis is converted to sucrose and then transported to other parts of the plant by phloem vessels and then stored as starch
- Transpiration is the pulling up of water against gravity, so water produced during respiration can evaporate from cells inside a leaf and diffuse out of the leaf through the stomata
- As the rate of evaporation of water increases the faster the loss of water through stomata and the increased rate of transpiration
- Rate of evaporation determines the rate of transpiration, warm and windy day, the rate of transpiration will be greater

CB6c&d/SB6c&d Transpiration & Translocation Questions

- What is the process called where plants absorb minerals against a concentration gradient?
- What do xylem vessels do?
- What happens to the glucose made during photosynthesis?
- What is transpiration?
- What effect will a wet day have on the rate of transpiration? What about a windy day?

CB7a/SB7a Hormones

Hormones are *Chemical Messengers* Sent in the *Blood*

1) Hormones are chemicals produced in various glands called endocrine glands. These glands make up your endocrine system.
2) Hormones are released directly into the blood. The blood then carries them to other parts of the body.
3) They travel all over the body but they only affect particular cells in particular places.
4) The affected cells are called target cells — they have the right receptors to respond to that hormone. An organ that contains target cells is called a target organ.

Hormones are slow compared to nervous impulses but they have longer-lasting effects.

Examples of target organs are : Pituitary gland, thyroid , adrenals, ovaries, testes and pancreas.

Some endocrine glands are the target organs for other organs. For example sex hormones oestrogen and testosterone which are released by reproductive organs stimulate the release of growth hormone.

CB7a/SB7a Hormones Questions

- Define the term hormone.
- Name one hormone produced in a) the ovaries b) the pancreas.
- Describe how a change in the amount of sex hormones produced during puberty leads to an increase in growth. Include the names of endocrine glands and target organs for the hormones you mention.

CB7b/ SB7b Hormonal Control of Metabolic Rate

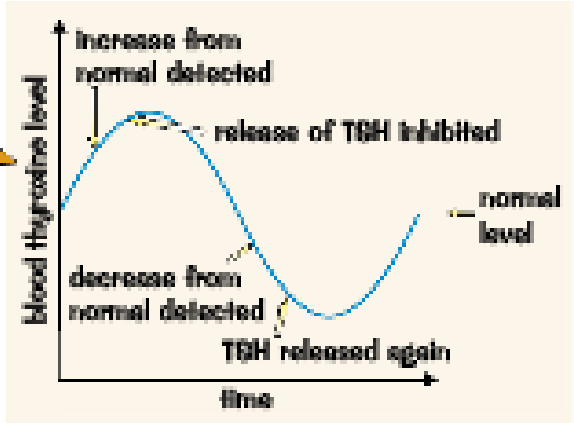
Hormone Release can be Affected by Negative Feedback

Your body can control the levels of hormones (and other substances) in the blood using negative feedback systems. When the body detects that the level of a substance has gone above or below the normal level, it triggers a response to bring the level back to normal again. Here's an example of just that:

Thyroxine Regulates Metabolism

Thyroxine is made in the thyroid gland from iodine and amino acids.

1) Thyroxine is a hormone released by the thyroid gland (found in the neck).
2) It plays an important role in regulating metabolic rate — the speed at which chemical reactions in the body occur. It's important for loads of processes in the body, such as growth and protein synthesis.
3) Thyroxine is released in response to thyroid stimulating hormone (TSH), which is released from the pituitary gland.
4) A negative feedback system keeps the amount of thyroxine in the blood at the right level — when the level of thyroxine in the blood is higher than normal, the secretion of TSH from the pituitary gland is inhibited. This reduces the amount of thyroxine released from the thyroid gland so the level in the blood falls back towards normal.



CB7b/ SB7b Hormonal Control of Metabolic Rate

Adrenaline Prepares you for 'Fight or Flight'

1) Adrenaline is a hormone released by the adrenal glands (which are located just above the kidneys).
2) Adrenaline prepares the body for 'fight or flight' — in other words, standing your ground in the face of a threat (e.g. a predator) or bravely running away. It does this by activating processes that increase the supply of oxygen and glucose to cells. For example:

- Adrenaline binds to specific receptors in the heart. This causes the heart muscle to contract more frequently and with more force, so heart rate and blood pressure increase.
- This increases blood flow to the muscles, so the cells receive more oxygen and glucose for increased respiration.
- Adrenaline also binds to receptors in the liver. This causes the liver to break down its glycogen stores to release glucose.
- This increases the blood glucose level, so there's more glucose in the blood to be transported to the cells.

3) When your brain detects a stressful situation, it sends nervous impulses to the adrenal glands, which respond by secreting adrenaline. This gets the body ready for action.

