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:

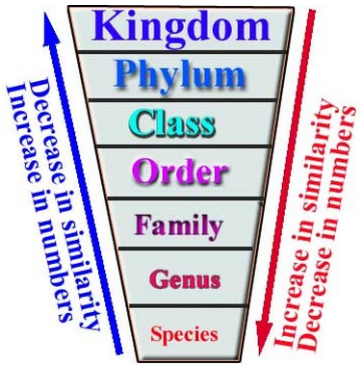
- Multicellular, cell walls not made of cellulose
- Saprophytic feeders – i.e fungi get their food from dead or decaying matter
- Complex cell structure with nucleus

Protoctista:

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

Prokaryotae:

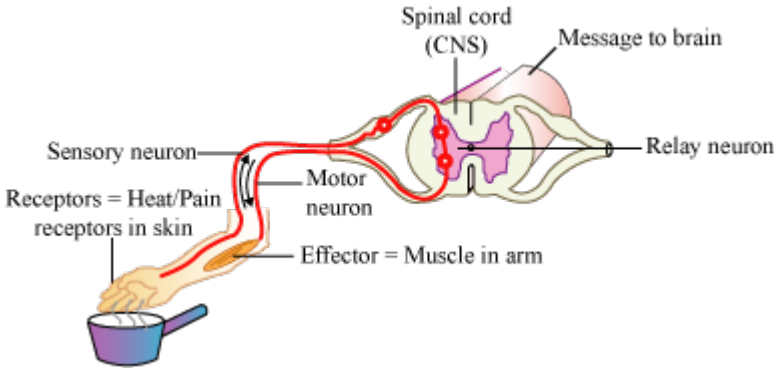
- unicellular, simple cell structure with no nucleus



- 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).

The Reflex Arc

- 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 <u>reflex arcs</u>:
  - 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 <u>don't</u> 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



Questions on Classification

- 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.

Questions on the Reflex Arc

- 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.

Naming species

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.

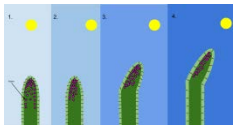
- E.g robins in America (turdus migratorius) and robins in the UK (erithacus rubecula) are different species

PLANT HORMONES –Auxins and Gibberellins

Tropisms

Responding to a stimulus by growing towards or away from it is called a tropism A tropism caused by light is called a <u>photo</u>tropism. A tropism caused by gravity is called a gravitropism.

A tropism <u>away</u> from a stimulus is a <u>negative</u> tropism and tropism <u>towards</u> a stimulus is a <u>positive</u> tropism.



Auxins and positive phototropism in shoots

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

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

Auxins and positive gravitropism in roots

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

Gibberellins stimulate growth of seeds

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

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

USES OF PLANT HORMONES

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

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

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

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

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

Questions on Naming Species

- 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?

Questions on Plant Hormones

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

VERTEBRATES AND INVERTEBRATES

Animals can be split into two groups. Vertebrates are animals that have a backbone – a supporting rod that runs the length of the body and belong to the phylum Chordata. Animals that don't have a backbone are called invertebrates. Both vertebrates and invertebrates (phyla – plural of phylum) are divided into smaller groups (classes), according to different characteristics .It is important to look at many characteristics when deciding which group to place an organism.

Grouping vertebrates into classes

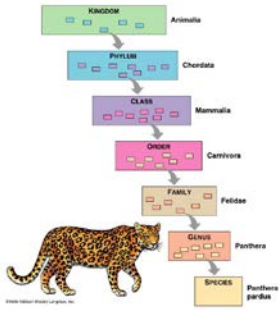
1. Vertebrates can be grouped into classes according to <u>how they absorb oxygen</u> for respiration:
   - Fish have gills to take in oxygen from the water
   - Amphibians : young amphibians have gills but adult amphibians usually have lungs and can absorb oxygen through their moist skin
   - Other groups of vertebrates (mammals, reptiles, birds) have lungs
2. Vertebrates can be grouped into classes according to <u>how they reproduce</u>:
   - Some vertebrates reproduce using external fertilisation – i.e the egg is fertilised outside the body of the female. where the adult female releases eggs into the water, where they're fertilised by the sperm released by an adult male (fish and amphibians)
   - Other vertebrates reproduce by placing sperm inside the female so that the egg is fertilised inside the body – internal fertilisation. Organisms which reproduce in this way and then lay eggs are known as oviparous (reptiles and birds). Organisms which reproduce in this way and then give birth to live young are known as viviparous (mammals).
3. Vertebrates can be grouped into classes according to the way in which they <u>regulate their body temperature</u> ('thermoregulation'):
   - Homeotherms ('warm blooded') e.g mammals, birds – have an internal mechanism that keeps their body temperature <u>constant</u>
   - Poikilotherms ('cold blooded') e.g reptiles, amphibians, fish – their body temperature <u>changes</u> according to the external temperature

Some vertebrates are difficult to classify as they don't fit perfectly into any class.

