

AS Biology 9700: full syllabus summary (all topics in one document)

This document condenses every AS topic of the Cambridge International AS & A Level Biology syllabus (9700) into one revision sheet: cell structure, biological molecules, enzymes, cell membranes and transport, mitosis, nucleic acids and protein synthesis, transport in plants, transport in mammals, gas exchange, infectious diseases and immunity. It is written for reading cover to cover in the final week before the exam, not for first learning a topic, so it states definitions, key equations and processes without background explanation. Topics are named rather than given syllabus section numbers, since section numbering can change between syllabus editions.

1. Cell structure

Magnification, resolution and units

Magnification is how many times larger an image is than the real object; resolution is the smallest distance between two points at which they can still be seen as two separate points, not one blur. A light microscope has a resolution of about 200 nm (0.2 µm), limited by the wavelength of visible light (roughly 400–700 nm) — resolution cannot be much better than a fraction of the wavelength used. An electron microscope uses electrons, which have a much shorter wavelength, giving a resolution of less than 1 nm, over 200 times better than a light microscope, which is why fine organelle detail (e.g. cristae, thylakoid stacks) is only visible by electron microscopy.

Quantity	Formula	Notes
Magnification	$M = I \div A$	I = size of image, A = actual size of object; I and A must be in the same units
Unit conversion	1 mm = 1000 µm = 1×10^6 nm	Convert to the smallest common unit before dividing

Worked example: an image of a cell measures 38 mm across, at a magnification of $\times 380$. Actual size = image size $\div$ magnification = $38 \text{ mm} \div 380 = 0.1 \text{ mm} = 100 \text{ µm}$.

Eukaryotic organelles

Organelle	Structure	Function
Nucleus	Double membrane (envelope) with pores; contains chromatin and a nucleolus	Houses DNA; nucleolus assembles ribosomal RNA and ribosome subunits
Rough endoplasmic reticulum (RER)	Membrane sacs studded with ribosomes	Synthesises and folds proteins for secretion or membranes
Smooth endoplasmic reticulum (SER)	Membrane tubules, no ribosomes	Synthesises lipids and steroids; detoxification



Golgi body	Stack of flattened membrane sacs (cisternae) with vesicles budding off	Modifies, sorts and packages proteins into vesicles
Mitochondrion	Double membrane; inner membrane folded into cristae; fluid matrix; own circular DNA and 70S ribosomes	Site of aerobic respiration; makes ATP
Chloroplast	Double membrane; thylakoid membranes stacked into grana, linked by lamellae; stroma; own DNA and 70S ribosomes; plants and algae only	Site of photosynthesis
Ribosome	Two subunits of rRNA and protein; 80S, free in cytoplasm or bound to RER in eukaryotes	Site of translation
Lysosome	Membrane sac of hydrolytic enzymes	Digests worn organelles, food vacuole contents, or pathogens
Cell surface membrane	Phospholipid bilayer with proteins	Controls entry/exit of substances (partially permeable)
Cell wall (plants/fungi)	Cellulose (plants) or chitin (fungi) fibres; freely permeable	Mechanical strength; prevents bursting under turgor
Vacuole (plants)	Fluid sac bound by a single membrane, the tonoplast	Stores solutes; maintains turgor pressure

Prokaryotic cells and viruses

Prokaryotic cells (e.g. bacteria) lack a nucleus and membrane-bound organelles. Their DNA is a single circular chromosome free in the cytoplasm (the nucleoid region), not associated with histone proteins, and they often also carry small circles of DNA called plasmids. Ribosomes are 70S, smaller than the 80S ribosomes of eukaryotes. The cell wall is made of peptidoglycan (murein), not cellulose.

Prokaryotic cells (typically 1–5 μm) are much smaller than eukaryotic cells (typically 10–100 μm).

Viruses are not cells: they have no cytoplasm, no ribosomes and no cell surface membrane, so they cannot respire or reproduce independently and must use a host cell's machinery. A virus particle is nucleic acid (DNA or RNA, never both) enclosed in a protein coat called a capsid, sometimes surrounded by a lipid envelope taken from the host membrane. Viruses are far smaller than cells, typically 20–300 nm.