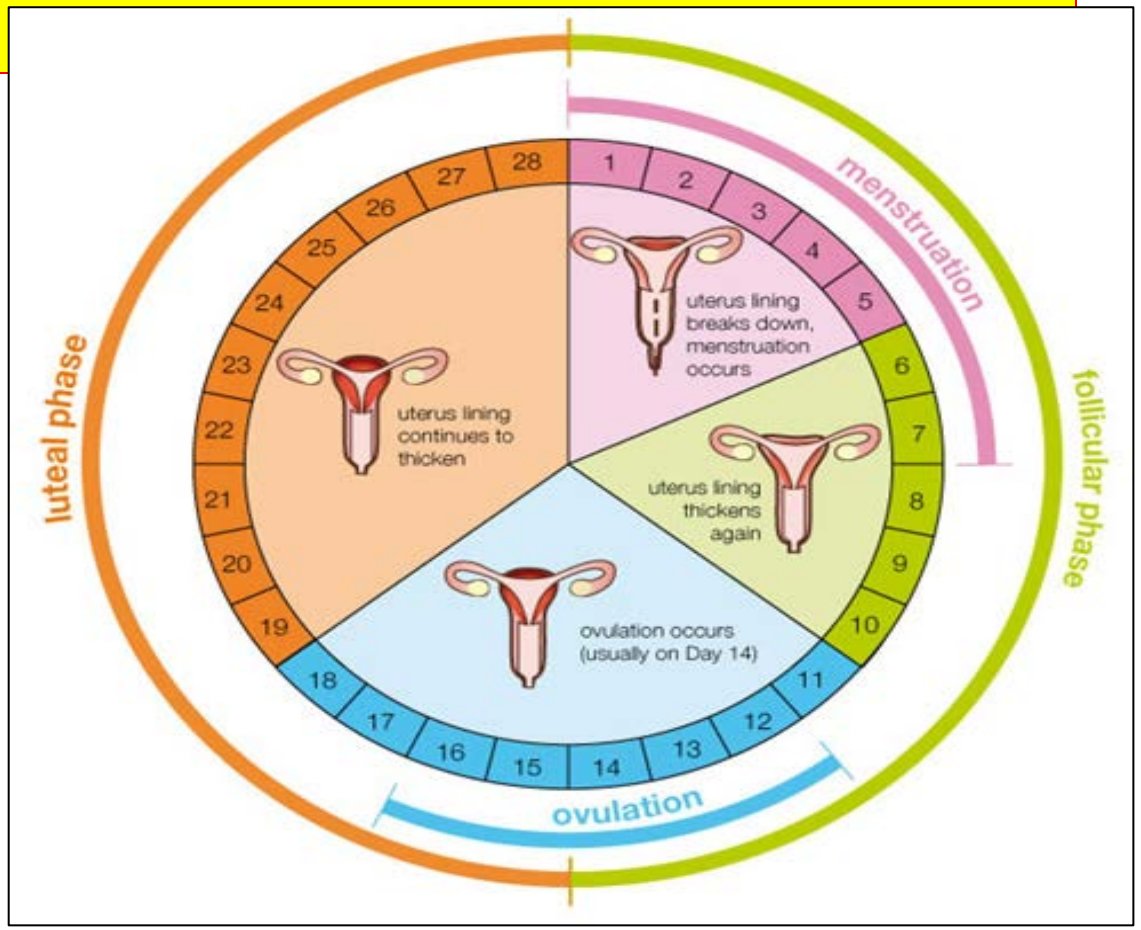
- Define the term **negative feedback .**
- Explain why negative feedback is important when controlling thyroxine release.
- Describe how negative feedback can control the amount of hormone in the blood

CB7c/ SB7c The Menstrual Cycle

The menstrual cycle is controlled by the hormones OESTROGEN and PROGSTERONE.

There are 4 stages to the menstrual cycle:

1. Menstruation
2. Uterus lining thickens
3. Ovulation
4. Uterus lining continues to thicken



If fertilisation occurs, the uterus lining is maintained because the corpus luteum continues to secrete progesterone. The developing embryo embeds in the lining and continues to grow.

CB7c/ SB7c The Menstrual Cycle Questions

1. Name the two main hormones in the menstrual cycle.

2. What are the four stages of the menstrual cycle in order.

3. Explain what happens to the uterus lining if fertilisation occurs.

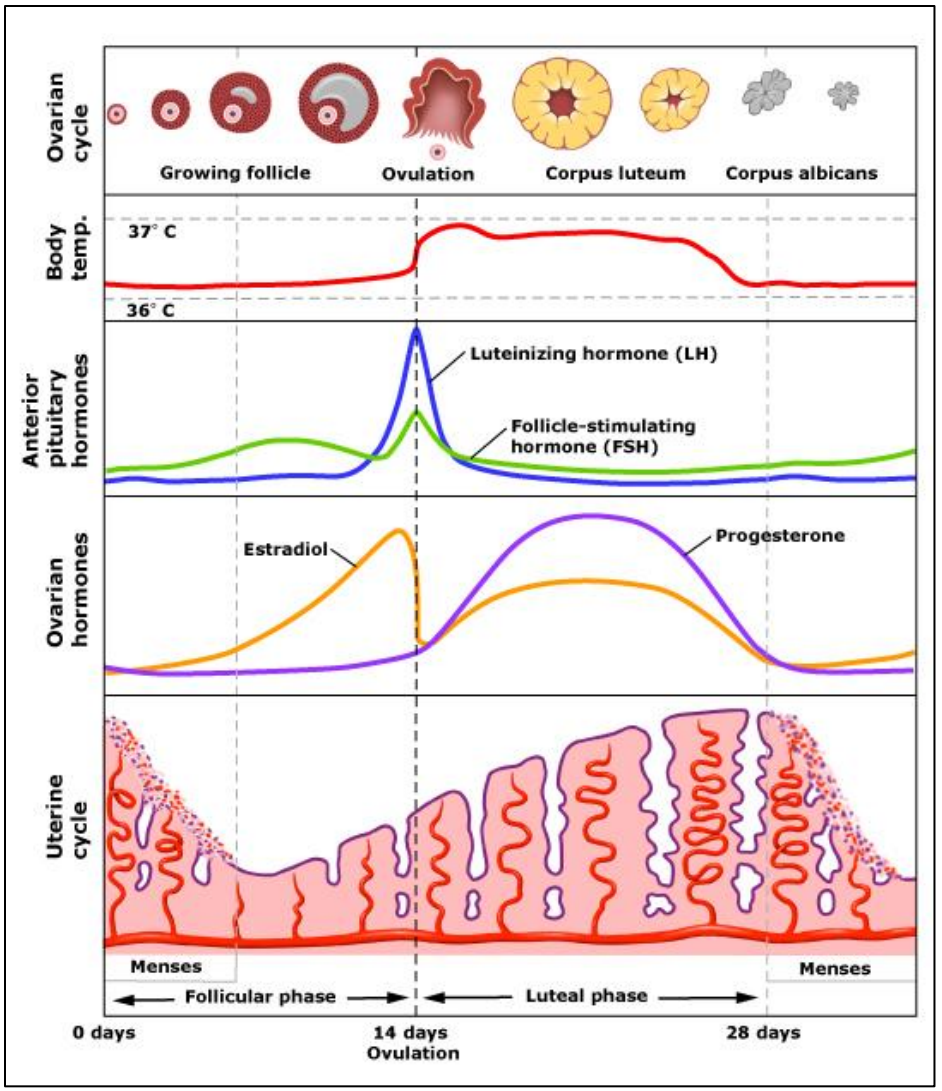
CB7d/ SB7d Hormones and The Menstrual Cycle

Progesterone is released after ovulation. Increasing progesterone inhibits FSH and LH. Falling progesterone triggers menstruation.

