BIOLOGY

PAPER 2 TOPICS

REVISION ORGANISER

Chapter 10: The human nervous system

Knowledge organiser

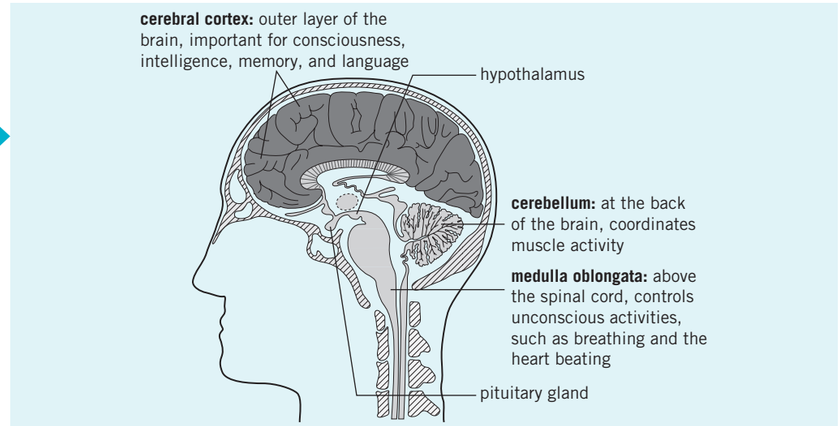
Nervous system responses

Stimulus	Receptor	Coordinator	Effector	Response
a change in the environment (**stimulus**) is detected by **receptors**	information from receptors passes along cells (**neurones**) to the CNS as electrical impulses	the CNS coordinates the body's response to the stimulus	effectors bring about a response, such as glands secreting hormones or muscles contracting	the body responds to the stimulus

The brain

The brain controls complex behaviour.

It is made of billions of interconnected neurones, with different regions that carry out different functions.



Accommodation

Accommodation is the process of changing the shape of the lens to focus on near or distant objects.

To focus on a *near* object

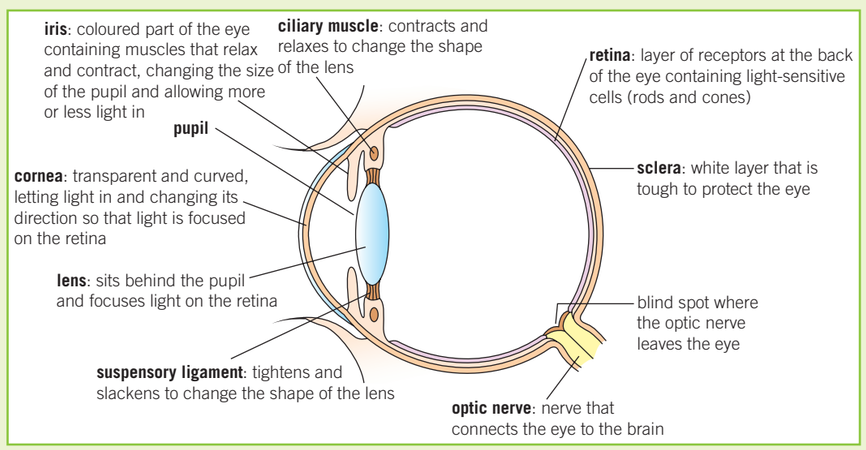
- ciliary muscles *contract*
- suspensory ligaments are slack
- so lens is thicker and more curved, and refracts light rays more strongly.

To focus on a *distant* object

- ciliary muscles relax
- suspensory ligaments are pulled tight
- so lens is thinner and flatter, and only refracts light rays slightly.

Structure of the eye

The eye is a **sense organ** containing **receptors** sensitive to light intensity and colour.

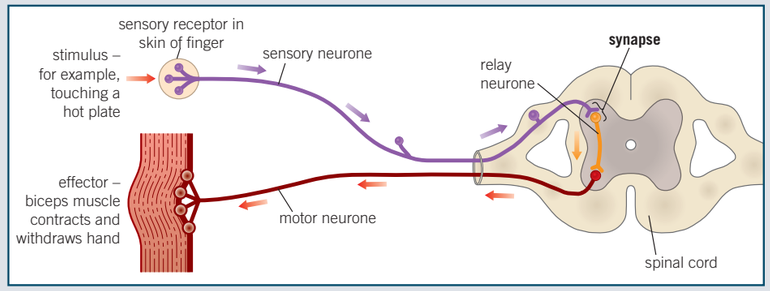


Reflex arcs

The nervous system is made up of the **central nervous system** (CNS) and a network of nerves. The CNS comprises the brain and spinal cord.

Reflex actions of the nervous system are automatic and rapid – they do not involve the conscious part of the brain.

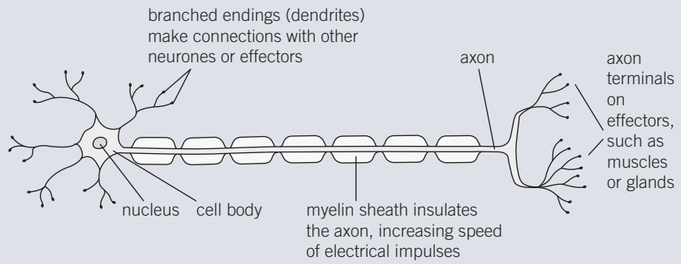
Reflex actions are important for survival because they help prevent damage to the body.



Reflex arc structures

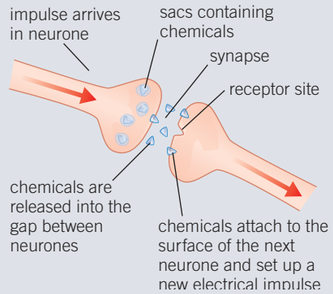
Neurones

Neurones carry electrical impulses around the body – relay neurones connect sensory neurones to motor neurones



Synapses

Synapses are gaps between neurones, which allow electrical impulses in the nervous system to cross between neurones



Research on the brain (HT only)

Neuroscientists have mapped the regions of the brain to particular functions by studying patients with brain damage, using MRI scanning techniques, and electrically stimulating parts of the brain.

The brain is very complex and delicate, making investigating and treating brain disorders difficult.

Brain damage and diseases can involve many different neurones, chemicals, and areas of the brain. Treatment is difficult because

- it is not fully understood what each area of the brain does
- drugs do not always reach the brain through its membranes
- surgery can easily cause unintended damage.

Common defects of the eyes

Myopia

Short-sightedness, when distant objects look blurred because rays of light focus in front of the retina.

This is corrected using **concave** spectacle lenses.

Hyperopia

Long-sightedness, when near objects look blurred because rays of light focus behind the retina.

This is corrected using **convex** spectacle lenses.

Treatment of eye defects

- spectacle lenses to refract light rays to focus on the retina
- hard and soft contact lenses – like traditional glasses, but on the surface of the eye
- laser eye surgery – to change the shape of the cornea
- replacement lenses – adding another lens inside the eye to correct defects permanently.

