

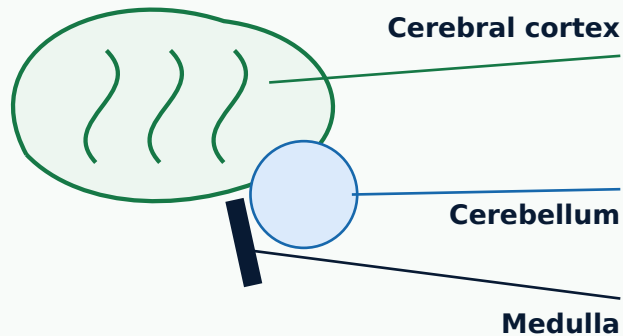
B5 Brain, eye and coordination

Separate Biology Paper 2 extras | AQA 8461 | Core: Foundation + Higher

Supplement to shared content: revise the main topic sheets as well.

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Brain structure and function



The brain contains billions of interconnected neurones and coordinates complex behaviour.

Cerebral cortex: consciousness, intelligence, memory and language.

Cerebellum: coordinates muscular activity and balance.

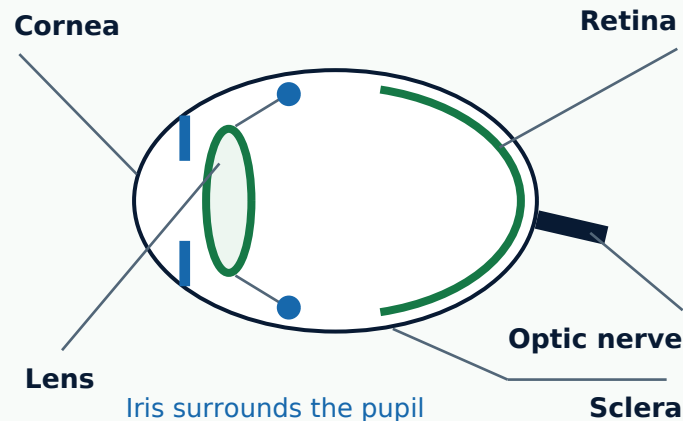
Medulla: controls unconscious activities such as breathing and heart rate.

Temperature control centre

The **thermoregulatory centre** in the brain monitors blood temperature. Skin receptors detect external temperature and send impulses to it.

Too hot: sweating and vasodilation. Too cold: shivering and vasoconstriction. Detailed mechanisms are Higher content.

The eye: receptor organ



Retina: light-sensitive receptor cells detect light intensity and colour. The optic nerve carries impulses to the brain.

Cornea: refracts light. **Lens:** changes shape to focus light onto the retina. **Sclera:** tough outer layer; protects the eye and supports its shape.

Iris: controls pupil size and therefore light entry. **Ciliary muscles** and **suspensory ligaments** alter lens shape.

Pupil reflex

Bright light: circular iris muscles contract and radial muscles relax; pupil narrows. Dim light: the reverse; pupil widens.

The pupil is a hole, not a muscle. Pupil size controls light entry; accommodation controls focus.

Accommodation and sight defects

Focus on	Ciliary muscles / ligaments / lens
Near object	Contract / loosen / thicker and more curved: more refraction.
Distant object	Relax / tighten / thinner and less curved: less refraction.

Accommodation changes lens shape so images of objects at different distances focus on the retina.

Correcting focus

Myopia (short-sightedness): distant objects focus in front of the retina. A concave (diverging) lens corrects it.

Hyperopia (long-sightedness): nearby objects would focus behind the retina. A convex (converging) lens corrects it.

Spectacles and contact lenses refract light. Other treatments include laser surgery to change cornea shape, and replacing the lens.

Exam precision: name the muscles, state the tension of the ligaments, then link lens shape to the amount of refraction.

B5 Kidneys, tropisms and practical skills

Separate Biology Paper 2 extras | AQA 8461 | Core: Foundation + Higher

Supplement to shared content: revise the main topic sheets as well.

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Kidneys and water balance

Water leaves in exhaled air, sweat and urine. Ions and small amounts of urea also leave in sweat. Sweat losses cannot be adjusted to maintain water/ion balance.