Increasing oestrogen stimulates LH production and causes thickening of the uterus wall. Falling oestrogen also stimulates menstruation.

FSH stimulates the growth and maturation of the follicle

A surge of LH triggers ovulation.



Another example of negative feedback

CB7d/ SB7d Hormones and The Menstrual Cycle Questions

1. High levels of which hormone inhibits LH and FSH?
2. What does oestrogen do?
3. What triggers menstruation?
4. What does FSH do?
5. Which hormone triggers ovulation?

CB7e/SB7e Control of Blood Glucose

Maintaining constant conditions inside the body is called Homeostatis.

Controlling blood glucose levels

High blood glucose levels cause tiredness and can damage organs. Low blood glucose levels may cause unconsciousness so the concentration of glucose in the blood must be kept constant.

1. When blood glucose levels are too high (often after a meal):
    - The pancreas releases a hormone called insulin
    - Insulin is transported in the blood to the liver
    - Insulin causes liver cells to take glucose out of the blood and convert it into glycogen (glycogen acts as a store of glucose because it can be converted back into glucose when required) and blood glucose concentration decreases (back to normal)
2. When blood glucose levels are too low:
    - The pancreas releases a hormone called glucagon
    - Glucagon is transported in the blood to the liver
    - Glucagon causes liver cells to convert glycogen back into glucose, which is then released into the blood and blood glucose concentration increases (back to normal)

The control of blood glucose concentration is an example of a negative feedback mechanism

DIABETES

People who have a disease called diabetes can't control their blood glucose levels very well . There are two types of diabetes.

Type 1 diabetes: develops in young people because the pancreas does not produce any insulin. When blood glucose concentrations rise, the body cannot bring them back down to normal.

Controlling type 1 diabetes:

1. Inject insulin into fat layer beneath skin (this helps diabetics keep their blood glucose levels low)

2. Exercise reduces blood glucose levels, eating fatty foods increases blood glucose levels and by exercising more and not eating fatty foods, diabetics can keep their blood glucose levels low so they don't need to inject as much insulin

CB7e/SB7e Control of Blood Glucose Questions

- What symptoms occur if blood sugar is too high/too low?
- What does the pancreas release and what does this do to glucose?
- Explain why people with type 1 diabetes must control their blood glucose concentration with injections of insulin.

CB7f/SB7f Type 2 Diabetes

Type 2 diabetes: In this type of diabetes, the pancreas releases insulin as normal however, the cells in a person's body don't respond

well to insulin (they become 'resistant' to insulin) and the person has problems in reducing blood sugar levels.

Unlike Type 1 diabetes which develops in young people, Type 2 diabetes usually develops in adulthood.

- Risk factors for Type 2 diabetes: high fat diets, lack of exercise, age
- Obesity and Body Mass Index (BMI):Doctors class people as obese if they have a BMI of over 30. BMI gives an

estimate of how healthy a person's mass is for their height. Correlation between high BMI and suffering Type 2 diabetes

Equation: BMI = weight in kilograms / (height in metres)^2

Unlike Type 1 diabetics, sufferers of Type 2 diabetes don't need to inject themselves with insulin as they control type 2 diabetes by changing diet (eating less fatty/sugary foods) and by exercising more

CB7f/SB7f Type 2 Diabetes Questions

- What is the difference between type 1 and type 2 diabetes?
- What are the risk factors for type 2 diabetes?
- Write down the equation for calculating BMI.

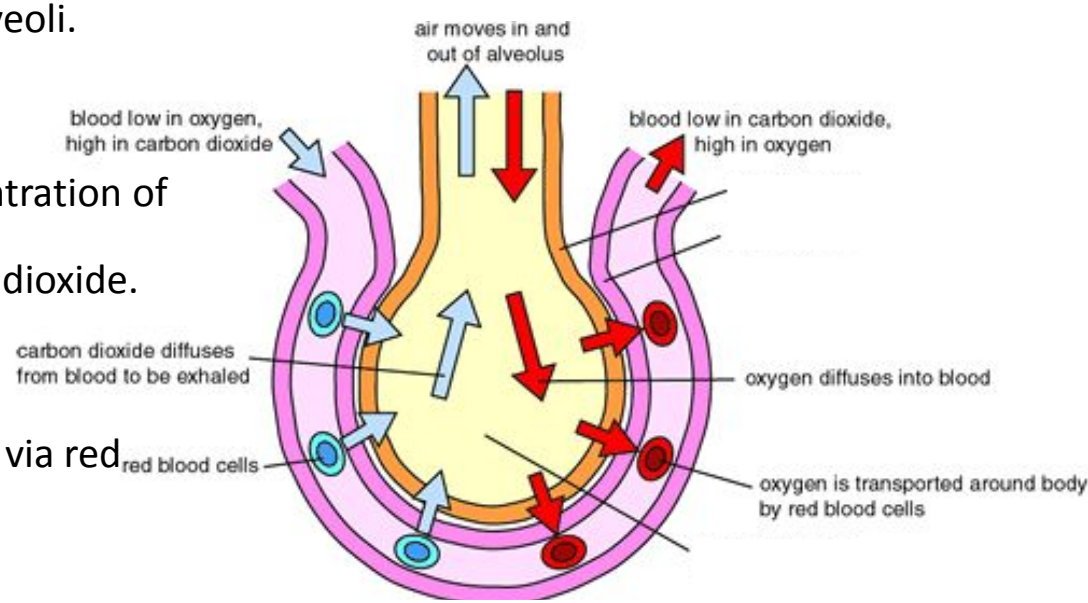
CB8a/SB8a Efficient transport and exchange