Easy to forget: the cell wall is freely permeable; it is the cell surface membrane, not the wall, that is selectively (partially) permeable. Mitochondria and chloroplasts have their own DNA and 70S ribosomes, evidence for the endosymbiotic theory that they were once free-living prokaryotes. The nucleolus makes rRNA, not DNA.

2. Biological molecules

Water and macromolecules

Water is a polar molecule: the oxygen atom carries a partial negative charge and each hydrogen a partial positive charge, so water molecules form hydrogen bonds with each other. This gives water a

high specific heat capacity (buffers temperature change), a high latent heat of vaporisation (evaporative cooling), cohesion between molecules (important in the transpiration stream) and makes it an excellent solvent for polar and ionic substances.

Large biological molecules (polysaccharides, proteins, nucleic acids) are polymers built from repeating monomer units. Monomers join by **condensation reactions**, forming a covalent bond and releasing one water molecule per bond; polymers are broken down by **hydrolysis reactions**, which use one water molecule to break a bond.

Carbohydrates

Monosaccharides (e.g. glucose, fructose, galactose) join by a condensation reaction between two –OH groups to form a **glycosidic bond**, releasing water. Two monosaccharides give a disaccharide: glucose + glucose → maltose; glucose + fructose → sucrose; glucose + galactose → lactose.

Polysaccharide	Monomer/bonds	Structure and role
Amylose (part of starch)	α-glucose, 1,4 glycosidic bonds only	Unbranched, coils into a helix; compact storage in plants
Amylopectin (part of starch)	α-glucose, 1,4 and 1,6 glycosidic bonds	Branched; branches allow fast hydrolysis for rapid glucose release
Glycogen	α-glucose, 1,4 and 1,6 glycosidic bonds	More highly branched than amylopectin; storage in animals and fungi, very rapid glucose release
Cellulose	β-glucose, 1,4 glycosidic bonds; alternate glucose units rotated 180°	Long straight unbranched chains, H-bonded together into microfibrils; high tensile strength in plant cell walls

Lipids

A triglyceride is one glycerol condensed with three fatty acids, forming three **ester bonds**. Unsaturated fatty acids contain one or more C=C double bonds, which kink the chain and lower melting point; saturated fatty acids have none. Phospholipids replace one fatty acid with a phosphate group, giving a hydrophilic head and two hydrophobic tails, the basis of the bilayer in cell membranes.

Proteins

An amino acid has a central carbon bonded to an amine group (–NH₂), a carboxyl group (–COOH), a hydrogen, and a variable R group. Two amino acids condense to form a **peptide bond** between the carboxyl of one and the amine of the next.

Level	What determines it
Primary	Sequence of amino acids joined by peptide bonds
Secondary	Hydrogen bonding between –NH and C=O groups of the backbone, forming an α-helix or β-pleated sheet
Tertiary	Further folding from R-group interactions: ionic bonds, hydrogen bonds, disulfide bonds and hydrophobic interactions
Quaternary	Two or more polypeptide chains associate (e.g. haemoglobin's four chains)

Fibrous proteins have a structural rather than catalytic or transport role. Collagen, for example, is found

in tendons, skin, bone and blood vessel walls: three polypeptide chains wind together into a triple helix, cross-linked by covalent bonds between adjacent molecules, giving it high tensile strength.

Biochemical tests

Test	Method	Positive result
Reducing sugar	Add Benedict's reagent, heat in a water bath	Blue → green → yellow → brick-red precipitate
Non-reducing sugar	Boil with dilute HCl to hydrolyse, neutralise with alkali, then Benedict's test	Brick-red precipitate (only after hydrolysis)
Starch	Add iodine/potassium iodide solution	Blue-black colour
Protein	Biuret test: NaOH then dilute CuSO_4	Blue → purple/lilac
Lipid	Emulsion test: shake with ethanol, then add to water	White emulsion

Easy to forget: a Benedict's colour change is only a rough quantitative trend (blue → red = more reducing sugar present); a negative result does not rule out sugar, since it may be a non-reducing sugar that needs hydrolysis first.