Key terms

Make sure you can write a definition for these key terms.

brain, central nervous system, concave, convex, effectors, hyperopia, involuntary, myopia, neurones, receptors, reflex action, spinal cord, stimulus, synapse

Chapter 11: Hormonal coordination 1

Knowledge organiser

Human endocrine system

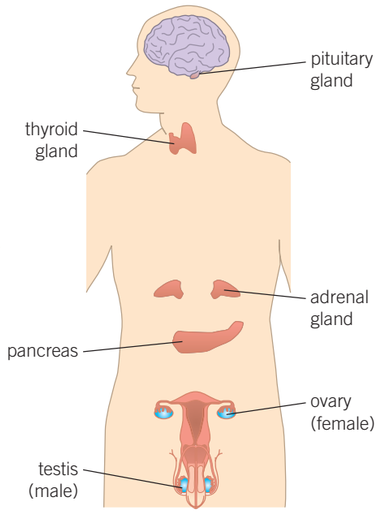
The **endocrine system** is composed of glands that secrete chemicals called **hormones** into the bloodstream.

The blood carries hormones to a target organ, where an effect is produced.

Compared to the nervous system, the effects caused by the endocrine system are slower but act for longer.

The **pituitary gland**, located in the brain, is known as a 'master gland', because it secretes several hormones into the blood.

These hormones then act on other glands to stimulate the release of other hormones, and bring about effects.



Endocrine gland	Role of the hormones
Pituitary	• controls growth in children • stimulates the thyroid gland to make thyroxine to control the rate of metabolism • in females – stimulates the ovaries to produce and release eggs, and make oestrogen • in males – stimulates the testes to make sperm and testosterone
Thyroid	• controls the rate of metabolism in the body
Pancreas	• controls blood glucose levels
Adrenal	• prepares the body for stress • involved in the 'fight or flight' response
Ovaries	• controls the development of female secondary sexual characteristics • controls the menstrual cycle
Testes	• controls the development of male secondary sexual characteristics • involved in the production of sperm

Negative feedback (HT only)

Negative feedback systems work to maintain a steady state. For example, blood glucose, water, and **thyroxine** levels are all controlled in the body by negative feedback.

Adrenaline

- produced by **adrenal glands** in times of fear or stress
- increases heart rate
- boosts delivery of oxygen and glucose to brain and muscles
- prepares the body for 'fight or flight' response
- does not involve negative feedback, as adrenal glands stop producing **adrenaline**

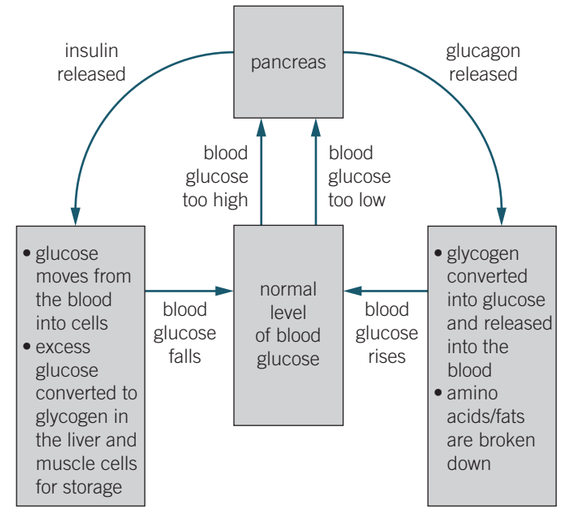
Thyroxine

- produced by the **thyroid gland**
- regulates how quickly your body uses energy and makes proteins (**metabolic rate**)
- important for growth and development
- levels controlled by negative feedback

Control of blood glucose levels

Blood glucose (sugar) concentration is monitored and controlled by the **pancreas**.

This is an example of negative feedback control, as the pancreas switches production between the hormones **insulin** and **glucagon** to control blood glucose levels.



Diabetes

Diabetes is a non-communicable disease where the body either cannot produce or cannot respond to insulin, leading to uncontrolled blood glucose concentrations.

Type 1 diabetes	Type 2 diabetes
early onset	usually later onset, obesity is a risk factor
pancreas stops producing sufficient insulin	body doesn't respond to the insulin produced
commonly treated through insulin injections, also diet control and exercise	commonly treated through a carbohydrate-controlled diet and exercise

Key terms

Make sure you can write a definition for these key terms.

adrenal gland | adrenaline | diabetes | endocrine system | glucagon | hormone | insulin | metabolic rate | negative feedback | pancreas | pituitary gland | thyroid gland | thyroxine

Chapter 11: Hormonal coordination 2

Knowledge organiser

Hormones in human reproduction

During puberty, reproductive hormones cause the secondary sex characteristics to develop:

Oestrogen

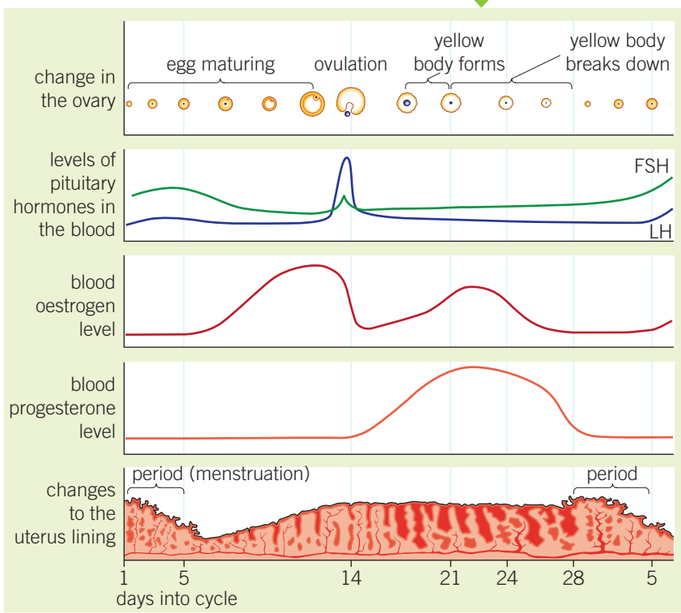
- main female reproductive hormone
- produced in the **ovary**
- at puberty, eggs begin to mature and one is released every ~28 days

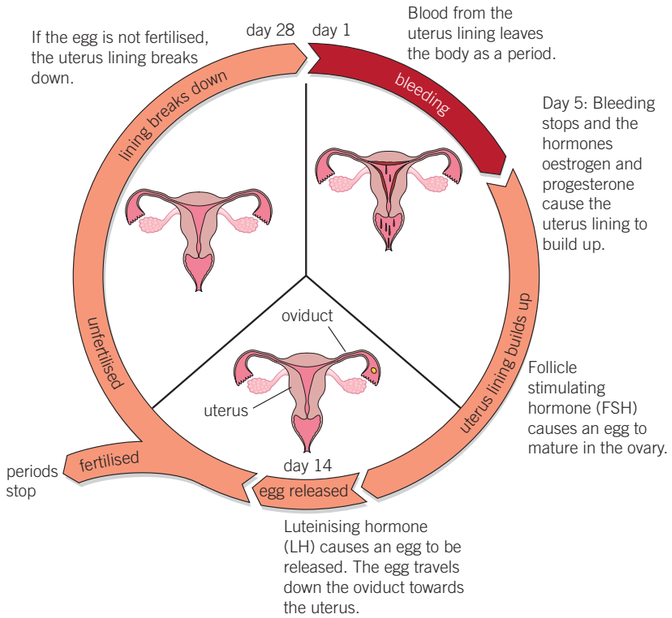
Testosterone

- main male reproductive hormone
- produced by the **testes**
- stimulates sperm production

The menstrual cycle

Hormone	Released by	Function
follicle stimulating hormone (FSH)	pituitary gland	• causes eggs to mature in the ovaries • stimulates ovaries to produce oestrogen
luteinising hormone (LH)	pituitary gland	• stimulates the release of mature eggs from the ovaries (**ovulation**)
oestrogen	ovaries	• causes lining of uterus wall to thicken • inhibits release of FSH • stimulates release of LH
progesterone	ovaries	• maintains thick uterus lining • inhibits release of FSH and LH





Treating infertility with hormones (HT only)

Hormones are used in modern reproductive technologies to treat **infertility**.