- Alveoli – tiny air sacs in the lungs – are surrounded by capillaries. Here is where gas exchange takes place.
- The oxygen diffuses into the blood, waste carbon dioxide diffuses out.
- Arriving at the alveoli blood has a high concentration of carbon dioxide and a low concentration of oxygen.
- The carbon dioxide is removed by exhaling.

Breathing in allows oxygen to enter the alveoli.

Blood leaving the alveoli has a high concentration of oxygen and a low concentration of carbon dioxide.

Oxygen is transported in the blood stream via red blood cells to be used for respiration



CB8a/SB8a Efficient transport and exchange questions

- What are alveoli?
- What is the difference between the blood arriving and leaving at the alveoli?
- How is carbon dioxide removed from the blood?
- How does oxygen reach the cell?

CB8b/SB8c The Circulatory System

Blood vessels

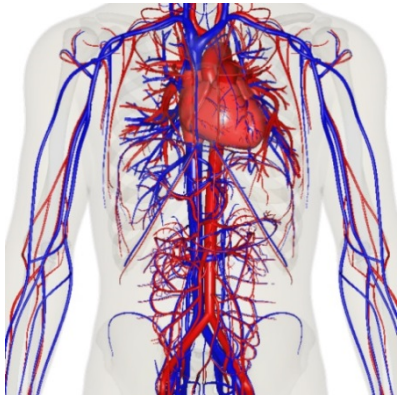
Blood vessels are tube-shaped organs that carry blood. There are 3 types of blood vessels – arteries, veins and capillaries

1. **Arteries** (e.g pulmonary artery, aorta): Carry blood away from the heart. Blood in arteries has to be under high pressure so that it can reach all parts of the body (remember that aorta carries blood all around the body. Arteries have strong, thick walls

2. **Veins** (e.g pulmonary vein, vena cava):Carry blood towards the heart. Blood in veins travels slowly and at low pressure, veins have thin walls and a wide, large passage for blood to flow

3. **Capillaries** Allow substances to diffuse into and out of the blood, into or out of cells and tissues. e.g oxygen diffuses from alveoli into capillaries in the lungs.

To help substances diffuse faster, capillaries have very thin walls (only one cell thick).



CB8b/SB8c The Circulatory System 2

Blood contains many different types of specialised cells which all have differentiated from blood stem cells.

Blood is made up of four main components plasma, red blood cells, white blood cells and platelets.

Plasma (55% of the blood): Plasma is the liquid (yellow colour) component of the blood which transports dissolved substances such as carbon dioxide, food substances and hormones

Red blood cells (45% of the blood): Red blood cells contain the red pigment haemoglobin and when blood in capillaries arrives at the alveoli it contains little oxygen.

The oxygen diffuses from the alveoli into the red blood cells. In the red blood cells, oxygen combines with haemoglobin to form oxyhaemoglobin (the reaction is reversible ↔)

haemoglobin + oxygen ↔ oxyhaemoglobin

Oxyhaemoglobin is then transported in red blood cells around the body to supply cells with oxygen for respiration. The oxyhaemoglobin splits, releasing oxygen (which diffuses into respiring cells) and haemoglobin.

When red blood cells return to the alveoli, haemoglobin will be able to combine with new oxygen molecules and the process repeats

CB8b/SB8c The Circulatory System 3

Structure of RBC: Biconcave disc (cells have a dimple on both sides) which gives red blood cells a large surface area to volume ratio for oxygen to diffuse into and out of the cell.

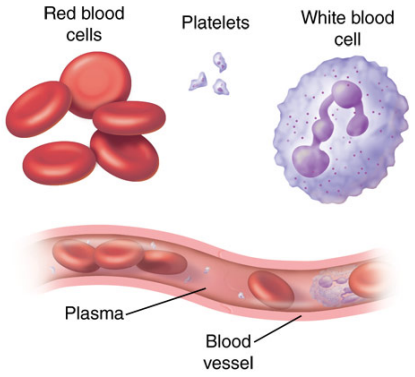
No nucleus which means there's more room for more haemoglobin so they can transport more oxygen.

Structure of White blood cells (less than 1% of blood): All white blood cells have a nucleus. White blood cells are bigger than red blood cells

Function: White blood cells are part of the body's defence against - part of the body's 'immune system'. Some white blood cells make antibodies which are proteins that bind to microorganisms that cause disease and destroy them. Other white blood cells destroy any foreign cells that enter the body by surrounding ('engulfing') them

Platelets (less than 1% of blood): Platelets are tiny fragments of cells that don't have nuclei.

Function: Platelets are important in clotting blood (when blood vessels are damaged). The clot dries out and forms a scab – this stops microorganisms getting into the body



CB8b/SB8c The Circulatory System Questions

- List the parts of the circulatory system.
- Name the 3 types of blood vessels.
- Why do arteries have thick walls?
- Name the 4 components of blood.
- Explain how oxygen is transported from the lungs to a tissue.

CB8c/SB8d The Heart

Blood coming in from the tissues is low in oxygen ('deoxygenated'). It is pumped by the heart to the lungs where haemoglobin in red blood cells picks up oxygen (i.e combines to form oxyhaemoglobin). Blood becomes 'oxygenated' and returns to the heart where it is then pumped around the body to the tissues and cells (so that cells receive oxygen for use in aerobic respiration).