Even within a class, some species have different characteristics to the rest:

e.g. axolotls have gills even as an adult but are still classed as amphibians (even though they respire more like fish

e.g. sharks use internal fertilisation and give birth to live young but are still classed as fish (even though they reproduce more like mammals)

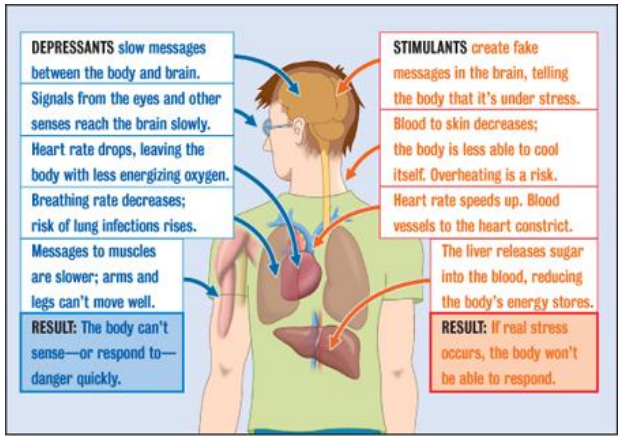


DRUGS

- A drug is a chemical substance that changes the way in which the body works.
- Some drugs particularly affect the central nervous system and change our behaviour – i.e the way we feel, think and act

Different types of drugs

- Drugs are grouped according to the effects they have on us.
- Narcotics: Slow down neurotransmission across synapses and make us feel sleepy so reactions are slower
- Painkillers e.g morphine: We feel pain when electrical impulses from a damaged area of the body are sent via neurones to the brain. Painkillers block some of these nerve impulses so we feel less pain
- Hallucinogens e.g LSD: Make us see, hear and feel things that aren't actually there
- Stimulants e.g caffeine: Increase the speed of neurotransmission across synapses and make us feel energetic and awake so reactions are faster
- Depressants e,g alcohol: Decrease the activity of neurones in the brain so can help us relax causing reactions to be slower.
- Any drug that's used to make people feel a certain way is a recreational drug – e.g alcohol, LSD (i.e one that's not taken because of illness)
- Some drugs are medicines that help to limit damage caused by diseases or injuries



Questions on Vertebrates and Invertebrates

- What is the name of the phylum that animals with backbones belong to?
- Describe how you would sort vertebrates into classes using facts about how they respire?
- Which animals fertilise externally?
- What do the words oviparous and viviparous mean?
- How could you group vertebrates in terms of the way they regulate body temperature?
- Why is a shark difficult to classify?

Questions on Drugs

- Define ‘drug’.
- How are drugs classified?
- What do narcotics and depressants have in common?
- How do painkillers work?
- Which drug will make our reactions faster?
- Explain the difference between a recreational drug and a medicinal drug?

SPECIES

A species is defined as a group of organisms that can interbreed (i.e reproduce with one another) to produce offspring that are fertile (i.e able to produce offspring of their own)

Difficulties when trying to classify a species

1. Variation exists (even within organisms of the same species)
2. Asexual reproduction:
   - Some organisms don't need to interbreed to produce offspring
   - If we don't see interbreeding we can't test whether or not two individuals are the same species
3. Ring species:
   - Sometimes there's a chain of different populations that can breed with their neighbouring populations but the two populations at the end of the chain can't interbreed
   - The chain often forms a ring shape and these organisms are called ring species - difficult to divide into separate species

e.g.Hybridisation in ducks:

- Mallard ducks can interbreed with closely related species to produce fertile hybrids
- Fertile hybrids can in turn breed with other closely related ducks to form other fertile hybrids
- This interbreeding results in the creation of ring species and is difficult to classify.

THE DAMAGE CAUSED BY SMOKING

Damage caused by tar

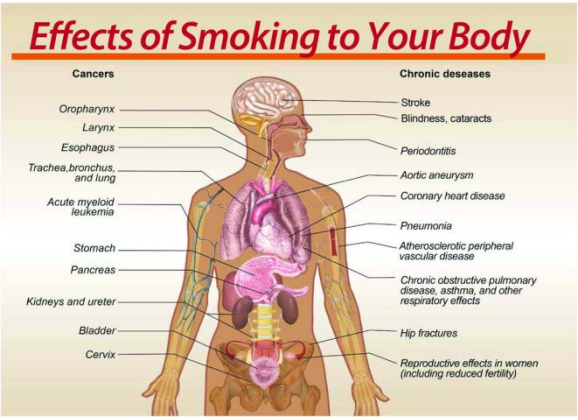
The sticky tar in cigarette smoke contains chemical substances called carcinogens which can cause cancers, most often in the lungs and mouth.

Damage caused by carbon monoxide

Oxygen binds to haemoglobin inside red blood cells, and is then transported round the body. Carbon monoxide combines with haemoglobin, reducing the amount of oxygen red blood cells can carry so body cells receive less oxygen.

Carbon monoxide also makes blood vessels narrower (vasoconstriction), which further reduces the oxygen carrying capacity of the blood. Carbon monoxide and other gases in tobacco smoke can also damage lung tissue – this causes respiratory diseases such as emphysema and chronic bronchitis.