3. Enzymes

Enzyme action

Enzymes are globular proteins that act as biological catalysts: they speed up reactions by lowering the activation energy needed, without being used up. The **induced-fit model** describes how the active site is not a rigid fit but changes shape slightly as the substrate binds, moulding around it and straining bonds in the substrate to help the reaction proceed.

Some enzymes need a non-protein **cofactor** to function. An inorganic cofactor (e.g. Cl^- or a metal ion such as Zn^{2+}) assists catalysis without being part of the protein's structure. A coenzyme is a small organic molecule (e.g. NAD) that binds loosely and is often chemically changed during the reaction. A prosthetic group is a cofactor permanently and tightly bound to the enzyme (e.g. the haem group in catalase).

Factors affecting rate

Factor	Effect
Temperature	Rate rises as kinetic energy and successful collisions increase (often roughly doubling per 10°C , the Q_{10} effect), up to an optimum; beyond the optimum, hydrogen and ionic bonds holding tertiary structure break, the active site changes shape (denaturation) and rate falls sharply
pH	Each enzyme has an optimum pH; above or below it, charges on R groups change, disrupting bonds that hold tertiary structure and denaturing the enzyme
Substrate concentration	Rate rises as concentration rises (more collisions), then plateaus at V_{max} once all active sites are saturated

Enzyme concentration	Rate rises proportionally, provided substrate is in excess
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Inhibitors

Type	Binding site	Effect of raising substrate concentration
Competitive	Active site (structurally resembles the substrate); reversible	Can outcompete the inhibitor, so V_{max} can still be reached
Non-competitive	An allosteric site elsewhere on the enzyme, distorting the active site	Cannot be overcome; V_{max} is reduced

Easy to forget: denaturation is a change of shape caused by broken hydrogen, ionic, disulfide or hydrophobic bonds, not the breaking of peptide bonds; primary structure is unaffected. Always name the bond type broken, not just "the enzyme changes shape".

4. Cell membranes and transport

Fluid mosaic model

The membrane is a phospholipid bilayer with hydrophilic heads facing the aqueous cytoplasm and extracellular fluid, and hydrophobic tails facing each other. Proteins are scattered through it (a "mosaic") and can move within the layer (it is "fluid"): integral proteins span the bilayer (some acting as channels or carriers), peripheral proteins sit on one surface. Cholesterol sits between phospholipid tails and restricts their movement, regulating fluidity. Glycoproteins and glycolipids on the outer surface act as receptors and cell-recognition markers.

Movement across membranes

Process	Direction	Uses ATP?	Route
Simple diffusion	High to low concentration	No	Directly through the bilayer (small, non-polar molecules, e.g. O_2 , CO_2)
Facilitated diffusion	High to low concentration	No	Through a channel or carrier protein (large or polar/charged molecules, e.g. glucose, ions)
Osmosis	High to low water potential	No	Through the bilayer and water-channel proteins (aquaporins)
Active transport	Low to high concentration	Yes	Through a specific carrier protein that changes shape
Endocytosis / exocytosis	Bulk movement, in or out	Yes	Membrane folds around material to form a vesicle (endocytosis), or a vesicle fuses with the membrane to release its contents (exocytosis); used for large particles or bulk material rather than individual molecules

Water potential (Ψ), measured in kPa, describes the tendency of water molecules to move out of a

solution. Pure water has the highest possible water potential, 0 kPa; any solute lowers it to a negative value. Water always moves from a higher (less negative) to a lower (more negative) water potential.