The heart is split into right and left sides and each side is split into two chambers – an atrium (atria – plural) and a ventricle. A vein called the vena cava brings deoxygenated blood from the body into the right atrium.

1. Superior vena cava – brings deoxygenated blood from upper body Inferior vena cava – brings deoxygenated blood from lower body. When the right atrium is full, muscles in the wall contract and the deoxygenated blood is forced through valves and into the right ventricle. Valves are flaps of tissue that prevent backflow of blood (i.e stop blood going back the way it came).Valves are prevented from turning inside out by tendons

2. When the right ventricle is full of blood, the muscles of the ventricle wall contract and the blood is forced out through some other valves into the pulmonary artery. The pulmonary artery carries the deoxygenated blood to the lungs where it picks up oxygen and becomes oxygenated

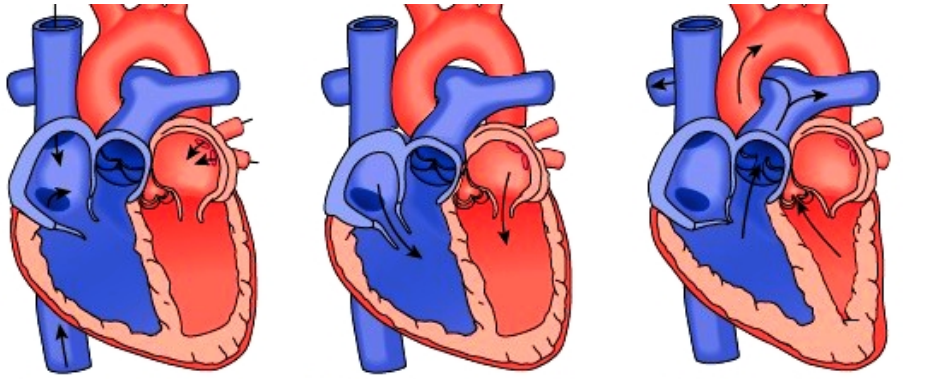
3. The oxygenated blood is then transported by the pulmonary vein from the lungs to the left atrium of the heart . When the left atrium is full, it contracts and the oxygenated blood is forced through valves and into the left ventricle

4. Once the left ventricle is full of oxygenated blood, the muscles of the ventricle wall contract and the blood is forced out through some other valves into an artery called the 'aorta'

5.The aorta carries oxygenated blood around the body (supplying cells with oxygen for use in aerobic respiration).The cycle then repeats (note: right and left sides of the heart work together, filling and emptying at the same time – it's just easier to explain the way the heart works by looking at each side in turn)

a. the left ventricle has to pump blood all the way round the body and the right ventricle only has to pump blood to the lungs therefore the muscle wall of the left ventricle is thicker than the muscle wall of the right ventricle

b. The septum separates the right and left sides of the heart. The right side of the heart (i.e the right atrium and right ventricle) pumps deoxygenated blood. The left side of the heart (i.e .the left atrium and the left ventricle) pumps oxygenated blood. the septum is important so that the oxygenated blood and deoxygenated blood do not mix



Atria fill with blood

Contraction of atria pumps blood into the ventricles.

Contraction of ventricles pumps blood into aorta and pulmonary artery

CB8c/SB8d The Heart Questions

- What does deoxygenated and oxygenated mean?
- Where does deoxygenated blood come from?
- Describe the structure of the heart.
- Why are the walls of the heart different thicknesses?
- What does the septum do?

CB8d/SB8e Cellular Respiration

During exercise:

- Muscles need more energy, they need more oxygen from respiration
- 1. the heart rate and stroke volume increase
- 2. breathing rate also increases to get more oxygen into the blood
- So more oxygen reaches muscle cells faster - faster rate of aerobic respiration in muscle cells - more energy released

During intense exercise:

- even increasing the heart rate and the breathing rate isn't enough to supply oxygen to muscle cells quickly enough
- anaerobic (less oxygen) respiration starts to happen (alongside aerobic respiration) inside muscle cells

Anaerobic respiration breaks down glucose without using oxygen - the waste product lactic acid is produced:

- glucose → lactic acid (+ energy released)
- The energy released by anaerobic respiration is less than the energy released by aerobic respiration

The waste lactic acid produced during anaerobic respiration is toxic so it must be broken down as soon as possible. Lactic acid can be broken down by oxygen into carbon dioxide and water:

(the lactic acid can't be broken down during exercise because there isn't enough oxygen available - it is being used in aerobic respiration)

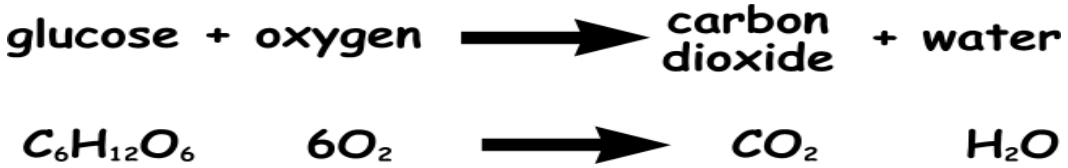
The extra oxygen needed after exercise is obtained by keeping the breathing rate and the heart rate high for a few minutes after exercise (i.e until the oxygen has broken down all the lactic acid produced into carbon dioxide and water). The time taken for the heart rate to return to normal (resting) after exercise is the 'recovery time' - the faster the recovery time, the fitter the person

CB8d/SB8e Cellular Respiration and questions

All cells in the body need energy – it is released by respiration. More active cells need more energy eg. muscles contract having to cause movement – this requires a lot of energy.

This process occurs inside organelles called mitochondria.

Aerobic respiration just means with a plentiful supply of oxygen.



This released energy can be used by the cells.