Nicotine is the <u>addictive</u> part of tobacco smoke and acts on receptor sites in the brain making you crave more of the drug.



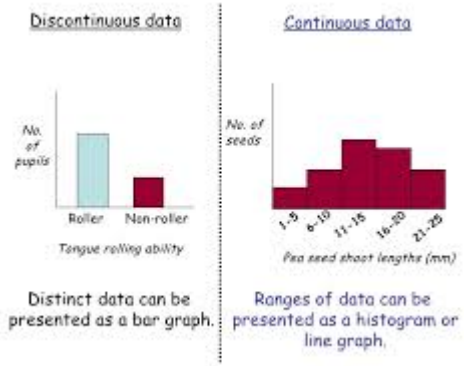
Questions on Species

- What is the definition of a species?
- Give two reasons why classifying a species is difficult.
- Why does the species definition not work for asexual species?
- What is meant by a ring species?
- Why do mallard ducks not fall neatly into the definition for a species?

Questions on Damage caused by Smoking

- Which part of cigarette smoke contains the most chemicals?
- What does carcinogenic mean?
- What is the effect of the carbon monoxide in cigarette smoke?
- Name two respiratory diseases caused by cigarette smoke.
- How does nicotine make smoking addictive?

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

THE EFFECTS OF ALCOHOL

Short-term effects of alcohol

1. Alcohol is a depressant so slows down activity of the brain leading to slower reaction times, blurred vision and loss of coordination, making it more difficult to do simple physical or mental tasks (e.g driving).

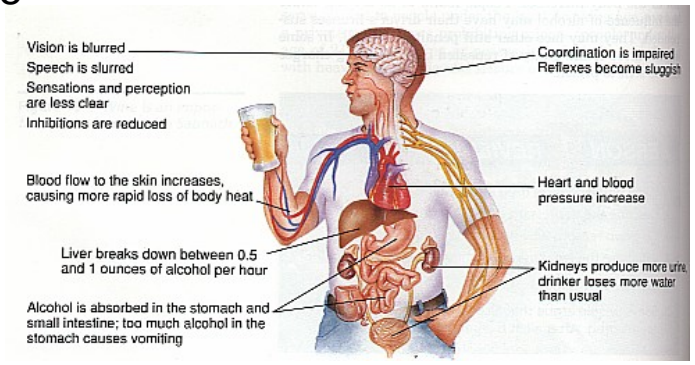
2. Alcohol can also lower inhibitions i.e people will do things after drinking alcohol that they wouldn't normally do, including taking greater risks. Very large amounts of alcohol can cause unconsciousness and possible death by choking on vomit or slow the nervous system down so much that breathing stops.

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



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?

Questions on the Effects of Alcohol

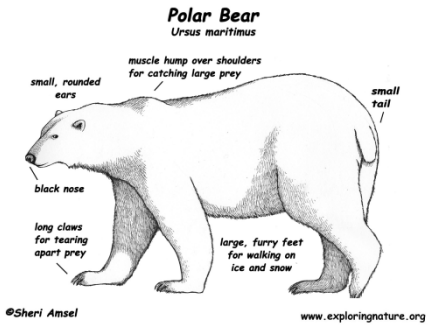
- Does alcohol speed up or slow down your reaction times?
- Why is it dangerous to lower your inhibitions?
- Which organ is most likely to be damaged by drinking too much alcohol? What is this called?
- Describe how the brain is affected by drinking too much alcohol.

ADAPTATION

All organisms are adapted to their surroundings so that they have variations in their characteristics that allows them to survive in their habitats (places where they live)

e.g organisms from polar regions (e.g polar bears) are adapted to the cold:

- Small ears stop heat loss
- Thick fur for insulation…white fur for camouflage in snow
- Thick layer of fat for insulation from cold
- Large spread out feet to lower pressure and stop it from sinking into the snow



e.g. Organisms living near deep-sea hydrothermal vents (deep-sea Pompeii worms) have the opposite problem. Hot fluids come out of these vents and cool quickly so deep-sea Pompeii worms must cope with big temperature changes, complete darkness and huge pressures:

- Body is adapted to cope with very high pressures
- No eyes (doesn't need them because its habitat deep under the sea is in complete darkness – it does have sensitive tentacles, though)
- Body is covered in a thick layer of bacteria that helps protect it from the heat
- Spends lots of time inside a paper-like tube to hide from predators

ETHICS AND TRANSPLANTS

In a transplant, a healthy organ such as a heart or liver is taken from one body (a donor) and put into a patient to replace an organ that no longer works properly.

There are not enough donor organs so doctors must decide which patients to operate on. How do they decide?

Scientific criteria - decisions based on the likelihood of success

- How similar are the tissues? The closer the match, the more likely the transplant will be successful.
- Are they of a similar age? The closer the age of the donor organ is to that of the patient, the more likely the operation will be a success
- How geographically close is the donor organ to the patient? The quicker the organ is transplanted, the more likely the operation will be successful
- How ill is the patient? A very ill patient is less likely to survive an operation than a healthy one.