FSH and LH can be given as a drug to treat infertility, or **in vitro fertilisation** (IVF) treatment may be used.

IVF treatment

1. mother given FSH and LH to stimulate the maturation of several eggs
2. eggs collected from the mother and fertilised by sperm from the father in a laboratory
3. fertilised eggs develop into embryos
4. one or two embryos are inserted into the mother's **uterus** (womb) when the embryos are still tiny balls of cells

Fertility treatment has some disadvantages:

- it is emotionally and physically stressful
- it has a low success rate
- it can lead to multiple births, which are a risk to both the babies and the mother.

Contraception

Fertility can be controlled by a variety of hormonal and non-hormonal methods of **contraception**.

Hormonal contraception

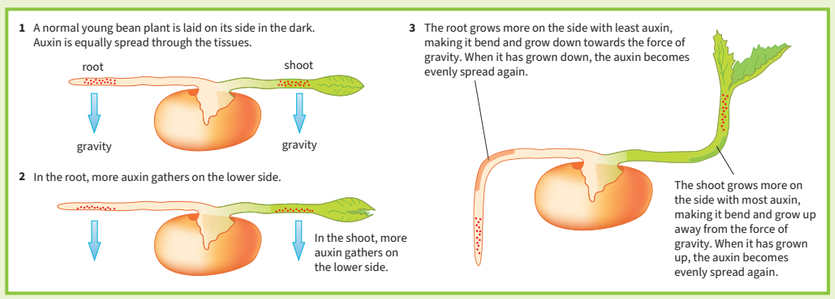
- oral contraceptives – contain hormones to inhibit FSH production so no eggs mature
- injection, implant, skin patch, or intrauterine devices (IUD) – slowly release progesterone to inhibit maturation and release of eggs; can last months or years

Non-hormonal contraception

- barrier methods, for example, condoms and diaphragms – prevent sperm reaching the egg
- copper IUD – prevents the implantation of an embryo
- surgical methods of male and female sterilisation
- spermicidal agents – kill or disable sperm
- abstaining from intercourse when an egg may be in the oviduct

Plant hormones

A plant's response can be known as **phototropism**, when the shoots bend towards light, and **gravitropism** when the root moves towards gravity. The responses are controlled by the hormone **auxin**. In phototropism, auxin moves from the side of the shoot with light to the unlit side, meaning the cells on that side will grow more. In gravitropism, high levels of auxin means that the growth of root cells in inhibited. (HT only) **Gibberellins** are also plant hormones which begin the process of seed germination by breaking down the food stores in the seeds and stimulate the growth of stems. Ethene is another hormone which controls cell division.



Key terms

Make sure you can write a definition for these key terms.

auxin · contraception · follicle stimulating hormone · gravitropism · infertility · in vitro fertilisation · oestrogen · ovary · luteinising hormone · menstrual cycle · ovulation · phototropism · progesterone · testes · uterus

Chapter 12: Homeostasis in action

Knowledge organiser

Homeostasis

Homeostasis is the regulation of internal conditions (of a cell or whole organism) in response to internal and external changes, to constantly maintain optimum conditions for functioning.

This maintains optimum conditions for all cell functions and enzyme action.

In the human body, this includes control of

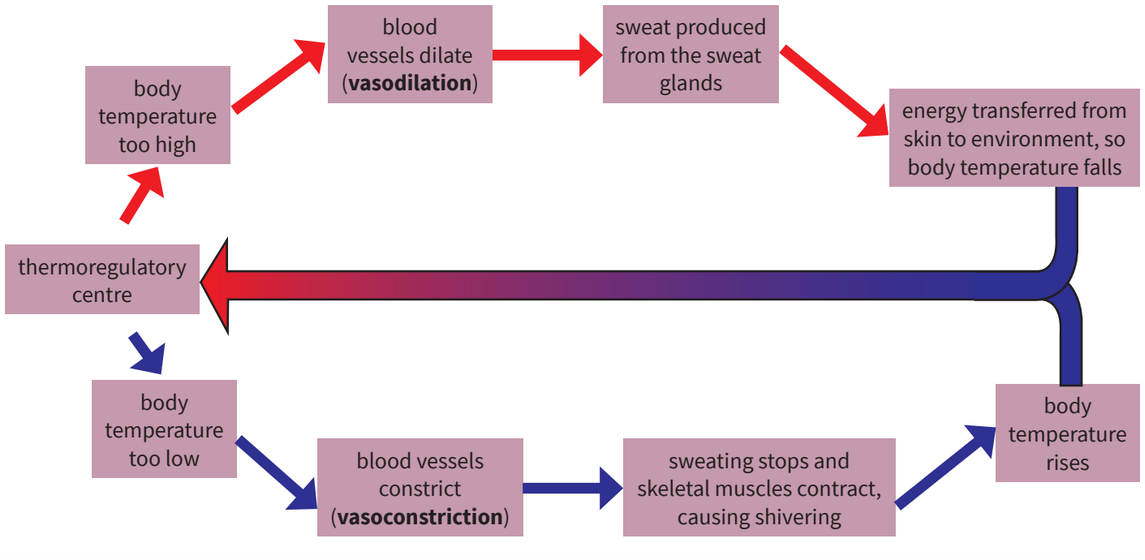
- blood glucose concentration
- body temperature
- water levels.

The automatic control systems of homeostasis may involve nervous responses or chemical responses.

All control systems involve

- receptor cells, which detect **stimuli** (changes in the environment)
- **coordination centres** (such as the brain, spinal cord, and pancreas), which receive and process information from receptors
- **effectors** (muscles or glands), which produce responses to restore optimum conditions.

Control of body temperature



Body temperature is monitored and controlled by the **thermoregulatory centre** in the brain. The centre contains receptors sensitive to the blood temperature.

The skin also contains temperature receptors and sends nervous impulses to the thermoregulatory centre.

Maintaining water and nitrogen balance

Water leaves the body through the lungs during exhalation, and water, ions, and **urea** are lost from the skin in sweat. The body has no control over these losses.