Glucose and oxygen are carried around the body by blood. Blood also takes away waste carbon dioxide. Diffusion is how these substances move into the blood, through a 1-cell-thick wall.

Respiring cells produce lots of carbon dioxide – less than in the blood – so it diffuses down a concentration gradient into the bloodstream.

They use up oxygen and glucose so they diffuse down the concentration gradient into the cells from the blood.

Where does respiration occur?
How does the respiratory system change during exercise?
State an advantage of anaerobic respiration for humans.
Design a table to compare and contrast aerobic and anaerobic respiration.

CB9a/SB9a Ecosystems

Organisms in an area depend on each other for food – i.e. they are interdependent.

As the numbers of one organism change, other organisms are affected.

e.g. when there's lots of prey, predators have more food so they increase in number

As predator number goes up, more prey are eaten so they decrease in number

The relationships between the organisms are always changing **-** this is called a dynamic relationship.

Food Chains

Some organisms are producers and make their own food e.g. green plants which use photosynthesis. The rest get their food from other organisms.

Primary consumers get their energy by eating plants so are herbivores.

Secondary consumers get their energy by eating primary consumers so are carnivores

Food chains show what eats what and arrows show the direction

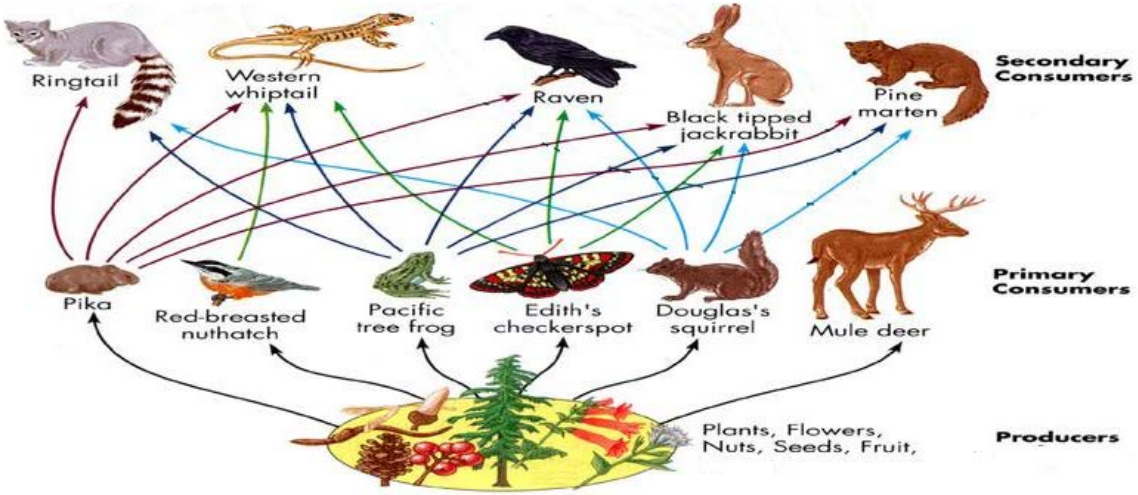
of energy flow.

e.g red oat grass (producer)→zebra (primary consumer)→lion (secondary consumer) which indicates zebras eat red oat grass. Lions eat zebras.

Organisms that feed at the same level in a food chain are in the same trophic level: Producers are at the first trophic level, primary consumers are at the second trophic level and secondary consumers are at the third trophic level

Food chains from a habitat can be joined together into a food web, which shows the feeding relationships between the different organisms

CB9a/SB9a Ecosystems Questions



- What does interdependent mean?
- What is a producer and where does it get its energy from?
- What are primary and secondary consumers?
- In a food web or chain what does the direction of the arrow show?

CB9b/SB9c Abiotic Factors and Communities

- The distribution of organisms is affected by abiotic factors such as temperature, moisture level, light intensity and soil pH. For example in a playing field you might find that daisies are more common in the open than under trees, because there is more light available in the open.
- Substance that cause harm in the environment are pollutants and cause pollution. Many human activities release pollutants. These can poison organisms or cause harm to organisms in other ways (such as plastics being eaten by fish).

CB9b/SB9c Abiotic Factors and Communities Questions

- Name 2 abiotic factors that are related to climate.
- What is pollution?
- How can pollution affect communities?
- Explain why drought in an ecosystem can have long term effects on the animals in a community.

CB9c/SB9d Biotic Factors and Communities

Biotic factors are the organisms in an ecosystem that affect other living organisms. They can also affect the distribution of organisms, for example: a)the availability of food – if there's a bumper year for berries then the population of blackbirds might increase because there will be enough food for all of them, so they are more likely to survive and reproduce.

b) Number of predators – if the number of lions (predator) decreases then the number of gazelles (prey) might increase because fewer of them will be eaten by the lions.

CB9c/SB9d Biotic Factors and Communities Questions

- What are biotic factors?
- Describe how preventing the introduction of harmful species can help protect biodiversity.
- Explain how the reintroduction of wolves to Yellowstone changed abiotic and biotic factors in that ecosystem.
- Describe how introducing a new predator can affect a community through predation and competition.

CB9d/SB9f PARASITES AND MUTUALISTS

In most feeding relationships, a predator kills and eats its prey and then moves to find more prey. But not all feeding relationships are like this.

Parasitism is a feeding relationship in which two organisms live together, with one feeding off (and benefiting from) the other. Parasites are usually <u>harmful</u> to their hosts.