Ethical criteria – decisions based on what is right and wrong

Examples:

- Should alcoholics be given liver transplants?
- Should obese people be given heart transplants?

Ethical decisions are hard because different people have different views on what is right and what is wrong.

- e.g some people believe certain lifestyles that cause diseases (e.g. alcohol addiction) are not the person's fault (i.e they are inherited traits or the result of unfortunate life events) so they should receive treatment like everyone else
- Other people instead think lifestyle is a choice (i.e you can choose whether or not to drink) so you shouldn't be allowed the same chance for treatment, especially as there is a shortage of donor organs.

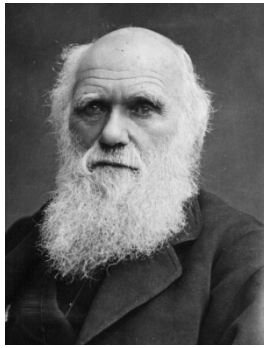
Questions on Adaptation

- Define adaptation.
- Describe 3 adaptations of a polar bear to enable it to live in the cold.
- Describe 3 adaptations of a Pompeii worm that allows it to live near hot sea vents.
- How has a giraffe adapted to its environment?

Questions on Ethics and Transplants

- Describe what happens in a transplant.
- Give 4 scientific criteria that a Doctor may use to make a decision about whether a transplant should occur?
- Why are ethical decisions harder to make?
- Should people who drink alcohol receive a transplant? What are the main arguments for and against?

EVOLUTION



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

PATHOGENS AND INFECTION

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

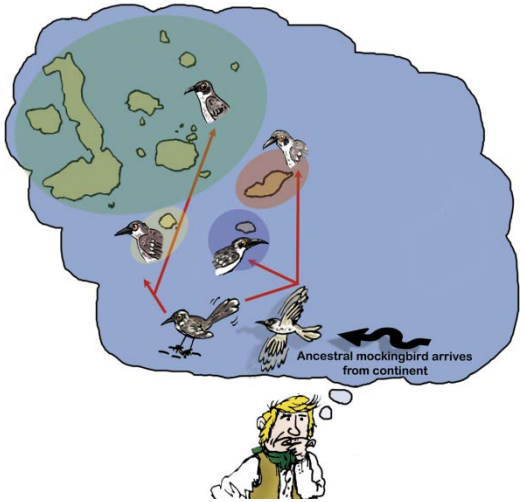
Questions on Evolution

- 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.

Questions on Pathogens and Infection

- 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.

Speciation

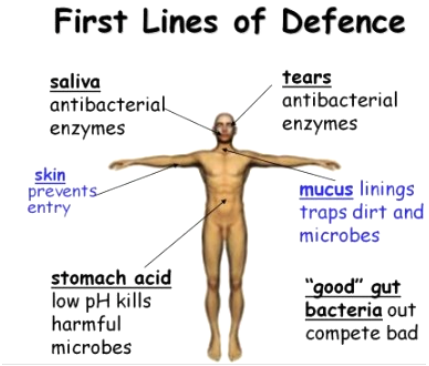


Speciation is the formation of a new species as a result of geographical isolation

Example of speciation:

- Darwin noted that although mockingbirds on different Galapagos islands were very closely related, each island had its own species of bird
- Darwin guessed that originally individuals from one species of mockingbird had reached the Galapagos islands
- The environmental conditions on each island were different: On each island, those with successful adaptations survived, bred, and passed on their genes to their offspring. The population of mockingbirds evolved in a different way (to adapt to the specific conditions on each island).
- Over time, the mockingbirds on each island became so different that they could no longer interbreed with birds from other islands to produce fertile offspring
- New mockingbird species were formed – this process is called speciation

Antiseptics, Antibiotics and Resistance



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.

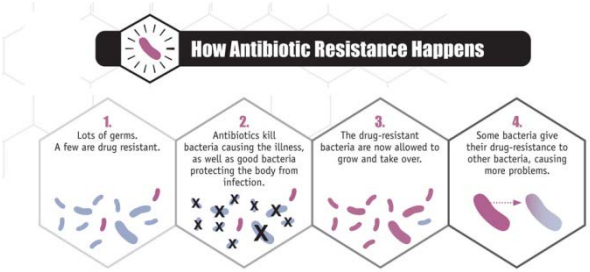
Antibiotics don't kill viruses so can't be used to treat diseases caused by viruses such as HIV (AIDS), influenza and mumps

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



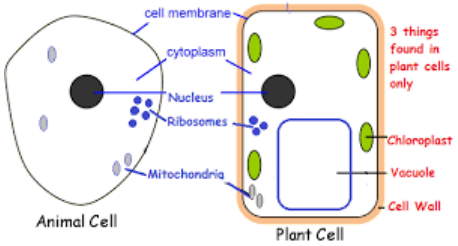
Questions on Speciation

- Define speciation.
- What did Darwin notice about the mocking birds on the Galapagos islands?
- What did Darwin say happened at the beginning?
- Why did the birds evolve differently on each island?
- Why did Darwin conclude that the birds were now different species of mocking bird?