In a plant cell, water potential is the sum of two components: $\Psi_{\text{cell}} = \Psi_{\text{solute}} + \Psi_{\text{pressure}}$. Solute potential (Ψ_{solute}) is always negative or zero, lowered by dissolved solutes; pressure potential (Ψ_{pressure}) is usually positive, produced by the protoplast pushing outward against the cell wall. In a hypotonic (dilute) solution, water enters the cell by osmosis and Ψ_{pressure} rises until it balances Ψ_{solute} ; the cell is then fully **turgid** and cannot burst, because the inelastic wall resists further expansion. In a hypertonic (concentrated) solution, water leaves the cell and the protoplast shrinks away from the wall (**plasmolysis**); at the point where the protoplast just starts to pull away from the wall, $\Psi_{\text{pressure}} = 0$ and $\Psi_{\text{cell}} = \Psi_{\text{solute}}$ (**incipient plasmolysis**).

Easy to forget: diffusion rate depends on surface area, concentration gradient and diffusion distance; link a structure's adaptations (thin, large surface area, short diffusion path) explicitly to these three factors.

5. Mitosis

The cell cycle

Interphase, the longest phase, has three parts: G1 (growth, organelle production), S (DNA replication, so each chromosome goes from one to two sister chromatids) and G2 (further growth, checking DNA for errors). Mitosis then divides the nucleus, and cytokinesis divides the cytoplasm.

Stages of mitosis

Stage	Key events
Prophase	Chromosomes condense and become visible, each as two sister chromatids joined at a centromere; the nuclear envelope breaks down; spindle fibres form
Metaphase	Chromosomes line up individually at the equator, attached to spindle fibres at the centromere
Anaphase	Centromeres split; sister chromatids are pulled to opposite poles by shortening spindle fibres
Telophase	Chromatids (now chromosomes) decondense; nuclear envelopes re-form around each set

Mitosis produces two genetically identical daughter cells (same chromosome number and alleles as the parent), for growth, repair and asexual reproduction. Cancer results from mutations in genes controlling the cell cycle, causing uncontrolled mitotic division and tumour formation.

Stem cells

A stem cell is an undifferentiated cell that can divide by mitosis and differentiate into specialised cell types. **Totipotent** cells (e.g. the zygote) can become any cell type, including extra-embryonic tissue; **pluripotent** cells (e.g. embryonic stem cells) can become almost any body cell type, but not extra-embryonic tissue; **multipotent** cells (e.g. bone marrow stem cells) can become a limited range of related cell types. In plants, cells in the meristems at root and shoot tips remain undifferentiated and can divide throughout the plant's life, allowing continued growth.

Easy to forget: a chromosome is one DNA molecule; a chromatid is one half of a replicated chromosome. Chromosome number stays constant (diploid) throughout mitosis; only the

chromatid number per chromosome changes across the cycle.

6. Nucleic acids and protein synthesis

DNA structure and replication

A nucleotide is a phosphate group, a pentose sugar (deoxyribose in DNA, ribose in RNA) and a nitrogenous base. DNA is a double helix of two antiparallel strands, held together by hydrogen bonds between complementary bases: adenine pairs with thymine (2 hydrogen bonds), cytosine pairs with guanine (3 hydrogen bonds).

Replication is **semi-conservative**: helicase unwinds and unzips the double helix by breaking hydrogen bonds; DNA polymerase then builds a new complementary strand against each template strand, using free nucleotides, so each new DNA molecule keeps one original strand and one new strand.

	DNA	RNA
Sugar	Deoxyribose	Ribose
Strands	Double	Single
Bases	A, T, C, G	A, U, C, G

Protein synthesis

Transcription (in the nucleus): RNA polymerase binds upstream of a gene, unwinds the DNA and builds a single-stranded pre-mRNA copy of the template strand (using U in place of T). In eukaryotes, non-coding introns are then spliced out and the remaining exons joined to give mature mRNA, which leaves through a nuclear pore.

Translation (at ribosomes): mRNA is read three bases (a codon) at a time. Transfer RNA molecules, each carrying a specific amino acid and a complementary anticodon, pair with each codon in turn at the ribosome; the ribosome catalyses a peptide bond between adjacent amino acids, building a polypeptide until a stop codon is reached.