Cells can gain or lose too much water by osmosis if blood water/ion balance is wrong.

Blood plasma filtered



Useful substances reabsorbed



Urine: urea + excess water / ions

Kidneys filter the blood and selectively reabsorb **all glucose**, required ions and required water. Urine contains urea plus excess water and ions.

Kidney failure

Dialysis: wastes and excess ions/water move out of blood across a partially permeable membrane. Repeated treatment is needed; diet and fluid intake may be restricted.

Transplant: a donor kidney can restore normal regulation, but surgery, shortage of donors and rejection are risks. Immunosuppressant drugs reduce rejection but increase infection risk.

Tropisms and auxin

Tropism: a directional growth response to a stimulus. Auxins control growth responses to light and gravity.

Light



More auxin
on shaded side

More elongation
shoot bends to light

A shoot grows towards light (**positive phototropism**) and away from gravity (**negative gravitropism**). Unequal auxin distribution causes unequal growth.

In shoots, auxin promotes cell elongation. With light from one side, the shaded side elongates more, bending the shoot towards the light.

Roots show positive gravitropism. High auxin concentration inhibits elongation in roots: the lower side grows less, so the root bends down.

Do not generalise: a concentration of auxin can have different effects in roots and shoots.

Required Practical 8: seedlings

Aim: investigate how light or gravity affects newly germinated seedlings; record effects with careful drawings and measurements.

Use equal-aged seedlings of the same species on moist material. Compare one-sided light with an evenly lit control; keep water, temperature and time equal.

For gravity, place seedlings horizontally in darkness to remove directional light. Compare with suitable controls. A rotating clinostat can prevent a constant directional gravity stimulus.

Mark starting positions; measure shoot/root length and direction or angle at fixed intervals. Use several seedlings per condition and repeat. Record units and calculate means.

Result	Explanation
Shoot bends to light	Shaded side elongates more.
Root bends down in dark	Lower side elongates less.

Evaluate: keep moisture equal; avoid damaged seedlings; compare change, not just final size. Use drawings with a scale. Wash hands after handling plant material.

B5 Higher mechanisms and applications

Separate Biology Paper 2 extras | AQA 8461 | Higher Tier only

Supplement to shared content: revise the main topic sheets as well.

Brain evidence and heat balance

Localising brain function: link damaged regions to lost abilities; electrically stimulate regions and observe responses; use MRI scans to study brain structure.

Brain research and treatment are difficult: the organ is complex, delicate and poorly regenerates. Damage can have serious or permanent effects; treatments require risk-benefit decisions.

Too hot

Vasodilation: skin blood vessels widen, increasing blood flow near the surface and energy transfer to the surroundings.

Sweating: sweat evaporates, transferring energy from the skin. Evaporation, not simply producing sweat, cools the body.

Too cold

Vasoconstriction: skin blood vessels narrow, reducing surface blood flow and energy transfer.

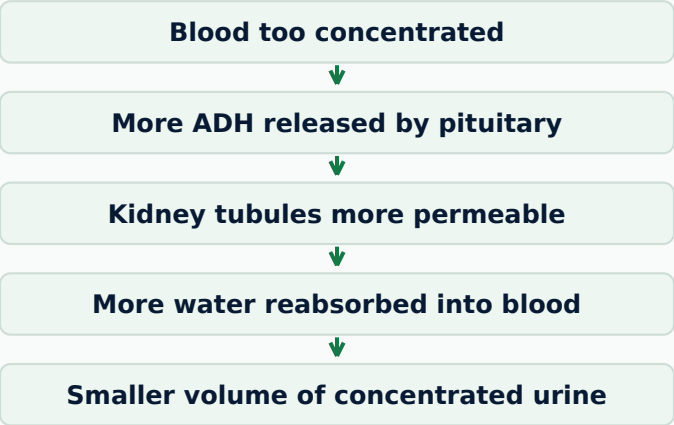
Shivering: rapid muscle contractions increase respiration and energy release, warming the body.

Blood vessels widen/narrow; they do not move nearer the skin. These responses use negative feedback.

Urea and ADH control

Digested proteins supply amino acids. Excess amino acids cannot be stored. The liver **deaminates** them to form ammonia, which is toxic and is converted to urea.