Questions on Antibiotics and Resistance

- 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?

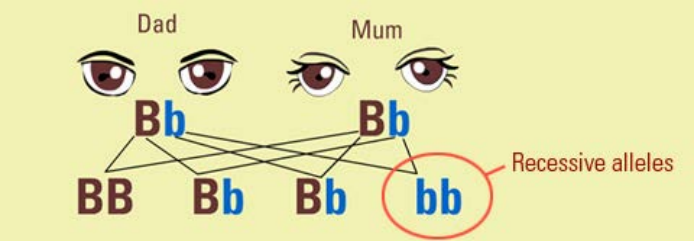
GENES



- 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).



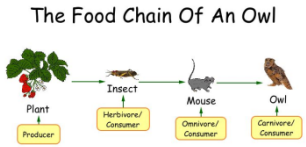
FOOD WEBS

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

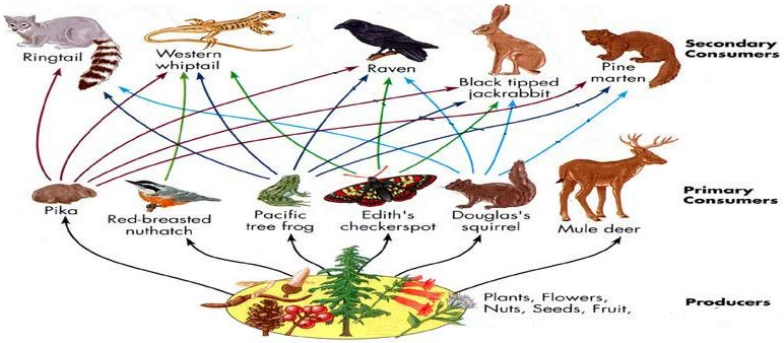


Food chains show what eats what and arrows show the direction of energy flow.

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.



Questions on Genes

- 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?

Questions on Food Webs

- What is a producer and where does it get its energy from?
- What are omnivores, carnivores and herbivores?
- What are primary and secondary consumers?
- In a food chain or web what does the direction of the arrow show?
- What are trophic levels?
- How is a food web different from a food chain?

EXPLAINING INHERITANCE

- 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)

	T	t
T	TT	Tt
t	Tt	tt

Interdependence and Food Webs

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.

Energy Transfers in Food Chains

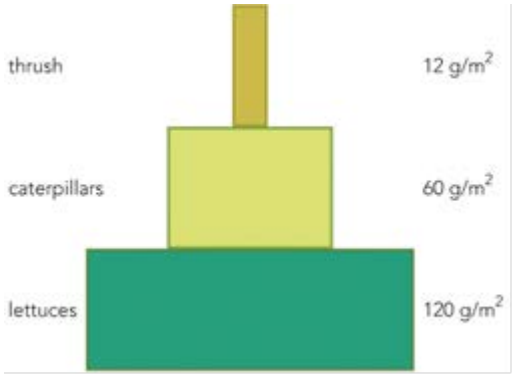
Energy is stored inside each living organism as 'biomass' (the total mass of an organism)

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

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

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

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



Questions on Inheritance

- 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?

Questions on Interdependence and Food Webs

- What does ‘interdependent’ mean?
- Describe what happens when there are lots of predators.
- Describe what happens when there are lots of prey?
- Define biomass.
- Why is a pyramid of biomass a pyramid?
- Give four reasons why energy is lost at each level.

Punnett squares

- 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

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 harmful to their hosts.

- The organism doing the feeding is called the parasite
- The organism which the parasite feeds on is called the host

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

Questions on Punnett Squares

- 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?

Questions on Parasites and Mutualists

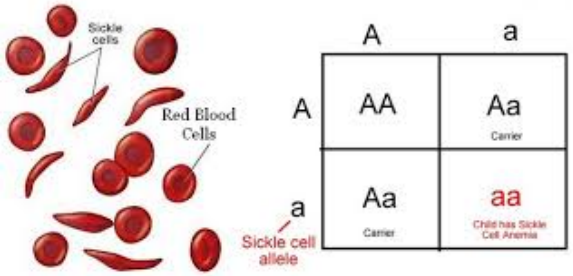
- Describe a parasitic feeding relationship.
- Give an example of a parasitic relationship.
- How is mutualism different from a parasitic relationship?
- Give an example of a mutualistic feeding relationship and explain why it is mutual.
- Give two examples of a mutualistic relationship which occurs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

GENETIC DISORDERS

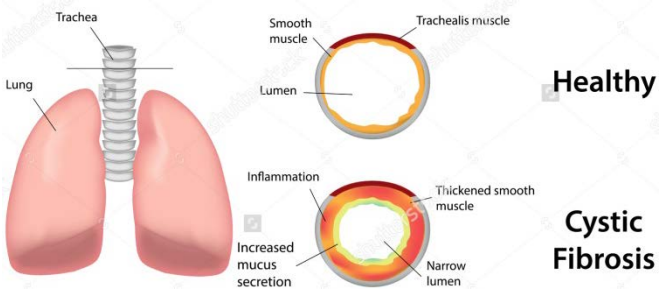
Genetic disorders such as sickle cell anaemia are caused by faulty alleles

- Sickle cell anaemia is a genetic disease that causes red blood cells to clump together. The allele that causes sickle cell anaemia is recessive and both copies are needed for people to suffer from the disorder.

