Course notes

Pearson Edexcel · International A-Level · Biology

Pearson Edexcel International A-Level · Biology: teaching notes

Version: YBI11; Issue 2; first teaching 2018

These notes cover selected topics of the course; they are not the whole specification.

Assessment and course boundaries

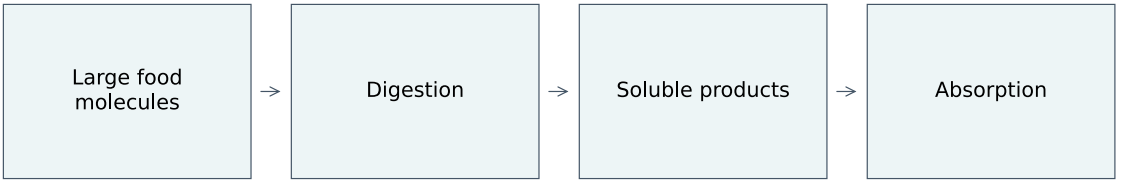
- Six separately assessed units; IAS uses Units 1–3, IAL uses Units 1–6.
- Units 3 and 6 are written practical-skills examinations based on experimental experience; they are not a Cambridge hands-on practical paper.
- Retain core-practical numbering from the specification.

Digestion, transport and health evidence

Official-unit focus: 1 Molecules, Diet, Transport and Health

Two foods can have the same mass but provide different nutrients. A health claim must distinguish the nutrient measured from the health outcome inferred.

Large insoluble food molecules are digested into smaller soluble molecules. Carbohydrases form sugars, proteases form amino acids, and lipases form fatty acids and glycerol. Bile emulsifies lipids and helps neutralize acidic stomach contents.



Absorption moves soluble products into blood or lymph. Thin exchange surfaces and a large surface area shorten diffusion paths and increase transfer. Enzyme activity and transport are different processes.

Use Benedict reagent with controlled heating for reducing sugars, iodine for starch, Biuret reagent for protein, and the ethanol emulsion test for lipids. Keep ethanol away

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from flames. Use positive and negative controls.

Checked worked case

Known: 6 of 24 study participants report a condition. Proportion = cases / total. Percentage = $6/24 \times 100 = 25\%$. The percentage describes this sample. It does not establish that one food caused the condition; confounders and how the sample was chosen matter.

Common error

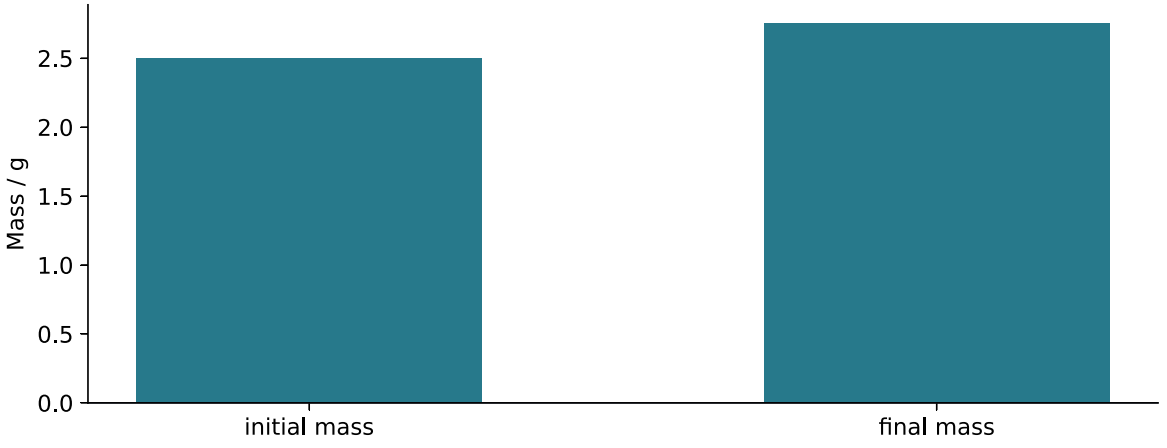
Bile is not an enzyme. A positive food test identifies a component under the test conditions; it does not show that a food is healthy or unhealthy in every diet.

Osmosis and a fair potato experiment

Official-unit focus: 1 Molecules, Diet, Transport and Health

A potato cylinder gains mass in one solution and loses mass in another. Its mass change provides evidence about movement of water, rather than movement of potato tissue.

Osmosis is the net movement of water through a partially permeable membrane from a more dilute solution to a more concentrated solution. Dissolved solutes can change the direction of net water movement.