Urea travels in the blood to the kidneys, where it is removed in urine. **Liver makes urea; kidneys excrete it.**



ADH is released by the pituitary when blood is too concentrated. It increases water reabsorption by changing kidney tubule permeability.

When blood is too dilute: less ADH, less water reabsorbed, and a larger volume of dilute urine. Negative feedback returns water concentration towards normal.

Plant hormones in agriculture

Hormone	Function and uses
Auxin	Controls growth. Uses: selective weedkillers, rooting powders, and promoting growth in tissue culture.
Gibberellins	Initiate seed germination. Uses: end seed dormancy, promote flowering, and increase fruit size.
Ethene	Controls cell division and fruit ripening. Used to control ripening during transport, storage and sale.

Selective weedkiller: an auxin-like chemical disrupts growth in susceptible broad-leaved weeds while leaving cereal crops or grasses largely unharmed at the correct dose.

Rooting powder: encourages cuttings to develop roots, allowing rapid cloning of useful plants.

Exam precision: pair a named hormone with its effect and the practical benefit. Ethene is a gas; auxin and gibberellin are not interchangeable.

B6 Reproduction, DNA and evolution

Separate Biology Paper 2 extras | AQA 8461 | Core: Foundation + Higher

Supplement to shared content: revise the main topic sheets as well.

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Reproduction and the DNA code

Sexual reproduction produces genetic variation. A varied population is more likely to include individuals suited to changed conditions; selective breeding can increase useful traits.

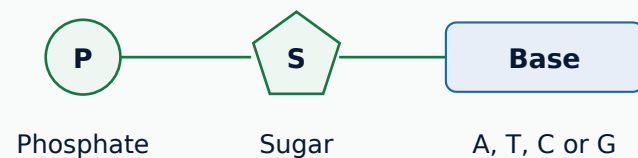
Asexual reproduction needs one parent, is rapid and energy-efficient, and can make many offspring in favourable conditions. Clones have little genetic variation, so the same change may harm many.

Some organisms use both: malaria parasites reproduce asexually in humans and sexually in mosquitoes; fungi form asexual spores but may reproduce sexually in adverse conditions; plants make seeds and may also form runners or bulbs.

DNA is a polymer of nucleotides. Each has a sugar, phosphate and base: A, T, C or G. Alternating sugars and phosphates form a backbone. Two strands form a double helix.

A sequence of **three bases** codes for a particular amino acid. Base order determines amino-acid order and therefore which protein is made.

One nucleotide



Cloning useful organisms

Tissue culture: plant cells divide by mitosis in sterile nutrient medium with hormones. Produces many clones rapidly, including rare plants or useful crop varieties.

Cuttings: take part of a parent plant, encourage roots and grow it into a genetically identical plant.

Embryo transplants: split cells from an early animal embryo before specialisation; implant the identical embryos into host mothers.

Adult-cell cloning

1. Remove the nucleus from an unfertilised egg cell.
2. Insert the nucleus from an adult body cell.
3. Stimulate division, for example with an electric shock.
4. Implant the developing embryo into a host mother.

The clone has the same nuclear genetic information as the adult nucleus donor, not the egg donor or host mother.

Evaluate: preserve useful traits or endangered genotypes, but cloning may have low success, welfare concerns and reduced variation. Identical genes do not guarantee identical outcomes in different environments.

How evolutionary ideas developed

Darwin: variation, competition and natural selection explain evolution. Wallace independently proposed natural selection; his work helped prompt Darwin to publish and advanced ideas about warning colouration.

Darwin faced opposition from religious beliefs, insufficient evidence at the time, and lack of understanding of inheritance. Genetics and other evidence later strengthened the theory.

Lamarck: proposed that acquired characteristics were inherited. This is not the accepted explanation for evolutionary change.

Speciation: populations become isolated, face different selection pressures and accumulate inherited differences. Eventually they cannot interbreed to produce fertile offspring.

Mendel: breeding pea plants led him to propose inherited units, passed from each parent. Their importance was recognised later; chromosomes were identified and genes were found to be sections of DNA.

Exam link: natural selection changes populations over generations. Individuals do not evolve because they need to.