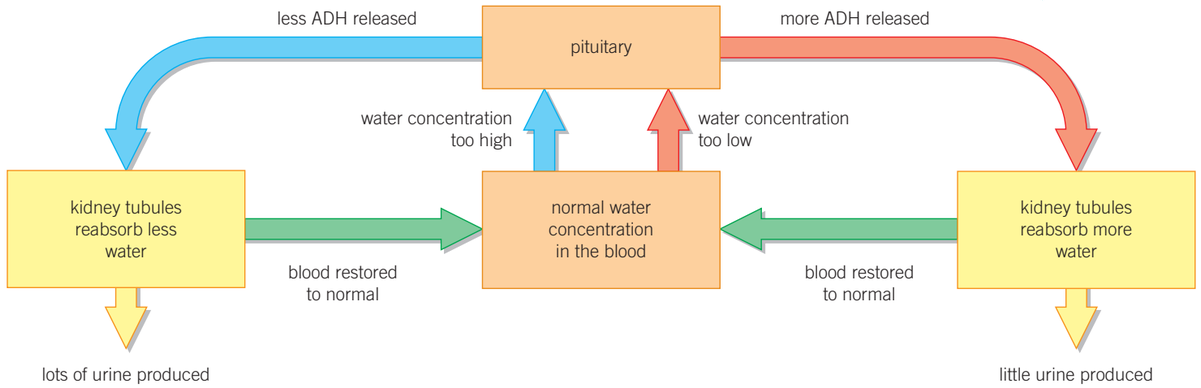
Excess water, ions, and urea are removed by the kidneys in **urine**.

Levels of water in the body must be balanced because cells do not function efficiently if they lose or gain too much water.

The kidneys produce urine by filtration of the blood and selective reabsorption of useful substances such as water, glucose, and some ions.

The water level in the blood is controlled through this process by the hormone **ADH**, which affects the amount of water absorbed by the **kidney tubules**.

This is a **negative feedback cycle**.



People who suffer from kidney failure may be treated by organ transplants or kidney **dialysis**.

Process of kidney dialysis

- blood temporarily removed from patient's body
- filtered through a dialysis machine
- patient's blood passes over dialysis fluid
- dialysis fluid has no urea
- urea and waste products diffuse from high concentration in patient's blood to low concentration in dialysis fluid
- patient's blood then returned to their body

Waste products

The digestion of proteins from food results in excess amino acids, which need to be excreted safely.

These amino acids are deaminated in the liver to form ammonia.

Ammonia is toxic, so it is immediately converted to urea for safe excretion.

Key terms

Make sure you can write a definition for these key terms.

ADH | adrenal gland | adrenaline | coordination centres | dialysis | effectors | endocrine system | homeostasis | hormone | kidney tubule | metabolic rate | negative feedback | stimuli | thermoregulatory centre | urea | urine | vasoconstriction | vasodilation

Chapter 13: Reproduction

Knowledge organiser

Types of reproduction

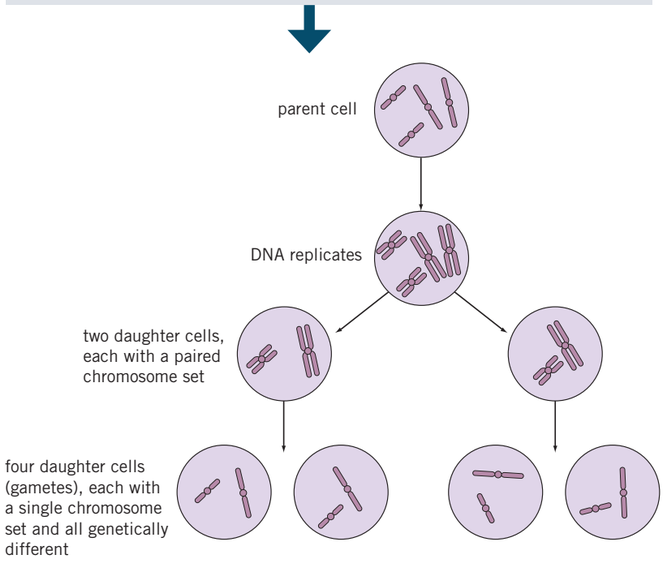
Sexual reproduction	Asexual reproduction
two parents	one parent
cell division through **meiosis**	cell division through **mitosis**
joining (fusion) of male and female sex cells (**gametes**) – sperm and egg in animals, pollen and ovule in plants	no fusion of gametes
produces non-identical offspring that are genetically different to parents	produces offspring that are genetically identical to parent (**clones**)
results in wide variation within offspring and species	no mixing of genetic information

Meiosis

Meiosis is a type of cell division that makes gametes in the reproductive organs.

Meiosis halves the number of chromosomes in gametes, and **fertilisation** (joining of two gametes) restores the full number of chromosomes.

The fertilised cell divides by mitosis, producing more cells. As the embryo develops, the cells differentiate.



DNA and the genome

Genetic material in the nucleus of a cell is composed of **DNA**.

DNA is made up of two strands forming a **double helix**.

DNA is contained in structures called **chromosomes**.

A **gene** is a small section of DNA on a chromosome that codes for a specific sequence of amino acids, to produce a specific protein.

The **genome** of an organism is the entire genetic material of that organism.

The whole human genome has been studied, and this has allowed scientists to

- search for genes linked to different diseases
- understand and treat inherited disorders
- trace human migration patterns from the past.

Inherited disorders

Some disorders are due to the inheritance of certain alleles:

- Polydactyly (extra fingers or toes) is caused by a **dominant** allele.
- Cystic fibrosis (a disorder of cell membranes) is caused by a **recessive** allele.

Embryo screening and gene therapy may alleviate suffering from these disorders, but there are ethical issues surrounding their use.

Genetic inheritance

gamete	specialised sex cell formed by meiosis
chromosome	long molecule made from DNA found in the nucleus of cells
gene	sequence of DNA that codes for a protein – some characteristics are controlled by a single gene (e.g., fur colour in mice and red-green colour-blindness in humans), but most are controlled by multiple genes interacting
allele	different forms of the same gene
dominant	allele that only needs one copy present to be expressed (it is always expressed)
recessive	allele that needs two copies present to be expressed
homozygous	when an individual carries two copies of the same allele for a trait
heterozygous	when an individual carries two different alleles for a trait
genotype	combination of alleles an individual has
phenotype	physical expression of the genotype – the characteristic shown

Genetic crosses

A **genetic cross** is when you consider the offspring that might result from two known parents. **Punnett squares** can be used to predict the outcome of a genetic cross, for both the genotypes the offspring might have and their phenotypes.

For example, the cross bb (brown fur) × BB (black fur) in mice:

		mother	
		B	**B**
father	**b**	Bb	Bb
	b	Bb	Bb

offspring genotype: 100 % Bb

offspring phenotype: all black fur (B is dominant)

Sex determination

Normal human body cells contain 23 pairs of chromosomes – one of these pairs determines the sex of the offspring.

In human females the sex chromosomes are the same (XX, homozygous), and in males they are different (XY, heterozygous).

A Punnett square can be used to determine the probability of offspring being male or female. The probability is always 50 % in humans as there are two XX outcomes and two XY outcomes.

		mother	
		X	**X**
father	**X**	XX	XX
	Y	XY	XY

Key terms

Make sure you can write a definition for these key terms.

allele *chromosome* *clone* *DNA* *dominant* *double helix* *fertilisation* *gamete* *gene* *genetic cross* *genome* *genotype* *heterozygous* *homozygous* *meiosis* *mitosis* *phenotype* *Punnett square* *recessive*

Chapter 14: Variation and evolution

Knowledge organiser

Variation in populations

Differences in the characteristics of individuals in a population are called **variation**.

Variation may be due to differences in

- the genes they have inherited, for example, eye colour.
- the environment in which they have developed, for example, language.
- a combination of genes and the environment.

Mutation

There is usually a lot of genetic variation within a population of a species – this variation arises from **mutations**.