Use percentage change to compare samples with different initial masses. A zero percentage change estimates a solution concentration with no net water movement. This is an estimate from a trend, not proof that water molecules stop moving.

Use equal-length cylinders from similar tissue, fixed solution volume, temperature and immersion time. Blot each cylinder in the same way before weighing. Repeat each concentration and plot mean percentage change against concentration.

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■ Checked worked case

Known: initial mass 2.50 g; final mass 2.75 g. Use percentage change = (final - initial) / initial × 100. Percentage change = (2.75 - 2.50) / 2.50 × 100 = +10%. A positive value means net water entry. Interpolate the concentration where the plotted trend crosses zero.

■ Common error

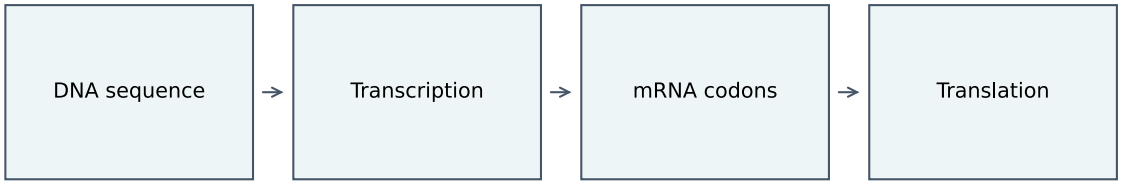
Blotting removes surface solution. Weighing a wet cylinder without blotting adds liquid that did not enter the cells. Repeats reduce random variation but do not correct a miscalibrated balance.

DNA, protein synthesis and evidence

Official-unit focus: 1 Molecules, Diet, Transport and Health; 5 Respiration, Internal Environment, Coordination and Gene Technology

A change in DNA can affect a protein, but not every DNA change changes the amino-acid sequence. The effect depends on the sequence and how it is used.

DNA stores information in a base sequence. Complementary base pairing supports copying. During gene expression, transcription makes RNA and translation uses codons to assemble an amino-acid sequence.



A codon comprises three bases. The genetic code is degenerate: more than one codon can specify the same amino acid. A substitution can therefore be silent, while insertions or deletions can shift the reading frame.

Keep DNA template, coding DNA and mRNA distinct. State the strand used and write sequences in the required direction. Use a codon table for mRNA, not an unexplained DNA triplet.

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■ Checked worked case

Known: an mRNA coding region contains 90 bases, including one stop codon. Codons = bases/3 = 90/3 = 30. A stop codon does not encode an amino acid, so the peptide contains 29 amino acids under this stated model.

■ Common error

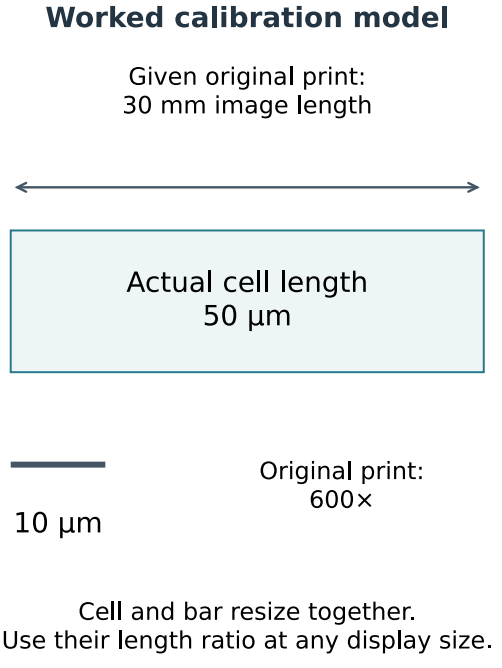
The number of bases is not automatically the number of amino acids. Real genes include regulatory regions and, in eukaryotes, often introns; a whole gene length is not a peptide-length calculation.

Cell measurements and scale

Official-unit focus: 2 Cells, Development, Biodiversity and Conservation

A cell can look larger on a screen without changing its real size. Two photographs at different zoom settings cannot be compared by eye alone.

Eukaryotic cells contain a nucleus. Prokaryotic cells have genetic material but no membrane-bound nucleus. A bacterial cell is a living cell; a virus depends on a host cell to reproduce.



A scale bar provides a known real distance in the same image. Convert the image length and real length to the same unit before dividing. Magnification is a ratio and has no unit.

Focus a prepared slide at low power first. Move to a higher power and use fine focus. Make a clear line drawing, label structures with straight lines, and record the scale

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rather than shading the image.