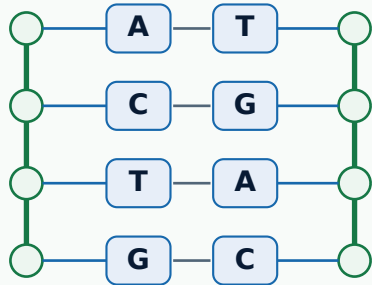
B6 From complementary bases to proteins

Separate Biology Paper 2 extras | AQA 8461 | Higher Tier only

Supplement to shared content: revise the main topic sheets as well.

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Complementary base pairing



Sugar-phosphate backbones

Base pairs join the two strands

A pairs with T; C pairs with G. The sequence on one DNA strand determines the complementary sequence on the other.

DNA strand	Sequence
Given	A T G C C A T
Complement	T A C G G T A

The sugar and phosphate form the backbone. Each base attaches to a sugar. The bases of opposite strands pair in the centre.

Keep distinct: a base pair joins the two strands; a triplet is three consecutive bases along one strand.

Protein synthesis

DNA in nucleus

Base sequence is the code



mRNA copy

Leaves nucleus for a ribosome



Ribosome in cytoplasm

Amino acids joined in coded order



Protein chain folds

Shape enables a specific function

DNA stays in the nucleus. A messenger RNA (mRNA) copy carries the code to a ribosome. Carrier molecules bring specific amino acids in the order specified by the code.

Amino acids join into a chain, which folds into a specific shape. Proteins include enzymes, hormones and structural molecules such as collagen.

Detailed knowledge of mRNA, tRNA and ribosome structure is not required.

Coding and non-coding variants

A mutation changes a DNA base sequence. A **coding variant** can alter the amino-acid sequence and hence protein folding, shape and activity.

For an enzyme, a changed active site may no longer fit its substrate. For a structural protein, altered shape may change its strength or function.

Not every mutation changes the phenotype. Many are neutral: they may not alter the protein, or may not significantly affect its function.

Non-coding DNA

Not all DNA codes for proteins. Non-coding sections can regulate whether genes are switched on or off. A variant here can change how a gene is expressed, altering the amount of a protein made.

Explain the causal chain

Coding: changed base sequence - changed amino-acid order - changed folding/shape - altered protein function - possible phenotype change.

Non-coding: changed regulatory DNA - altered gene expression - altered protein production - possible phenotype change.

B7 Decay, practical evidence and biomass

Separate Biology Paper 2 extras | AQA 8461 | Core: Foundation + Higher

Supplement to shared content: revise the main topic sheets as well.

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Decomposition and useful decay

Microorganisms secrete enzymes outside their cells to break down dead material and waste. Soluble products then diffuse into the cells.

Factor	Effect on decay
Temperature	Warmer conditions increase enzyme activity up to an optimum; high temperatures denature enzymes.
Water	Needed for chemical reactions and microbial growth. Dry material decays slowly.
Oxygen	Supports aerobic respiration, usually speeding decomposition.

Compost: provide suitable warmth, moisture and oxygen. Aerobic decay releases mineral ions, which can be returned to soil as fertiliser.

Biogas generators: anaerobic decay of waste produces methane-rich biogas used as fuel. Keep suitable temperature and exclude oxygen; organic waste supplies material for microbes.

Matter is recycled. Energy is transferred through organisms and to the surroundings, not recycled in the ecosystem.

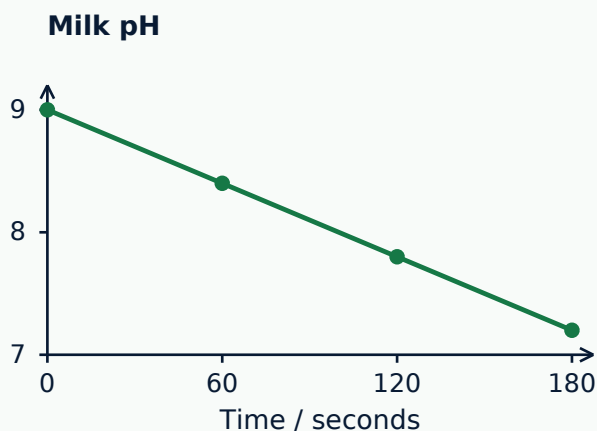
Safety: school supervision, eye protection and care with water baths. Follow approved disposal. Do not taste milk or culture it at home.