A mutation is a change in a DNA sequence:

- mutations occur continuously
- very rarely a mutation will lead to a new phenotype, but some may change an existing phenotype and most have no effect
- if a new phenotype is suited to an environmental change, it can lead to a relatively rapid change in the species.

Selective breeding

Selective breeding (artificial selection) is the process by which humans breed plants and animals for particular genetic characteristics.

Process of selective breeding:

1. choose parents with the desired characteristic from a mixed population
2. breed them together
3. choose offspring with the desired characteristic and breed them
4. continue over many generations until all offspring show the desired characteristic

The characteristic targeted in selective breeding can be chosen for usefulness or appearance, for example:

- disease resistance in food crops
- animals that produce more meat or milk
- domestic dogs with a gentle nature
- larger or unusual flowers.

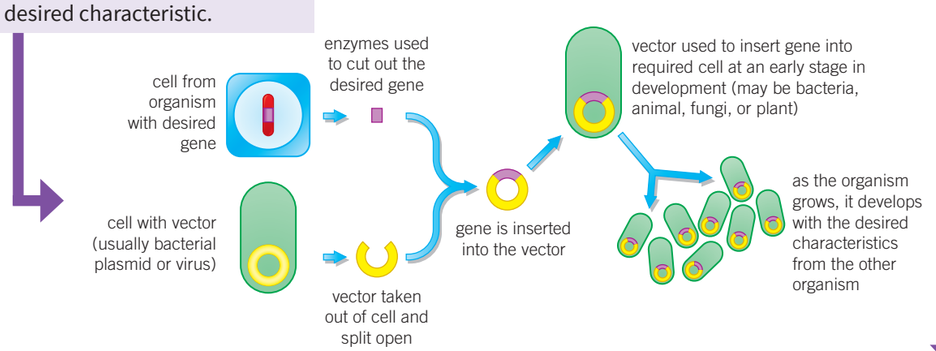
Disadvantages of selective breeding:

- can lead to **inbreeding**, where some breeds are particularly prone to inherited defects or diseases
- reduces variation, meaning all of a species could be susceptible to certain diseases

Genetic engineering (HT only)

Genetic engineering is a process that involves changing the genome of an organism by introducing a gene from another organism, to produce a desired characteristic.

- Bacterial cells have been genetically engineered to produce useful substances, such as human insulin to treat diabetes.
- Plant crops have been genetically engineered to be resistant to diseases, insects, or herbicides, or to produce bigger and better fruits and higher yields. Crops that have undergone genetic engineering are called **genetically modified** (GM).

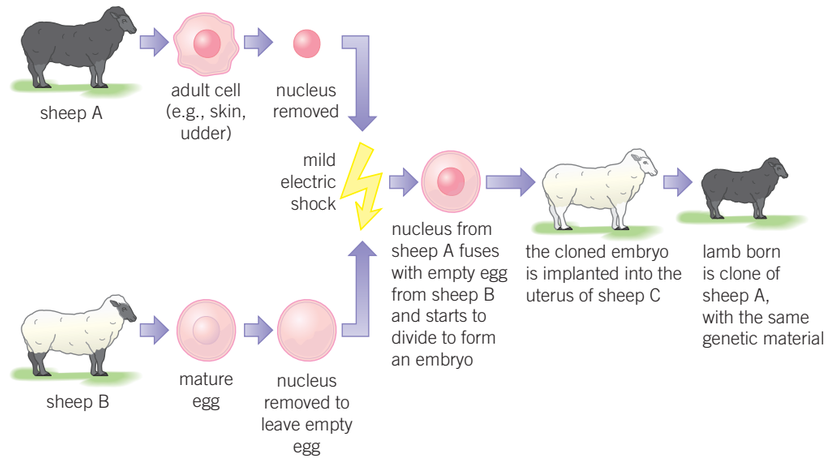


Benefits	Risks
• potential to overcome some inherited human diseases • can lead to higher value of crops as GM crops have bigger yields than normal • crops can be engineered to be resistant to herbicides, make their own pesticides, or be more resistant to environmental conditions	• genes from GM plants and animals may spread to other wildlife, which could have devastating effects on ecosystems • potential negative impacts on populations of wild flowers and insects • ethical concerns, for example, in the future people could manipulate the genes of children to ensure certain characteristics • some believe the long-term effects on health of eating GM crops have not been fully explored

Cloning

A **clone** is an individual that has been produced **asexually** and is genetically identical to its parent.

Adult cell cloning



Methods of cloning

Tissue culture

Small groups of cells from part of a plant are used to grow identical new plants. This is important for preserving rare plant species and growing plants commercially in nurseries.

Cutting

An older, simple method used by gardeners to produce many identical plants from a parent plant.

Embryo transplant

Cells are split apart from a developing animal embryo before they become specialised, then the identical embryos are transplanted into host mothers.

Benefits	Risks
• large number of identical offspring produced • quick and economical • desired characteristics guaranteed	• limits variation and causes reduction in gene pool • clones may be vulnerable to diseases/ changes in the environment • ethical considerations around cloning living organisms

Key terms

Make sure you can write a definition for these key terms.

asexual *clone* *cutting* *embryo transplant* *genetically modified* *genetic engineering* *inbreeding* *mutation* *selective breeding* *tissue culture* *variation*

Chapter 15: Genetics and evolution

Knowledge organiser

Theory of evolution

Evolution is the gradual change in the inherited characteristics of a population over time.

Evolution occurs through the process of **natural selection** and may result in the formation of new species.

Darwin published this theory in *On the Origin of Species* (1859). His ideas were considered controversial and only gradually accepted because

- they challenged the idea that God made all of the Earth's animals and plants
- there was insufficient evidence at the time the theory was published, although much more evidence has been gathered since
- mechanisms of inheritance and variation were not known at the time
- other theories, such as that of Jean-Baptiste Lamarck, were based on the idea that the changes that occur in an organism over its lifetime could be passed on to its offspring. We now know that in the majority of cases this type of inheritance cannot occur.

Process of natural selection

The theory of evolution by natural selection states that

- organisms within species show a wide range of variation in phenotype
- individuals with characteristics most suited to the environment are more likely to survive and breed successfully
- these characteristics are then passed on to their offspring.

Evidence for evolution

The theory of evolution by natural selection is now widely accepted because there are lots of data to support it, such as

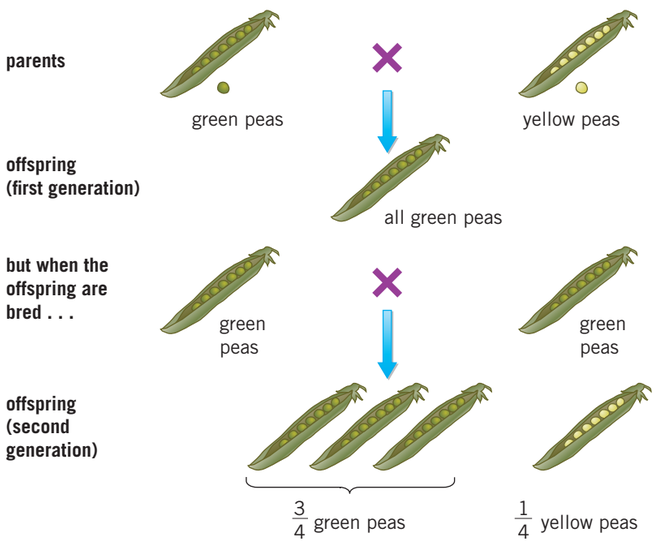
- it has been shown that characteristics are passed on to offspring in genes
- evidence from the **fossil record**
- the evolution of antibiotic resistance in bacteria.