Checked worked case

Known: a cell image is 30 mm long and represents a 50 micrometre cell. Use magnification = image size / actual size. Convert 30 mm to 30,000 micrometres. Magnification = 30,000 / 50 = 600. A separate 10 mm scale bar representing 20 micrometres gives 10,000 / 20 = 500, and that magnification applies to every object in its image.

Common error

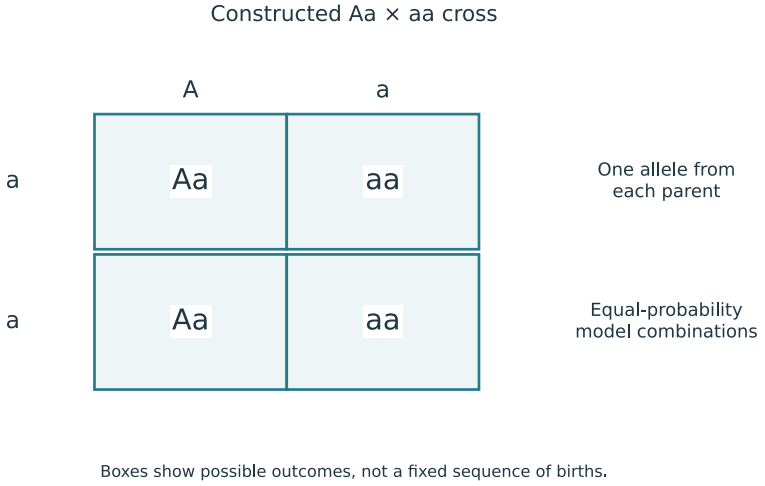
A nucleus is not the only cell structure. Do not claim bacteria have no DNA, or that more magnification always means better resolution.

Inheritance, variation and probability

Official-unit focus: 2 Cells, Development, Biodiversity and Conservation

Two parents can carry a recessive allele without expressing the associated phenotype. Their children do not have to match the parents phenotypically.

An allele is a variant of a gene. A genotype lists alleles; a phenotype is the expressed characteristic, influenced by genotype and sometimes environment. Dominant and recessive describe the relationship between alleles, not how common they are.



In a simple monohybrid cross Aa × Aa, gametes carry A or a. Combining independent gametes gives AA, Aa, Aa and aa. The predicted probabilities describe many possible fertilizations, not a fixed order of children.

Write parental genotypes and gametes before making the grid. State the inheritance model and phenotype key. Use a pedigree to check consistency with a model; do not infer certainty from a small family alone.

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■ Checked worked case

Known: Aa × Aa with complete dominance. Probability of aa = 1/4 = 25%. Probability of the dominant phenotype = 3/4 = 75%. If four children are born, there is no guarantee that exactly one has the recessive phenotype.

■ Common error

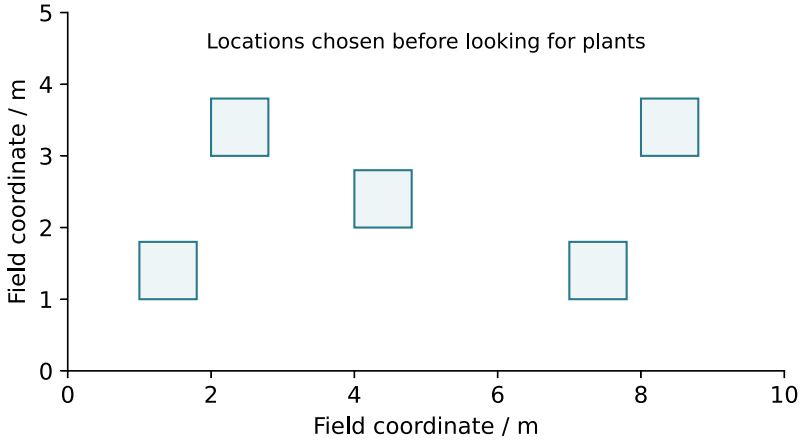
A dominant allele can be rare. Mutation is a source of new variation; selection changes the relative success of existing variants rather than directing mutations toward a goal.

Sampling populations without choosing the answer

Official-unit focus: 2 Cells, Development, Biodiversity and Conservation; 4 Energy, Environment, Microbiology and Immunity; 6 Practical Skills in Biology II

A field edge looks richer in plants than its centre. Choosing only the richest patches would build the desired result into the sampling method.