Easy to forget: the genetic code is a triplet code, non-overlapping and degenerate (most amino acids have more than one codon), but not ambiguous, since each codon specifies only one amino acid. AUG is both the start codon and codes for methionine.

7. Transport in plants

Xylem and phloem

	Xylem	Phloem
Cells	Vessel elements: dead, lignified, hollow tubes with no end walls, pits in the walls	Sieve tube elements (living, no nucleus, sieve plates with pores) and companion cells (living, nucleus, many mitochondria, linked by plasmodesmata)
Transports	Water and mineral ions	Organic solutes, mainly sucrose (translocation)
Direction	One way, roots to leaves	Source to sink, either direction depending on plant needs

Transpiration

Water evaporates from moist mesophyll cell walls into the air spaces of the leaf and diffuses out through open stomata (the **transpiration** stream). This water loss lowers the water potential of the mesophyll cells, drawing water from the xylem by osmosis, which pulls the whole water column upward under tension. Cohesion between water molecules (hydrogen bonding) keeps this column continuous, and adhesion to xylem walls resists the column collapsing; this is the **cohesion-tension theory**. Root pressure (from active uptake of ions into the root xylem, lowering its water potential) gives an additional, smaller push. Transpiration rate increases with higher temperature, higher light intensity (more stomata open), lower humidity and higher wind speed (removes the water vapour boundary layer).

Translocation

The **mass flow hypothesis**: at the source (e.g. a leaf), companion cells actively load sucrose into sieve tubes, lowering the sieve tube's water potential, so water enters by osmosis from the xylem, raising hydrostatic pressure. At the sink (e.g. a root or fruit), sucrose is removed and used or stored, raising the sieve tube's water potential there, so water leaves by osmosis, lowering hydrostatic pressure. This pressure difference drives a mass (bulk) flow of phloem sap from source to sink.

Xerophytic adaptations

Plants in dry habitats (xerophytes) reduce water loss by transpiration in several ways: a thick waxy cuticle reduces evaporation directly through the leaf surface; sunken stomata, or stomata in pits or grooves, trap a layer of humid air next to the leaf and reduce the diffusion gradient; rolled leaves or leaf hairs also trap a boundary layer of moist air; a reduced leaf surface area, e.g. needle-shaped leaves, reduces the evaporating surface; and some plants shed leaves or close stomata during drought to cut water loss further.

Easy to forget: xylem transport is entirely passive (no ATP used); phloem loading at the source requires ATP for active transport of sucrose. Always use water-potential language ("higher/lower"), not "more/less water".

8. Transport in mammals

The heart and cardiac cycle

Mammals have a double circulatory system: blood passes through the heart twice per full circuit, once to the lungs (pulmonary circulation) and once to the body (systemic circulation), keeping oxygenated and deoxygenated blood separate and maintaining high pressure. The heart has four chambers: right atrium and right ventricle handle deoxygenated blood; left atrium and left ventricle handle oxygenated blood. Atrioventricular valves (tricuspid on the right, bicuspid/mitral on the left) prevent backflow into the atria during ventricular contraction; semilunar valves in the pulmonary artery and aorta prevent backflow into the ventricles.

The heartbeat is **myogenic**: it is initiated by the sinoatrial node (SAN, the pacemaker) in the right atrium wall, which triggers atrial contraction (systole). The wave of excitation reaches the **atrioventricular node** (AVN), which imposes a short delay before conducting the impulse down the bundle of His and Purkyne fibres to the ventricle apex, so that ventricular systole spreads from the apex upward towards the base, squeezing blood upward and out through the semilunar valves.