  Symptoms: Sufferers become easily tired and short of breath and have painful joints (because their red blood cells stick together and block blood vessels – can sometimes be fatal)



- Another genetic disorder caused by a recessive (faulty) allele is cystic fibrosis. Lungs get clogged with thick mucus, making breathing difficult and leading to infections. Mucus also blocks some of the tubes that carry enzymes to the small intestine to digest food.
- Lack of enzymes able to digest food can result in weight loss



POLLUTION

The World's human population is growing rapidly which has contributed to an increase in the production of both air and water pollutants.

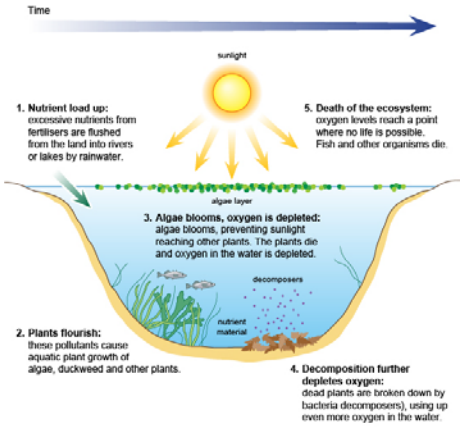
Air pollution

1. Sulfur dioxide gas released from the burning of fossil fuels causes acid rain
2. Carbon dioxide gas also released by the burning of fossil fuels (and deforestation) causes climate change (global warming)

Water pollution

Increased use of fertiliser:

- Fertilisers contain nitrates and phosphates – both nutrients needed by plants to grow well
- farmers add fertiliser to crops to help them grow better
- However, if too much fertiliser is used, it can get into water and raise the natural concentration of nitrates and phosphates – this is called eutrophication.



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

Questions on Genetics Disorders

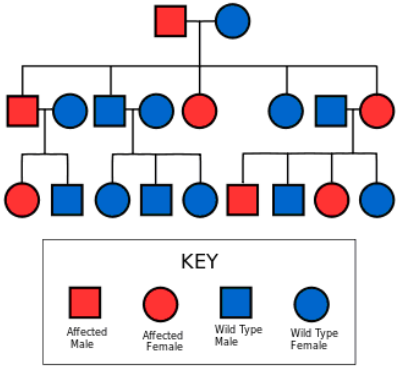
- What causes genetic disorders?
- What happens to the blood cells in sickle cell anaemia?
- The allele for sickle cell anaemia is recessive. What does this mean?
- What are the symptoms of cystic fibrosis?
- What is a long term effect of having the above condition?

Questions on Pollution

- Name two gases that lead to air pollution.
- Which of these gases cause acid rain and which causes global warming?
- How have more nitrates and phosphates got into our water system?
- Why does an ‘algal bloom’ occur?
- What does an algal bloom stop from getting through to the other plants?
- Bacterial decomposers breakdown the dead plants. What do they take out of the water as they do this?
- What is this whole process called?

Family Pedigree Charts

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.



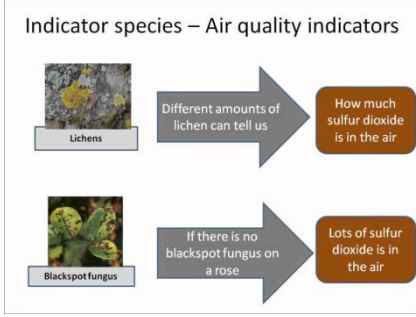
Carriers

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.

POLLUTION INDICATORS



Some organisms are very sensitive to polluting chemicals and they can be used to help show us the presence of pollution – these are called indicator species.

Air pollution indicators

e.g. Blackspot fungus that infects roses is killed by sulfur dioxide pollution in the air and presence of blackspot on roses shows the air is clean.

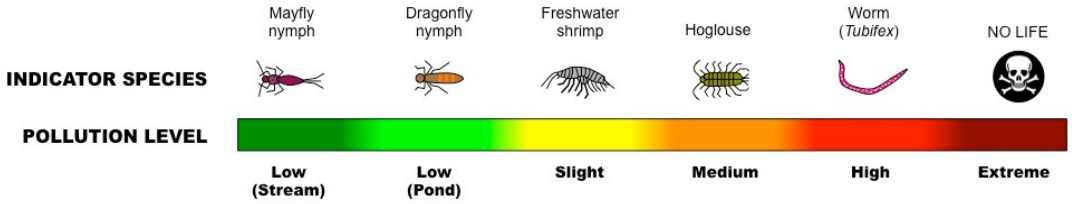
e.g. lichens

- Different species of lichen can tolerate different amounts of sulfur dioxide and other polluting gases such as nitrogen oxides so lichens can be used to indicate the presence of these gases in the air

Water pollution indicators

Different animals that live in water need varying amounts of oxygen.