A population consists of organisms of one species in a defined area. Random quadrats estimate density without deliberately selecting patches. A transect investigates change along an environmental gradient.



Estimate total abundance by multiplying mean density by area, with consistent units. This assumes sampled areas represent the habitat. Patchiness and too few samples widen uncertainty.

Choose coordinates with random numbers before visiting the patches. Record quadrat area and counting rules. For a transect, use fixed distances and measure a relevant abiotic variable. Do not damage habitats or sample unsafe locations.

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■ Checked worked case

Known: five 0.25 square metre quadrats contain 3, 4, 6, 5 and 2 plants. Mean count = 20/5 = 4. Density = 4/0.25 = 16 plants per square metre. Estimated abundance in 100 square metres = 16 × 100 = 1,600 plants.

■ Common error

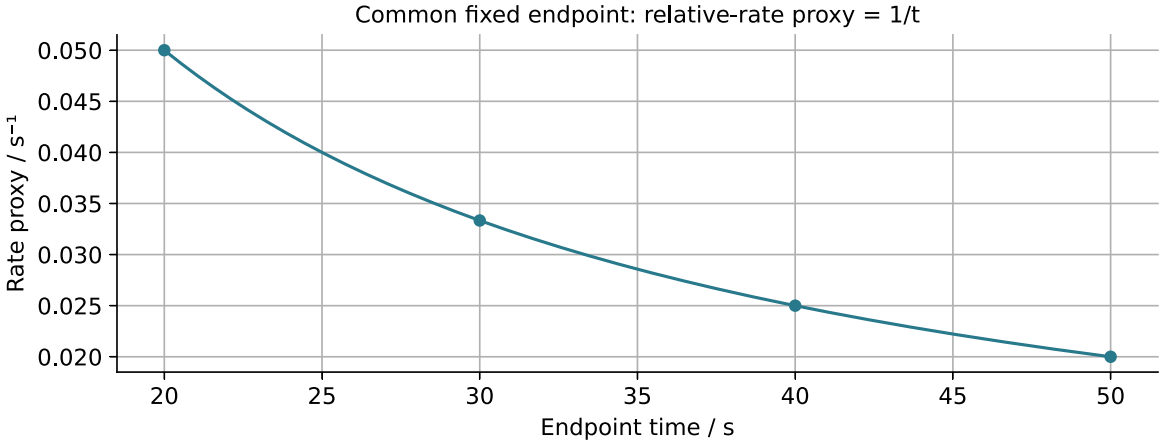
Quadrats suit organisms that do not move quickly. A food chain arrow shows the direction of energy transfer, not the direction a predator travels.

Enzyme rate and controlled measurements

Official-unit focus: 3 Practical Skills in Biology I

An enzyme works quickly at one temperature and slowly at another. Heating can increase successful collisions, but excessive heat can change the active site.

An enzyme is a biological catalyst. The substrate binds at an active site whose shape and chemical properties support the reaction. A catalyst increases rate without being used up overall.



Measure rate using product formed per unit time or a fixed endpoint. For an endpoint test, 1/time is a rate proxy if the same amount of product or substrate change defines the endpoint each time.

For starch digestion, equilibrate enzyme and starch in a water bath, control pH with buffer, mix measured volumes, and test samples with iodine at fixed intervals. Use a clean spot for each test. Do not put iodine into the reaction mixture.

■ Checked worked case

Known: the endpoint is reached in 40 s. Use rate proxy = 1/time. Rate proxy = 1/40 = 0.025 per second. At 20 s the proxy is 0.050 per second, twice as large. This comparison is valid only if the same endpoint and starting concentrations are used.