Blood vessels and blood

	Artery	Vein	Capillary
Wall	Thick, muscular and elastic	Thin	One cell thick (endothelium only)
Lumen	Narrow	Wide	Very narrow, single blood cell width
Valves	Absent (except at heart exits)	Present	Absent
Pressure	High, pulsing	Low, steady	Falls along its length

Red blood cells are biconcave (large surface area to volume ratio for gas exchange) and packed with haemoglobin, a protein with quaternary structure: four polypeptide chains, each with a haem group containing Fe^{2+} , each reversibly binding one O_2 , summarised as $\text{Hb} + 4\text{O}_2 \rightleftharpoons \text{Hb}(\text{O}_2)_4$. Binding of the first O_2 makes further binding easier (cooperative binding), producing an S-shaped (sigmoid) oxygen dissociation curve. A rise in CO_2 concentration (and fall in pH) shifts the curve to the right, the **Bohr effect**, reducing haemoglobin's affinity for O_2 so more is released at respiring tissues.

Tissue fluid

At the arterial end of a capillary bed, high hydrostatic pressure forces plasma (minus large proteins) out through gaps in the capillary wall into the surrounding tissue, forming tissue fluid. At the venous end, hydrostatic pressure has fallen while the plasma proteins left behind lower the water potential inside the capillary, so most tissue fluid re-enters by osmosis; the small remaining excess is drained by the lymphatic system and returned to the blood.

Easy to forget: fetal haemoglobin has a higher affinity for O_2 than adult haemoglobin (its dissociation curve sits to the left), allowing O_2 to transfer from mother to fetus across the placenta.

9. Gas exchange

Structure of the gas exchange system

Air passes through the trachea (supported by C-shaped cartilage rings, keeping it open), which branches into two bronchi, then into narrower bronchioles, ending in clusters of alveoli. Alveoli provide the exchange surface: their walls are a single layer of squamous epithelium, they are surrounded by a dense capillary network with walls also one cell thick (a short diffusion distance), there are millions of them (a very large total surface area, around 70 m^2 in humans), and their inner surface is moist, allowing gases to dissolve before diffusing.

Ventilation

	Inspiration	Expiration (quiet breathing)
External intercostal muscles	Contract, pulling ribs up and out	Relax
Diaphragm	Contracts, flattens	Relaxes, domes upward

Thoracic volume	Increases	Decreases
Pressure inside thorax	Falls below atmospheric	Rises above atmospheric
Airflow	Into the lungs	Out of the lungs

Easy to forget: quiet expiration is passive (elastic recoil of the lungs and relaxation of muscles); only forced expiration uses the internal intercostal and abdominal muscles.

10. Infectious diseases

Pathogens and transmission

Pathogens causing disease belong to several groups: bacteria, viruses, protoctists and fungi.

Transmission can be direct (e.g. droplet infection, direct contact, sexual contact) or indirect (e.g. via contaminated water or food, or via a vector such as a mosquito).

Disease	Pathogen and type	Transmission / key mechanism
Cholera	<i>Vibrio cholerae</i> , bacterium	Faecal-contaminated water; a toxin causes chloride ion secretion into the gut lumen, water follows by osmosis, causing severe watery diarrhoea and dehydration
Tuberculosis (TB)	<i>Mycobacterium tuberculosis</i> , bacterium	Airborne droplets; infects the lungs, forming areas of damaged tissue (tubercles)
Malaria	<i>Plasmodium</i> species, protoctist	Vector-borne, transmitted by <i>Anopheles</i> mosquitoes; the parasite develops in the liver, then repeatedly infects and bursts red blood cells
HIV/AIDS	HIV, a virus	Transmitted via bodily fluids (blood, semen, breast milk); infects and destroys helper T cells, eventually collapsing immune function (AIDS)
Measles	Measles virus	Airborne droplets; highly infectious

Antibiotics

Antibiotics kill or inhibit bacteria without harming host cells by targeting structures or processes unique to bacteria: for example, penicillin-type antibiotics inhibit the enzyme that cross-links peptidoglycan in the bacterial cell wall, so the wall weakens and the bacterium lyses (bursts) as it grows. Antibiotics are ineffective against viruses, which have no cell wall, ribosomes or independent metabolism to target. Antibiotic resistance arises when a random mutation gives some bacteria a survival advantage in the presence of the antibiotic; these survive, reproduce and pass the resistance allele on, so the resistant strain increases in frequency by natural selection.