Extinction

Extinction is when there are no remaining individuals of a species still alive.

Factors that may contribute to a species' extinction include

- new predators
- new diseases or pathogens
- increased competition for resources or mates
- catastrophic events (e.g., asteroid impacts, volcanic eruptions, earthquakes)
- changes to the environment (climate change, destruction of habitats).



Development of gene theory

Further work by many scientists led to the development of **gene theory**.

In the late nineteenth century the behaviour of chromosomes during cell division was observed.

↓

In the early twentieth century genes and chromosomes were observed to behave similarly, leading to the idea that genes were located on chromosomes.

↓

In the mid-twentieth century the structure of DNA and mechanism of gene function were determined.

Key terms

Make sure you can write a definition for these key terms.

evolution *extinction* *fossil record* *natural selection* *speciation* *antibiotic-resistance* *gene theory*

Speciation

Alfred Wallace worked with Darwin to propose the theory of evolution by natural selection. He is also known for his work on the theory of **speciation**.

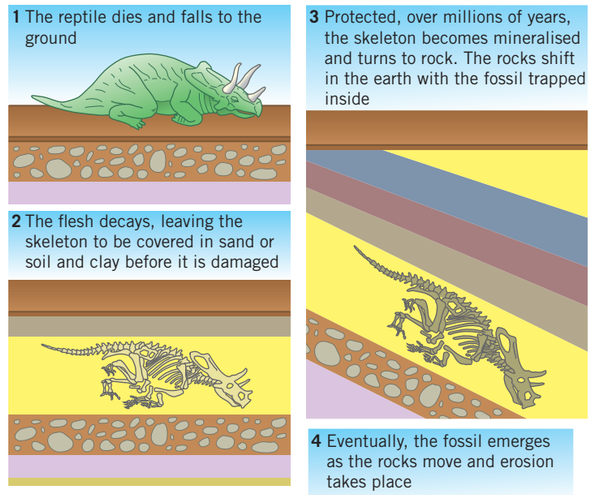
Speciation is the gradual formation of a new species as a result of evolution. More evidence and work from scientists over time have led to our current understanding of the theory of speciation.

Process of speciation

1. two populations of one species are isolated (e.g., by a river or mountain range)
2. natural selection occurs so that the better-adapted individuals reproduce and pass on these different characteristics
3. the populations have an increasing number of genetic mutations as they adapt to their different environments
4. eventually the two populations are so genetically different they cannot breed to produce fertile offspring

Fossils

Benefits of the fossil record	Problems with the fossil record
• can tell scientists how individual species have changed over time • fossils allow us to understand how life developed over Earth's history • fossils can be used to track the movement of a species or its ancestors across the world	• many early organisms were soft-bodied, so most decayed before producing fossils • there are gaps in the fossil record as not all fossils have been found and others have been destroyed by geological or human activity – this means scientists cannot be certain about how life began on Earth

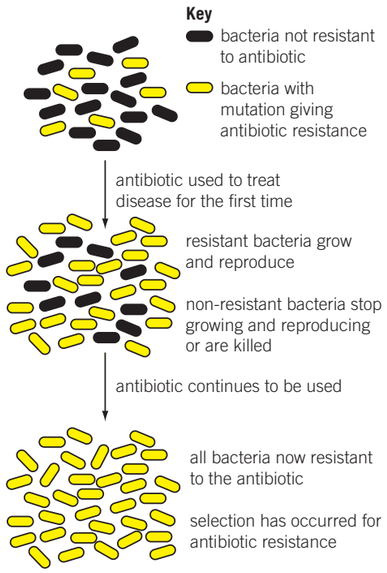


Emergence of antibiotic resistance

The development of new antibiotics is expensive and slow, so is unlikely to keep up with the emergence of new antibiotic-resistant bacteria strains.

To reduce the rise of antibiotic-resistant strains

- doctors should only prescribe antibiotics for serious bacterial infections
- patients should complete their courses of antibiotics so all bacteria are killed and none survive to form resistant strains
- the use of antibiotics in farming and agriculture should be restricted.



Chapter 16: Adaptations and interdependence

Knowledge organiser

Ecosystem organisation

Individual organisms

↓

Population
the total number of organisms of the same species that live in one specific geographical area

↓

Community
group of two or more populations of different species living in one specific geographical area

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Ecosystem
the interaction of a community of living organisms with the non-living parts of their environment

A stable community is one where all the species and environmental factors are in balance so that population sizes remain fairly constant.

An example of this is the interaction between predator and prey species, which rise and fall in a constant cycle so that each remains within a stable range.

Competition

To survive and reproduce, organisms require a supply of resources from their surroundings and from the other living organisms there.

This can create competition, where organisms within a community compete for resources.

There are two types of competition – **interspecific competition** is between organisms of different species and **intraspecific competition** is between organisms of the same species.

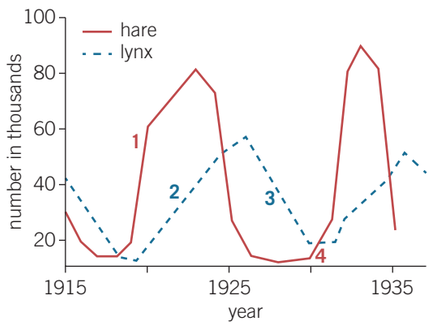
Animals often compete for:
- food
- mates
- territory.

Plants often compete for:
- light
- space
- water and mineral ions from the soil.

Interdependence

Within a community each species **interacts** with many others and may depend on other species for things like food, shelter, pollination, and seed dispersal.

If one species is removed it can affect the whole community – this is called **interdependence**.



1 If the population of hares increases there is a larger food supply for the lynx.

2 This can therefore support more lynx, so more offspring survive.

3 The growing numbers of lynx eventually reduce the food supply. The number of predators starts to decrease.

4 The prey population starts to increase once more – the cycle then begins again.

Abiotic factors

Abiotic factors are non-living factors in the ecosystem that can affect a community.

Too much or too little of the following abiotic factors can negatively affect the community in an ecosystem:
- carbon dioxide levels for plants
- light intensity
- moisture levels
- oxygen levels for animals that live in water
- soil pH and mineral content
- temperature
- wind intensity and direction.

Biotic factors

Biotic factors are living factors in the ecosystem that can affect a community.

For example, the following biotic factors would all negatively affect populations in a community:
- decreased availability of food
- new predators arriving
- new pathogens
- competition between species, for example, one species outcompeting another for food or shelter, causing a decline in the other species' population.

Adaptations of organisms

Organisms have features – **adaptations** – that enable them to survive in the conditions in which they live. The adaptations of an organism may allow it to outcompete others, and provide it with an evolutionary advantage.

Structural adaptations

The physical features that allow an organism to successfully compete:
- sharp teeth to hunt prey
- colouring that may provide camouflage to hide from predators or hunt prey
- a large or small body-surface-area-to-volume ratio.