- The organism doing the feeding is called the <u>parasite</u>
- The organism which the parasite feeds on is called the <u>host</u>

Examples of parasites:

- Headlice and fleas – live outside their host, feeding off their blood
- Tapeworms – live inside vertebrate intestines. Absorb nutrients from the host's gut and can cause the host to lose a lot of weight
- Mistletoe – grows its roots into the veins of the host tree and can absorb water and mineral salts from it

Mutualism is a relationship where both organisms benefit – this is called mutualism.

e.g in Africa, oxpeckers eat parasitic insects (e.g fleas) that live on the skin of large herbivores so oxpeckers feed themselves,

and at the same time remove fleas from herbivores and both organisms benefit

e.g cleaner fish eat dead skin and parasites from the skin of larger fish, such as sharks so both organisms benefit

Some organisms live in mutualistic relationships inside other organisms

- e.g. nitrogen-fixing bacteria live inside legumes and turn nitrogen in the air into nitrogen compounds. The bacteria are protected from the environment and obtain chemical substances from the plant that they use as food. The plant gets nitrogen compounds (nitrates) from the bacteria, which it uses for growth and both the bacteria and the plant benefit from the relationship.

- e.g. chemosynthetic bacteria live in the gut of giant tubeworms which provide a place for bacteria to live, and offer protection. Bacteria convert sulfur compounds into food that tapeworms can eat so both tubeworms and bacteria benefit from the relationship

CB9d/SB9f Parasitism and Mutualism Questions

- Describe a parasitic feeding relationship.
- Give an example of a parasitic relationship.
- How is mutualism different from a parasitic relationship?
- Give an example of a mutualistic feeding relationship and explain why it is mutual.
- Give two examples of a mutualistic relationship which occurs *inside* another living organism.

CB9e/SB9g Biodiversity and Humans

Human Interactions have an *Impact* on *Ecosystems*

1) Like all organisms, we humans have an impact on the ecosystems around us.
2) The human population on Earth has grown hugely in the last couple of centuries and is continuing to rise.
3) When the Earth's population was much smaller, the impacts of human activity were usually small and local. Nowadays though, our actions can have a far more widespread effect.
4) Our increasing population puts pressure on the environment, as we take land and resources to survive.
5) But people around the world are also demanding a higher standard of living (and so demand luxuries to make life more comfortable — cars, smartphones, etc.). So we use more raw materials (e.g. oil to make plastics), but we also use more energy for the manufacturing processes. This all means we're taking more and more resources from the environment more and more quickly.
6) Unfortunately, many raw materials are being used up quicker than they're being replaced. So if we carry on like we are, one day we're going to run out.
7) As we produce and consume things we create waste (e.g. waste chemicals), and if we don't handle it properly it can cause harmful pollution like sewage and toxic gases.
8) These human actions are negatively impacting both local biodiversity (the number of species in the local area) and global biodiversity (the number of species on the entire planet) in many ways....

The process of eutrophication

Fertiliser is added to crops

Heavy rain washes fertiliser off

Nitrates and phosphates contained within fertiliser are washed into streams or rivers

This encourages number of algae in water to increase (‘algal bloom’)

These surface plants block sunlight which is needed for photosynthesis hence plants in the water die and stop producing oxygen through photosynthesis.

Bacteria, which decompose dead plants in the water, reproduce quickly (i.e increase in number quickly) and use up more and more oxygen for respiration.

So oxygen concentration in the water decreases so larger fish in water die due to a lack of oxygen

CB9e/SB9g Biodiversity and Humans Questions

- Give two reasons why farming fish maybe a better way to provide food for humans than catching wild fish.
- How does adding fertiliser benefit a farmers field?
- Explain how eutrophication can change biodiversity in an aquatic eco system.
- Give two ways in which introduced species can affect a native food web.

CB9f/SB9h Preserving biodiversity

Maintaining Biodiversity Benefits Wildlife and Humans

Conservation schemes help maintain biodiversity by protecting species (see previous page). As well as benefitting endangered species they often help humans too:

1) Protecting the human food supply — over-fishing has greatly reduced fish stocks in the world's oceans. Conservation programmes can ensure that future generations will have fish to eat.

2) Ensuring minimal damage to food chains — if one species becomes extinct it will affect all the organisms that feed on and are eaten by that species, so the whole food chain is affected. This means conserving one species may help others to survive.

3) Providing future medicines — many of the medicines we use today come from plants. Undiscovered plant species may contain new medicinal chemicals. If these plants are allowed to become extinct, perhaps through rainforest destruction, we could miss out on valuable medicines.

4) Providing industrial materials and fuels — plant and animal species are involved in the production of industrial materials (e.g. wood, paper, adhesives and oils) and some fuels. If these species become extinct these important resources may become more difficult to produce.

CB9f/SB9h Preserving biodiversity Questions

- Give two reasons why tigers need conservation.
- Explain why tiger conservation is being carried out in captivity.
- Suggest what else needs to be done before tigers can be returned to the wild.
- Explain why maintaining biodiversity by setting up conservation schemes can be challenging

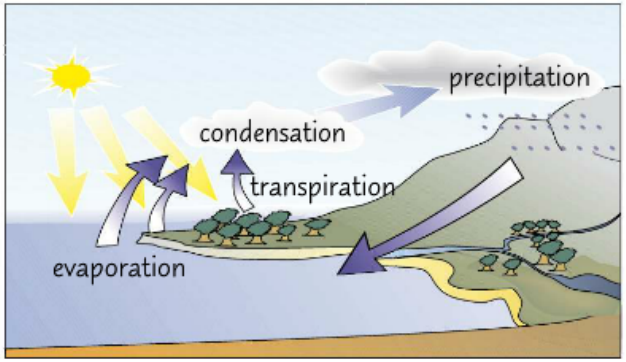
CB9g/SB9j The Water Cycle

Materials are Constantly Recycled in an Ecosystem

1) An ecosystem is all the organisms living in an area, as well as all the non-living conditions, e.g. soil quality, availability of water, temperature.
2) Materials are recycled through both the living (biotic) and non-living (abiotic) components of ecosystems:
    1) Living things are made of elements they take from the environment. For example, plants take in carbon, hydrogen, oxygen, nitrogen, etc.
    2) They turn these elements into the complex compounds (carbohydrates, proteins and fats) that make up living organisms. These are taken in by animals when they eat the plants.
    3) The elements are recycled — they return to the environment (e.g. soil or air) through waste products or when organisms die, ready to be used by new plants and put back into the food chain.
    4) Dead organisms and waste products decay because they're broken down by decomposers (usually microorganisms) — that's how the elements get put back into the soil.