Easy to forget: antibiotics fail against colds or flu because those are caused by viruses, not because the antibiotic is "too weak"; always explain in terms of the pathogen type and the antibiotic's target.

11. Immunity

Non-specific defences

Physical and chemical barriers (skin, mucous membranes, stomach acid, lysozyme enzyme in tears and saliva) prevent pathogens entering. If a pathogen breaches these, phagocytes (e.g. macrophages, neutrophils) engulf it by phagocytosis: the pathogen is enclosed in a phagosome, which fuses with a lysosome, and hydrolytic enzymes digest it. This response is the same regardless of the pathogen (non-specific).

Specific immune response

Each pathogen carries surface molecules called antigens, recognised by lymphocytes with a complementary receptor. Humoral immunity: a B lymphocyte with a matching receptor binds the antigen, is activated (with help from a helper T cell) and undergoes clonal selection and division, producing plasma cells that secrete large quantities of antibodies specific to that antigen, and memory cells that persist. Cell-mediated immunity: helper T cells recognise antigen presented on an infected cell's surface and release cytokines that activate B cells and cytotoxic T cells; cytotoxic T cells then destroy infected body cells directly.

An antibody is a protein with quaternary structure: two identical heavy chains and two identical light chains, joined by disulfide bonds, forming a Y-shape with two identical variable regions (antigen-binding sites, complementary to one specific antigen) and a constant region.

Primary and secondary response; types of immunity

On first exposure, the **primary response** is slow to reach a high antibody concentration because clonal selection of the rare matching lymphocyte takes time; the pathogen may cause disease symptoms before it is cleared. Memory cells remain afterwards. On re-exposure, the **secondary response** is faster and reaches a much higher antibody concentration, because memory cells recognise the antigen immediately and divide rapidly, often clearing the pathogen before symptoms appear.

	Active immunity	Passive immunity
Source of antibodies	Made by the individual's own plasma cells	Given from an outside source
Memory cells formed?	Yes	No
Duration	Long-lasting	Short-term
Natural example	Recovering from infection	Antibodies crossing the placenta / in breast milk
Artificial example	Vaccination	Injection of antibodies (antiserum)

Vaccination introduces antigens (from a dead or attenuated pathogen, a toxoid, or an isolated antigen) to trigger a primary response and memory cell formation without causing disease, so a real infection later triggers a fast, protective secondary response. If enough of a population is vaccinated, the pathogen cannot spread easily even to unvaccinated individuals, giving herd immunity.

Easy to forget: antibodies do not destroy pathogens directly; they mark them for destruction (agglutination, or as a signal for phagocytes) and neutralise toxins or prevent attachment to host cells.

Common mistakes

- Writing "the enzyme is destroyed" instead of "denatured": the bonds maintaining tertiary structure break, but peptide bonds and primary structure are unaffected.
- Confusing diffusion and osmosis: osmosis is specifically the movement of water across a partially permeable membrane down a water potential gradient; do not use "concentration gradient" language for osmosis in mark schemes.
- Stating water potential is "high" or "low" without a comparison: always compare two named regions, e.g. "water moves from the cell (higher Ψ) to the solution (lower Ψ)".
- Mixing up chromosome and chromatid, or the chromosome-number change in mitosis: mitosis keeps the chromosome number constant; it is the chromatid number that changes through the cycle.
- Treating translocation and transpiration as the same process: transpiration is passive water movement in xylem; translocation is active loading followed by mass flow of solutes in phloem.
- Omitting units: always state units for water potential (kPa), rate calculations (e.g. $\text{cm}^3 \text{min}^{-1}$) and magnification (a ratio, so no unit).
- Assuming antibiotics work on viral infections: viruses lack the bacterial structures, such as a peptidoglycan cell wall, that antibiotics target.
- Confusing an antigen with an antibody: an antigen triggers the immune response; an antibody is produced in response to it.
- Describing a structure without linking it to function: for "describe" or "explain how X is adapted" questions, always pair the feature with its functional consequence.