Required Practical 10: milk decay

AQA's suggested **model** adds lipase to milk: fatty acids form and pH falls. Natural microbial decay instead produces lactic acid.

Add sodium carbonate and Cresol red to milk. Equilibrate milk mixture and lipase separately at each water-bath temperature. Mix, start timing, then record the time for **purple to yellow** (same pH endpoint).

Keep milk/lipase volumes and concentrations, initial pH and indicator amount fixed. Repeat; compare means. A **pH probe** can record the full curve.

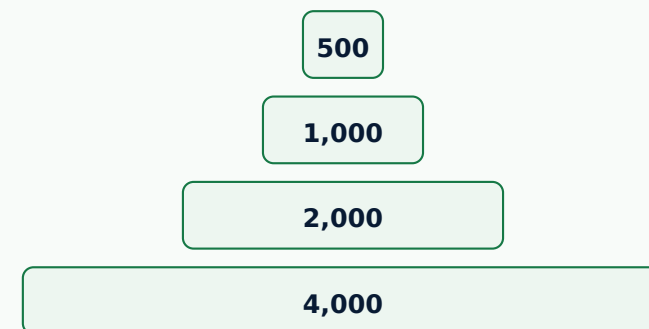


Illustrative lipase model data at 30 C

Rate proxy = $1 / \text{time (s}^{-1}\text{)}$. Shorter time means faster activity. High temperatures may denature lipase. pH is not microbial abundance.

Trophic levels and biomass

Bottom to top: **producers (level 1), primary consumers (2), secondary consumers (3), tertiary consumers (4)**. Apex predators have no predators in the food web considered.



Illustrative dry biomass / g per m2

Use **dry biomass** for comparison. A pyramid of biomass represents mass at each trophic level, not the number of organisms.

Only about 1% of incident light energy is transferred by photosynthesis. Typically only about 10% of biomass transfers to the next trophic level; these are different comparisons.

Biomass transfer efficiency (%)

= biomass transferred / biomass available x 100.

Here: $500 / 1,000 \times 100 = 50\%$.

Losses: uneaten material, faeces, and products of respiration/excretion (carbon dioxide, water and urea). Respiration transfers energy to surroundings; mass does not turn into heat.

B7 Food security and biotechnology

Separate Biology Paper 2 extras | AQA 8461 | Core: Foundation + Higher

Supplement to shared content: revise the main topic sheets as well.

Securing enough food

Food security means having enough food to feed a population. It depends on reliable supply, not simply producing more in one place.

Pressure	Why it matters
Population growth	Raises food demand.
Changing diets	More demand for scarce resources; meat often needs substantial feed and land.
Pests/pathogens	Damage crops and livestock.
Environmental change	Drought and other changes can reduce yields.
Conflict	Disrupts production and distribution.
Costs	Can make production or access unsustainable.

Evaluate proposals using yield, cost, environmental impacts, welfare, nutrition and sustainability. A local benefit can have a wider cost.

Use the evidence: a high yield is not enough if it cannot be maintained or does not reach the people who need it.

Farming and sustainable fisheries

Intensive farming: restricting livestock movement and controlling temperature reduce energy transfers, so more food can contribute to biomass growth. High-protein feed can support growth.

Benefits include higher yields and lower costs per unit. Balance these against animal welfare, disease transmission, waste and environmental impacts.

Crops can be protected using pesticides and herbicides; fertilisers replace mineral ions. These improve yield but may damage ecosystems if misused.

Maintaining fish stocks

Overfishing removes fish faster than populations replace them. Breeding stocks must remain large enough for sustainable reproduction.

Fishing quotas limit catches. **Larger mesh sizes** allow smaller, immature fish to escape and reproduce before capture.

Management must consider evidence on population size, age structure, illegal catches and effects on other species. Short-term income can conflict with long-term supply.