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■ Common error

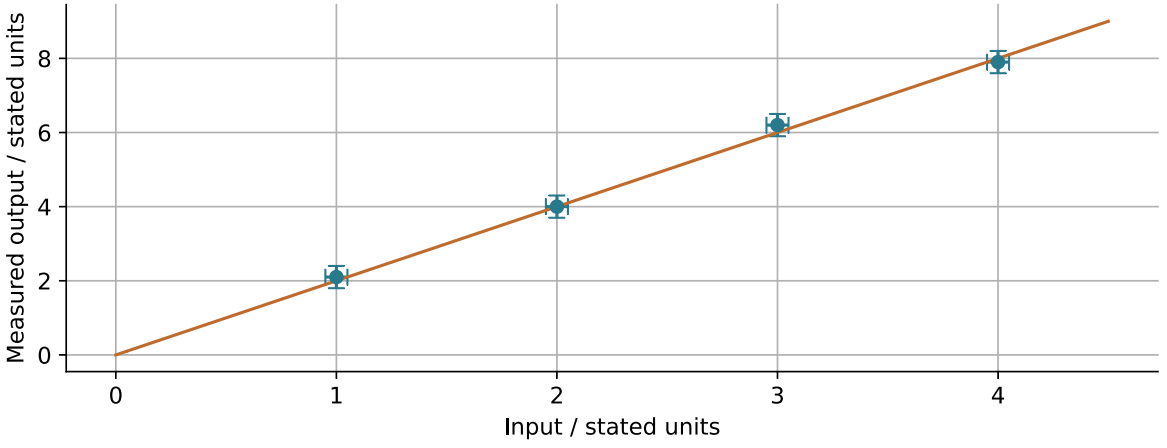
An optimum is specific to the enzyme and conditions. Low temperature usually slows the reaction; it does not necessarily denature the enzyme. Endpoint intervals limit precision.

Uncertainty, gradients and model testing

Official-unit focus: 3 Practical Skills in Biology I; 6 Practical Skills in Biology II

A line passing near every data point is useful, but its gradient can still be uncertain. A graph is evidence for a model within the measurement range.

Random variation makes repeated readings differ. Systematic error shifts results consistently. Absolute uncertainty has the measured unit; relative or percentage uncertainty compares uncertainty with the measured value.



For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation. For a difference, add absolute uncertainties. A nonzero intercept can reveal an offset or an incomplete model.

Show units on axes and choose a sensible scale. Plot uncertainty bars where justified, draw a best-fit line rather than joining every point, and estimate steepest and shallowest plausible gradients when the course method calls for them.

■ Checked worked case

Known: length = 50.0 mm with uncertainty 1.0 mm. Percentage uncertainty = absolute uncertainty/value $\times 100 = 1.0/50.0 \times 100 = 2.0\%$. For a quotient of two independently measured quantities with maximum percentage uncertainties 2% and 3%, the summed maximum estimate is 5%.

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■ Common error

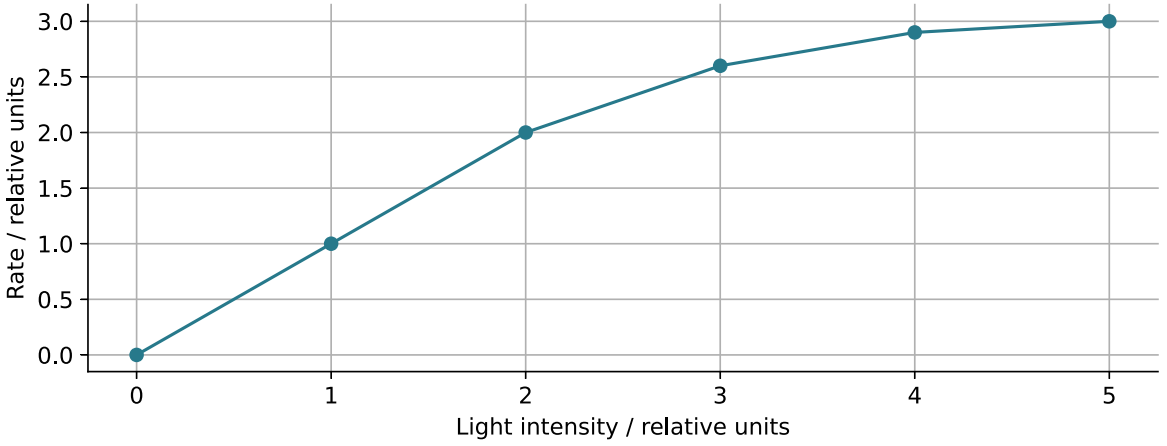
Repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error. Do not quote more decimal places than your measurement can support.

Photosynthesis and limiting factors

Official-unit focus: 4 Energy, Environment, Microbiology and Immunity

A brighter lamp does not always produce more oxygen from pondweed. Another factor may limit the process when light is already sufficient.

Photosynthesis transfers energy from light into chemical stores. Carbon dioxide and water form carbohydrate, releasing oxygen. Chlorophyll absorbs light; light intensity, temperature and carbon dioxide supply can affect rate.



Change only one factor when testing a limiting factor. At low light, extra light may increase rate. At a plateau, the changed factor is no longer the main limit in that range; the graph alone does not identify which other factor is limiting.

Measure collected gas volume over a fixed time instead of assuming all bubbles have the same volume. Control temperature, plant size and carbon dioxide supply. Allow the plant to adjust before each reading and repeat.