Behavioural adaptations

The behaviour of an organism that gives it an advantage:
- making nests to attract a mate
- courtship dances to attract a mate
- use of tools to obtain food
- working together in packs.

Functional adaptations

Adaptations related to processes that allow an organism to survive:
- photosynthesis in plants
- production of poisons or venom to deter predators and kill prey
- changes in reproduction timings.

You can work out how an organism is adapted to where it lives when given information on its environment and what it looks like.

For example, without the following adaptations the organisms below would be at a disadvantage in their environment.

Organism	Example adaptations
	• white fur for camouflage when hunting prey • feet with large surface area to distribute weight on snow • small ears to reduce heat loss • thick fur for insulation
	• feet with large surface area to distribute weight on sand • hump stores fat to provide energy when food is scarce • tough mouth and tongue to allow camel to eat cacti • long eyelashes to keep sand out of eyes
	• spines instead of leaves to reduce surface area and therefore water loss, and to deter predators • long roots to reach water underground • large, fleshy stem to store water

Some organisms are **extremophiles**, which means they live in environments that are very extreme where most other organisms could not survive. For example, areas with:
- very high or low temperatures
- extreme pressures
- high salt concentrations
- highly acidic or alkaline conditions
- low levels of oxygen or water.

Bacteria that live in deep sea vents are extremophiles.

Deep sea vents are formed when seawater circulates through hot volcanic rocks on the seafloor. These environments have very high pressures and temperatures, no sunlight, and are strongly acidic.

Key terms

Make sure you can write a definition for these key terms.

abiotic factor *adaptation* *biotic factor* *community* *ecosystem* *extremophile* *interaction* *interdependence* *interspecific competition* *intraspecific competition* *population*

Chapter 17: Organising an ecosystem

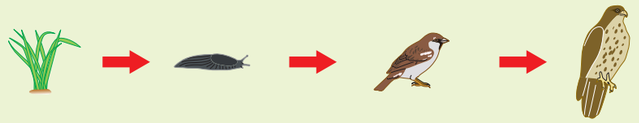
Knowledge organiser

Levels of organisation

Feeding relationships within a community can be represented by **food chains**.

Photosynthetic organisms that synthesise molecules are the producers of all **biomass** for life on Earth, and so are the first step in all food chains.

A range of experimental methods using transects and quadrats are used by ecologists to determine the distributions and abundances of different species in an ecosystem.



all food chains begin with a **producer**, for example, a green plant or alga producing glucose through photosynthesis

slugs are **primary consumers** – they are **herbivores** that eat producers

sparrows are **secondary consumers** – they are **carnivores** that eat primary consumers

hawks are **tertiary consumers** – they are carnivores that eat secondary consumers

Consumers that kill and eat other animals are predators, and those that are eaten are **prey**.

Apex **predators** are carnivores with no predators.

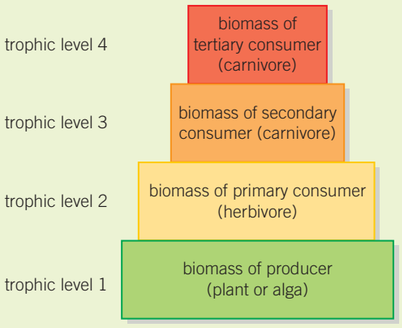
Organisms usually have more complex feeding relationships, with more than one predator or more than one food source. These can be shown in a **food web**.

Pyramids of biomass

The **trophic level** of an organism is the number of steps it is from the start of its food chain.

Pyramids of biomass represent the relative amount of biomass at each trophic level of a food chain.

Biomass is the amount of living or recently dead biological matter in an area. Biomass is transferred from each trophic level to the level above it in the food chain.



Producers transfer about 1% of the incident light energy used for photosynthesis to produce biomass.

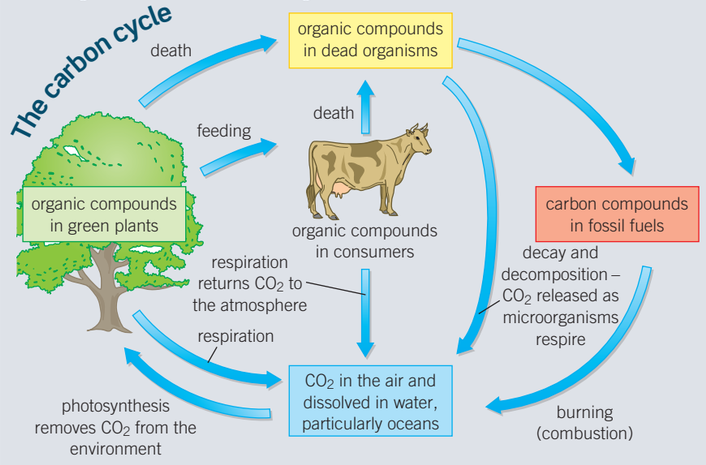
Approximately 10% of the biomass from each trophic level is transferred to the level above it.

This loss of biomass moving up the food chain is due to several factors:

- use in life processes, such as respiration
- not all of the matter eaten is digested, some is egested as waste products
- some absorbed material is lost as waste
- energy is used in movement and to keep animals warm.

How materials are cycled

All materials in the living world are recycled, which provides the building materials for future organisms.

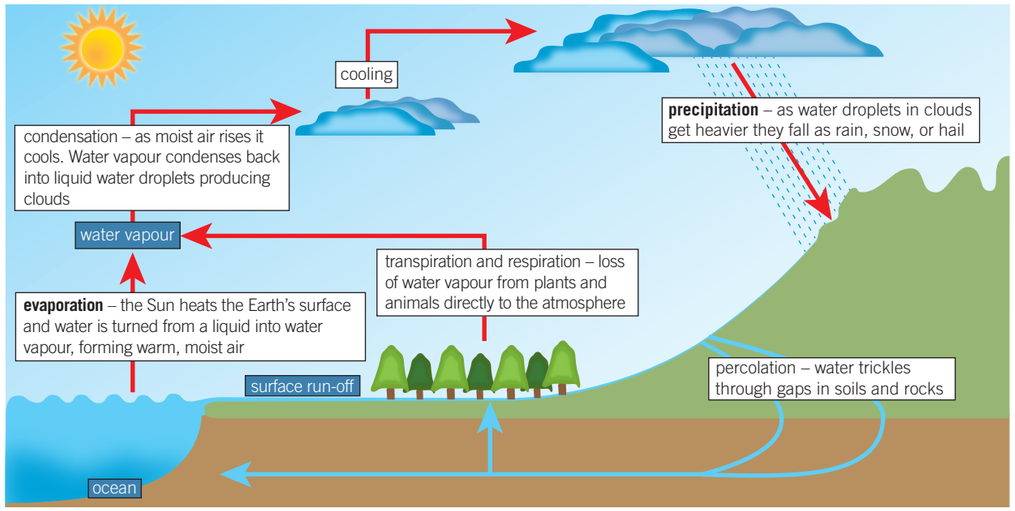


Key terms

Make sure you can write a definition for these key terms.

biomass carbon cycle carnivore consumer decomposer evaporation fertiliser food chain food web herbivore precipitation predator prey producer trophic level water cycle

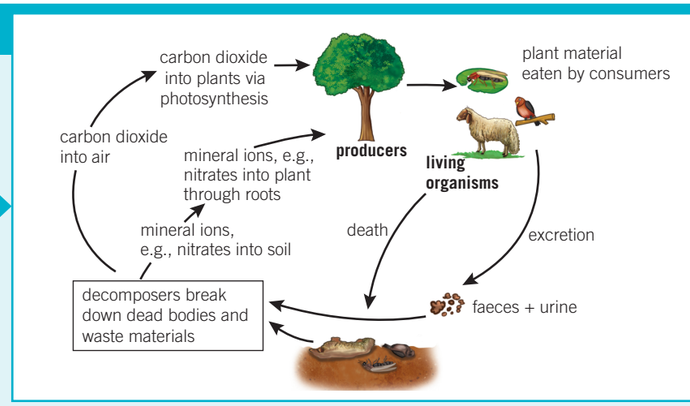
The water cycle



Decomposition

Decomposers, such as bacteria and fungi, break down dead plant and animal matter by secreting enzymes into the environment. The small soluble food molecules produced then diffuse into the decomposer.