- Stonefly larvae and freshwater shrimps need lots of oxygen so they are <u>clean</u> water indicators (i.e if there's lots of them it indicates that the water is clean there)
- Bloodworms and sludgeworms are adapted to live where there's little oxygen in the water and are <u>polluted</u> water indicators (i.e if there's lots of them it suggests the water is very polluted there)



Questions on Pedigree Charts

- 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?

Questions on Pollution Indicators

- What is an indicator species?
- If you saw Blackspot fungus on roses what would that tell you?
- Which plant can tolerate different amounts of sulphur dioxide?
- If you found lots of freshwater shrimps in the water what would this indicate? Why?
- If you found lots of sludgeworms in the water what would this indicate? Why?

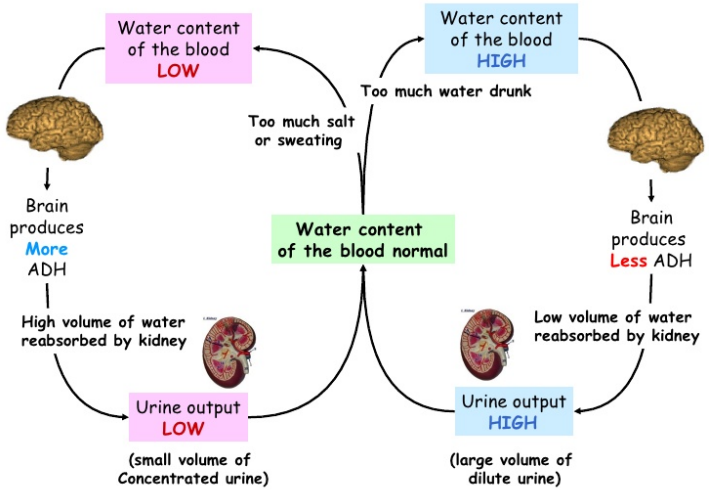
HOMEOSTASIS

The conditions inside the body (the ‘internal environment) must remain stable which is called homeostasis.

The control of water in the body is called ***osmoregulation***

The body loses water in urine, breath and sweat. Kidneys can control the amount of water that is lost through urine. If the body has too much water, kidneys respond by producing more urine so more water is lost.

If the body doesn’t have enough water, kidneys produce less urine and less water is lost (the brain also responds by giving us a feeling of thirst).



The Importance of Recycling

Tonnes of waste is produced every year, much of it ending up buried in the ground in landfill sites

Problems with landfill sites:

- Use up a lot of land
- Risk of pollution
- Materials can't be used again (this is a problem because we are running out of some raw materials completely e.g zinc)

- *Recycling* is the process of taking materials out of waste before disposal and converting them into new products we can use.
- Recycling can reduce demand for resources and also reduce the problem of waste disposal.
- Materials that can be recycled:
  - Metals in drinks cans can be melted down and recycled as new drinks cans or part of a car
  - Paper can be recycled as more paper or cardboard
  - Plastic bottles can be recycled as fleece clothing

Questions on Homeostasis

- Define homeostasis
- What is osmoregulation?
- Name three ways that the body loses water.
- What organ of the body controls the amount of water loss?
- What does the brain do when the body loses too much water?

Questions on Recycling

- Give three problems associated with landfill sites.
- Define recycling.
- Describe two advantages of recycling.
- Give two examples of materials that can be recycled.
- Which material can be recycled to form fleece clothing?

Controlling Body Temperature

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

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

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

1. **Shivering**: The hypothalamus causes muscles to shiver - shivering releases heat which warms you up
2. **Hairs stand on end**: The hypothalamus causes erector muscles in the dermis to contract and the body hairs stand upright. This traps more air next to the skin, providing insulation
3. **Vasoconstriction**: Hypothalamus causes blood vessels to narrow ('vasoconstriction') so blood flow to the surface of the skin is reduced and therefore less heat is lost.

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

1. **Sweating**: The hypothalamus causes sweating. As sweat evaporates it transfers heat energy from the skin to the surroundings and the skin cools down
2. **Hairs lie flat**: The hypothalamus causes erector muscles in the dermis to relax sot hey lie flat and no heat is trapped between hairs which cools us down
3. **Vasodilation**: Hypothalamus causes blood vessels to widen ('vasodilation') and blood flow to the surface of the skin is increased so more heat is lost.