Biotechnology: all core content

Mycoprotein

The fungus **Fusarium** is grown on glucose syrup under aerobic conditions in a fermenter. Fungal biomass is harvested and purified to make a protein-rich food.

A controlled supply of nutrients and oxygen supports growth; temperature and pH are monitored. The product can substitute for meat.

Useful genetically modified organisms

GM bacteria can produce human insulin. The insulin is harvested and purified for treating diabetes.

GM crops can improve yield or nutritional value. Golden rice produces a substance converted to vitamin A, helping address deficiency where appropriate.

Evaluate benefit, cost, access and possible environmental effects, including transfer of introduced genes to other plants.

Tier boundary: these biotechnology applications are core in AQA 8461 section 4.7.5.4. Detailed genetic-engineering procedures are Higher content elsewhere in B6.

B7 Environmental change and distribution

Separate Biology Paper 2 extras | AQA 8461 | Higher Tier only

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Explain a distribution change

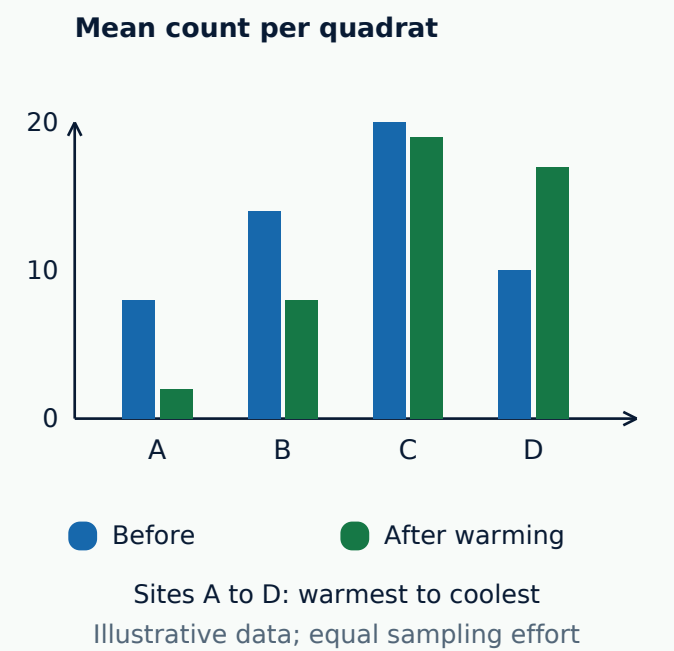
Distribution is where organisms occur. Environmental change may affect survival, reproduction, competition and therefore where a species is found.

Change	Possible effect
Temperature	Shifts suitable conditions; populations may move towards cooler latitudes or higher altitudes.
Water availability	Drought reduces survival of water-dependent species; wetter conditions favour others.
Atmospheric gases	Changes in carbon dioxide can affect photosynthesis; air pollutants can affect sensitive species.

Environmental changes may be **seasonal**, **geographic** or caused by **human activity**. The effect depends on each species and interactions with others.

Causal explanation: identify the changed factor, explain its biological effect, then link that effect to survival/reproduction and distribution.

Read evidence with care



Site	Before	After
A	8	2
B	14	8
C	20	19
D	10	17

Counts fall most at warmer sites A/B and rise at cooler site D. This is **consistent with** a shift towards cooler sites; it does not prove temperature alone caused it.

Evaluate and quantify

At site A: decrease = $8 - 2 = 6$.
Percentage decrease = $6 / 8 \times 100 = 75\%$.
Always divide by the original value.

A larger count at one site is not automatically a larger total population. Sample across the whole range using consistent effort before comparing overall abundance.

Strengthen the evidence

Use repeated sampling over several years, enough randomly located quadrats or a justified transect, and the same season, area and method each time.

Measure the proposed environmental factor. Check alternative explanations such as rainfall, soil pH, pollution, disease, habitat loss and competing species.

Look for a relationship across multiple sites and repeated periods; report variability and uncertainty. Correlation supports a hypothesis but is not proof of causation.

Exam response structure

1. Describe the pattern with figures.
2. Explain a plausible biological mechanism.
3. Identify a limitation or confounding factor.
4. State what further evidence would help.

The dataset on this page is illustrative, not a claim about a named species or a real field study.