These materials are cycled through an ecosystem by decomposers returning carbon to the atmosphere as carbon dioxide and mineral ions to the soil.



Gardeners and farmers try to provide optimum conditions for the rapid decay of waste material by decomposers.

Decomposition will occur faster in warm temperatures, when oxygen and moisture levels are high, and there is a neutral pH.

The compost produced from this decay is then added to soil as a natural **fertiliser** for growing garden plants and crops.

When there is a lack of oxygen, waste is decomposed anaerobically.

Anaerobic decay produces methane gas. Biogas generators use anaerobic decay to produce methane for use as a fuel.

Impacts of environmental change

Environmental changes affect the distribution of species in ecosystems.

These changes may be seasonal, geographic, or caused by humans, and include:

- temperature – varies greatly between locations and seasons, and warming temperatures have contributed to species migrating away from the Equator
- availability of water – during droughts animals have to move away from their usual habitats to areas with more water, and cannot survive if this is not possible
- composition of atmospheric gases – human activities release greenhouse gases and pollutants, which cause harmful effects like climate change and acid rain.

Chapter 18: Biodiversity and ecosystems

Knowledge organiser

Biodiversity

Biodiversity is the variety of all the different species of organisms (plant, animal, and microorganism) on Earth, or within a specific ecosystem.

High biodiversity ensures the stability of an ecosystem, because it reduces the dependence of one species on another in the ecosystem for food or habitat maintenance.

The future of the human species depends on us maintaining a good level of biodiversity. Many human activities, such as **deforestation**, are reducing biodiversity, but only recently have measures been taken to try to prevent this.

Global warming

Levels of carbon dioxide and methane in the atmosphere are increasing due to human activity, contributing to global warming and climate change. Global warming is the gradual increase in the average temperature of the Earth.

This scientific consensus is based on systematic reviews of thousands of peer-reviewed publications.

Global warming has resulted in

- large-scale habitat change and reduction, causing decreases in biodiversity
- extreme weather and sea level changes
- migration of species to different parts of the world, affecting ecosystems
- threats to the security and availability of food.

Waste management

Rapid growth of the human population and increases in the standard of living mean humans are using more resources and producing more waste.

Waste and chemical materials need to be properly handled in order to reduce the amount of **pollution** they cause. Pollution kills plants and animals, and can accumulate in food chains, reducing biodiversity.

Pollution can occur

- in water, from sewage, fertiliser run-off, or toxic chemicals (e.g., from factories)
- in air, from smoke and acidic gases
- on land, from landfill and toxic chemicals.

Land use

Rapid population growth has led to humans using much more land for building, quarrying, farming, and dumping waste. This reduces the area in which animals can live and can further destroy habitats through pollution.

For example, the destruction of **peat bogs** (areas of partially decayed vegetation) to produce garden compost has decreased the amount of this important habitat, and the biodiversity it supports. The decay or burning of peat for energy also releases carbon dioxide into the atmosphere, contributing to **global warming**.

Deforestation

Large-scale deforestation in tropical areas has been carried out to provide land for cattle and rice fields, and to grow crops for **biofuels**.

This has resulted in

- large amounts of carbon dioxide being released into the atmosphere due to burning of trees
- extinctions and reductions in biodiversity as habitats are destroyed
- climate changes, as trees absorb carbon dioxide and release water vapour.

Farming techniques

Sustainable methods of food production need to be developed if we are going to feed the Earth's human population.

Intensive farming techniques make food production more efficient by restricting energy transfer from food animals to their environment.

This can be done by:

- limiting the movement of the animals
- controlling the temperature of their surroundings.

In order to also maximise yield from animals and crops, farmers also:

- feed animals high-protein foods to increase growth
- give animals antibiotics to prevent or treat disease
- regularly use fertilisers, herbicides, and pesticides on crops.

Sustainable fisheries

Fish stocks in the oceans are declining. It is important to maintain fish stocks to ensure breeding continues, or certain species may disappear altogether in some areas.

To avoid this happening, net sizes (bigger holes to stop young fish being caught) and fishing quotas (how many fish can be caught) are controlled in many places.

Food security

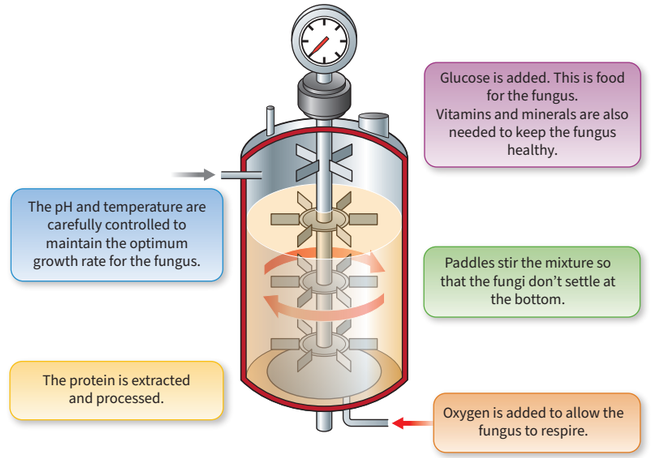
Food security is having enough food to feed a population.

Biological factors threatening human food security include:

- rapid population growth and increasing birth rate in some countries
- changing diets in developed countries, requiring scarce food resources to be transported globally
- new pests and pathogens impacting farming of vast amounts of crops
- environmental changes, such as drought, affecting food production
- increasing cost of agricultural inputs, like fertilisers
- conflicts in some parts of the world, which affect the availability of water or food.

The role of biotechnology

Scientists can use new technologies to solve the problem around food production for a growing population. The fungus *Fusarium* is used to make mycoprotein, a protein-rich alternative to meat. *Fusarium* is cultured in aerobic conditions in fermenters.



Advantages of intensive farming	Disadvantages of intensive farming
• high yield and quicker growth of crops and animals • efficient use of food, with less waste produced • can meet demand for food from a rapidly increasing population	• increased risk of antibiotic-resistant bacteria strains • pesticides and herbicides may kill beneficial organisms and reduce biodiversity • ethical issues about animal welfare and quality of life • large carbon dioxide and methane emissions

Key terms

Make sure you can write a definition for these key terms.

biodiversity *biofuel* *deforestation* *food security*
global warming *intensive farming* *peat bog* *pollution*