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

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

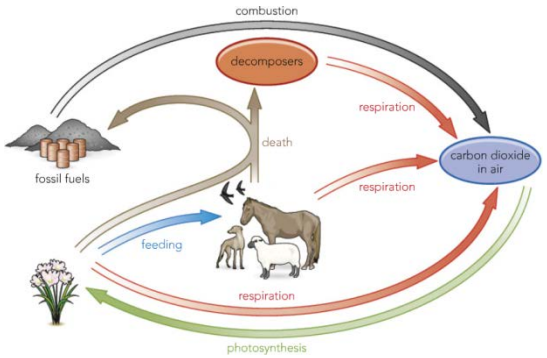
THE CARBON CYCLE

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.

Questions on Controlling Body Temperature

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

Questions on the Carbon Cycle

- 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.

HORMONES

Hormones are produced and then released by endocrine glands into the bloodstream, where they are then transported around the body. Once in the blood, hormones act as 'chemical messengers', causing certain parts of the body to respond to their presence. An organ that responds to a certain hormone is called a 'target organ'.

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

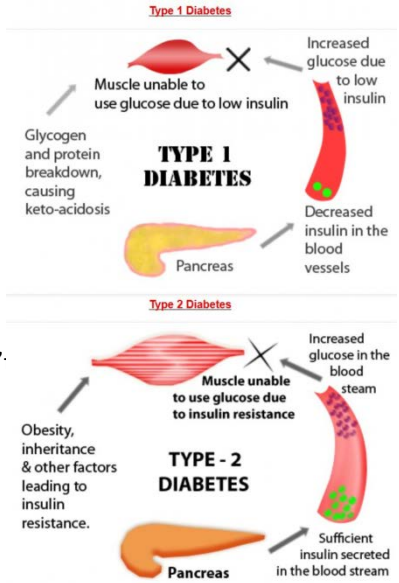
People who have a disease called diabetes can't control their blood glucose levels very well . There are two types of diabetes.

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



Type 2 diabetes: In this type of diabetes, the pancreas releases insulin as normal however, the cells in a person's body don' 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

THE NITROGEN CYCLE

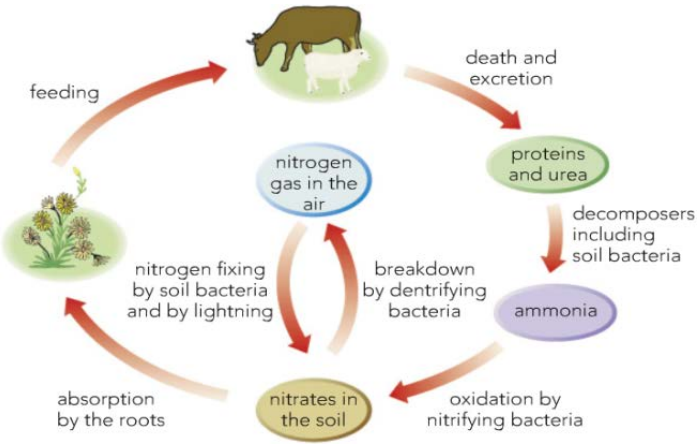
Nitrogen (in the form of nitrates) is useful to both plants and animals as it is used to make proteins, which are important for growth.

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.



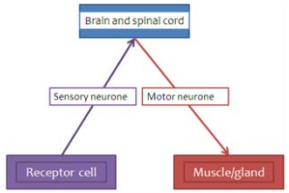
Questions on Hormones

- Which gland secretes hormones?
- How are hormones transported around the body?
- What symptoms occur if blood sugar is too high/too low?
- What does the pancreas release and what does this do to glucose?
- 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.

Questions on the Nitrogen Cycle

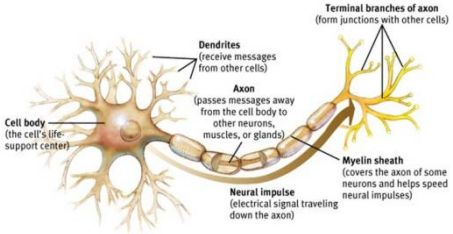
- Why do plants need the nitrogen in nitrates?
- How do decomposers and nitrifying bacteria increase the amount of nitrogen available for plants?
- How are nitrogen fixing bacteria different from nitrifying bacteria?
- How do the nitrates in plants get passed to primary and secondary consumers?
- How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

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

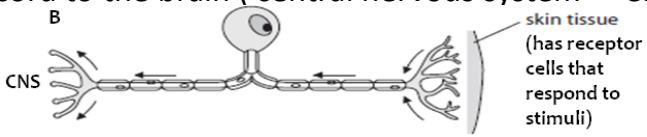


Neurotransmission – how impulses travel along neurones

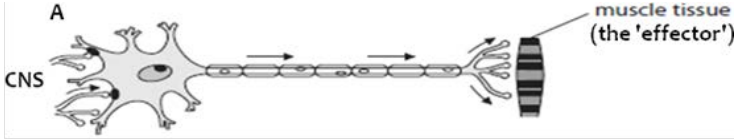
- Dendrites receive impulses from receptor cells or other neurones
- Impulses move along the dendron, past the cell body and to the axon
- When impulses reach axon endings ('terminals'), chemicals called neurotransmitters are released across the gap ('synapse')
- This causes the electrical impulse to 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



Questions on 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?