...and Water is Recycled in the Water Cycle

1) The Sun makes water evaporate from the land and sea, turning it into water vapour. Water also evaporates from plants via transpiration
2) The warm water vapour is carried upwards (as warm air rises). When it gets higher up it cools and condenses to form clouds.
3) Water falls from the clouds as precipitation (usually rain, but sometimes snow or hail) and is returned to the land and sea.
4) The flow of fresh water through the water cycle allows nutrients to be transported to different ecosystems.



CB9g/SB9j The Water Cycle questions

- Name 3 substances that cycle through ecosystems.
- The water cycle depends on the ability of water to change state with temperature. Identify the processes that cause water to change state in the water cycle.
- Explain how distillation can produce safe drinking water from dirty water.
- Describe how water is cycled in the water cycle

CB9h/SB9k The Carbon Cycle

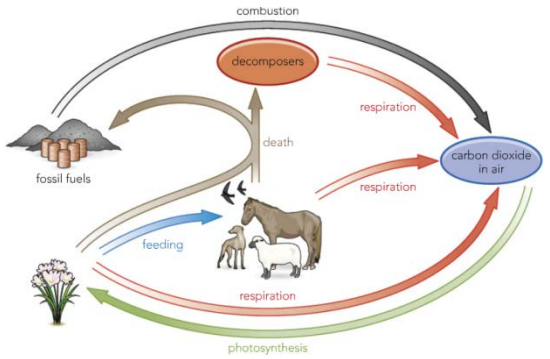
Removing carbon dioxide from the atmosphere by photosynthesis in plants

- Carbon dioxide may diffuse into a leaf to take part in photosynthesis and removes carbon dioxide from the atmosphere.
- Photosynthesis equation: *carbon dioxide + water → glucose + oxygen*

Carbon compounds formed by photosynthesis (glucose) are passed along food chains

- When primary consumers eat plants (producers), the carbon compounds contained within plants are passed along the food chain to the primary consumers
- When the primary consumers are eaten, the carbon compounds are in turn passed on to the secondary consumers.

Returning Carbon Dioxide to the Atmosphere



1.Respiration in plants <u>and</u> animals: Both plants and animals use glucose for respiration.

This process releases carbon dioxide back into the atmosphere.

Respiration equation: ***glucose + oxygen → carbon dioxide + water***

2.Decomposition of dead animals/plants by microorganisms: When plants and animals die, decomposers (e.g fungi, bacteria) break down the carbon-containing compounds in their bodies and use them for respiration which in turn produces carbon dioxide.

3. Burning of fossil fuels: Sometimes dead plants or animals are buried quickly underground before decomposer organisms can begin decaying them. Over millions of years, dead organisms underground are changed by heat and pressure into fossil fuels which contain carbon compounds so when they burn, carbon dioxide is released into the atmosphere.

CB9h/SB9k The Carbon Cycle Questions

- What is the word equation for photosynthesis?
- What effect does photosynthesis have on the amount of carbon dioxide in the air?
- How do the carbon compounds made in plants (glucose) pass into primary and secondary consumers?
- How does respiration return carbon dioxide back into the atmosphere? What is the word equation for respiration?
- How do decomposers increase the level of carbon dioxide in the air?
- Name one other way that carbon dioxide is added to the atmosphere.

CB9i/SB9l The Nitrogen Cycle

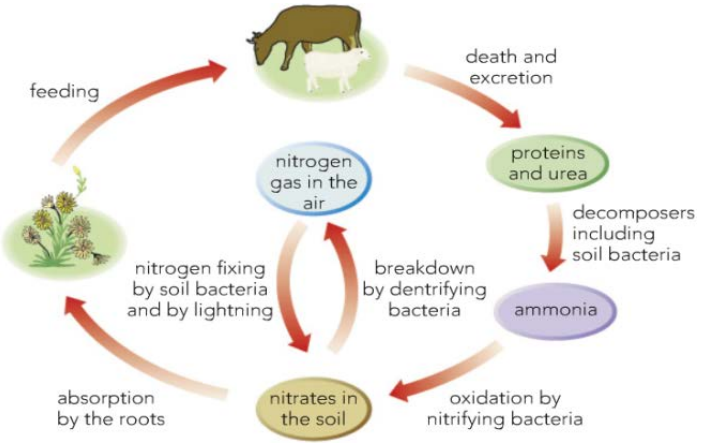
Nitrogen (in the form of nitrates) is useful to both plants and animals as it is used to make proteins, which are important for growth.

How plants obtain nitrogen (they can't get it directly from the air as it is too unreactive)

- Decomposers that feed on dead plants and animals break down some of the proteins and urea into ammonia
- Nitrifying bacteria in the soil convert ammonia into nitrate**s**
- There are also nitrogen fixing bacteria in the soil that can directly 'fix' nitrogen gas into nitrates
- Plants can then absorb the nitrates through their roots, and use them for growth (when plants are eaten by consumers, the nitrogen in the plants get passed on).

How nitrogen is returned to the atmosphere

When soils are lacking in oxygen, e.g when waterlogged the denitrifying bacteria will convert nitrates back into nitrogen gas.



CB9i/SB9l The Nitrogen Cycle Questions

- Why do plants need the nitrogen in nitrates?
- How do decomposers and nitrifying bacteria increase the amount of nitrogen available for plants?
- How are nitrogen fixing bacteria different from nitrifying bacteria?
- How do the nitrates in plants get passed to primary and secondary consumers?
- How is nitrogen returned to the atmosphere by denitrifying bacteria?