■ Checked worked case

Known: 6.0 cubic centimetres of gas are collected in 3.0 minutes. Use rate = volume/time. Rate = 6.0/3.0 = 2.0 cubic centimetres per minute. Bubble counts can be a rough proxy, but bubbles of different size make comparisons less reliable.

■ Common error

Moving a lamp changes light and may also change temperature. A photosynthesis experiment needs control of heating, not just a ruler.

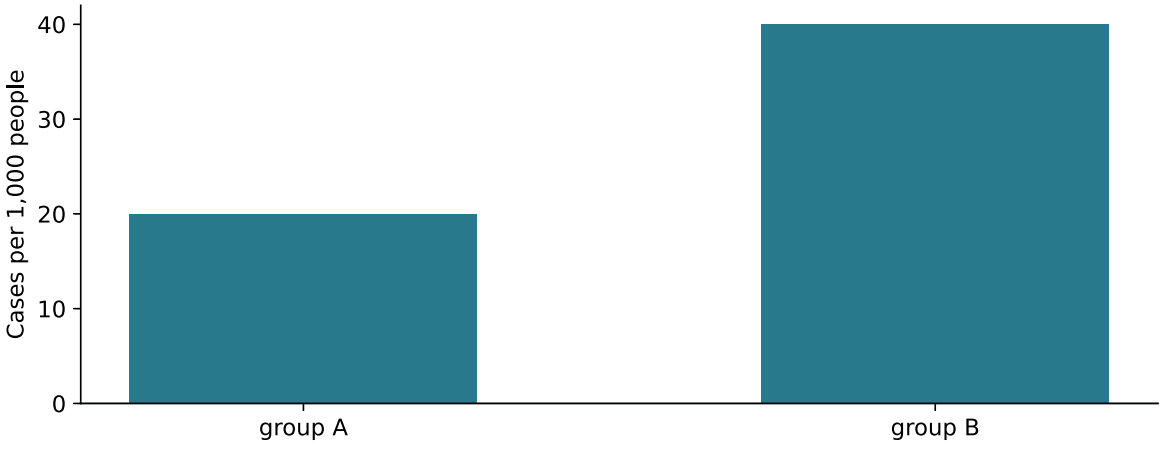
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Disease transmission and immune response

Official-unit focus: 4 Energy, Environment, Microbiology and Immunity

An antibiotic may help against a bacterial infection but fail against a viral illness. Treatment depends on the causal organism and the evidence supporting diagnosis.

Pathogens cause infectious disease. Physical barriers, phagocytosis and specific immune responses reduce infection. Antibodies bind particular antigens. Vaccination exposes the immune system to antigen safely enough to develop memory.



After vaccination, memory cells can support a faster secondary response. Antibiotic resistance arises through heritable variation and selection; an individual bacterium does not choose to become resistant because it needs to survive.

Use published infection data to compare rates per equal population size. Distinguish prevalence at a time from new cases over a period. In school, use safe simulations or approved cultures rather than collecting unknown pathogens.

■ Checked worked case

Known: 18 cases occur in 900 people. Rate per 1,000 = cases / population × 1,000. Rate = 18/900 × 1,000 = 20 cases per 1,000. A second group with 10 cases in 250 people has 40 per 1,000, even though it has fewer cases.

■ Common error

Antibiotics do not act on viruses in the same way they act on bacteria. A vaccine is not an immediate cure for an established infection.

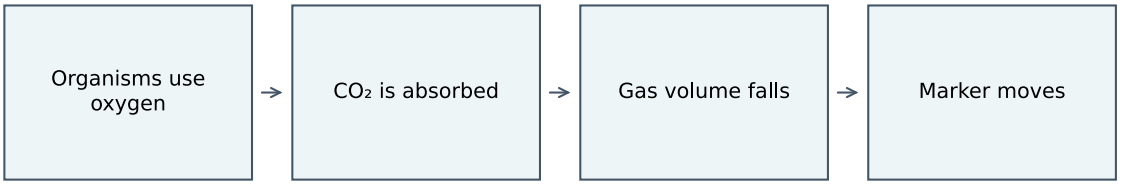
Respiration, ATP and energy transfers

Official-unit focus: 5 Respiration, Internal Environment, Coordination and Gene Technology

A muscle can use oxygen while you exercise without producing a flame. Respiration transfers energy through a controlled series of reactions.

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Aerobic respiration uses oxygen and releases carbon dioxide and water from organic substrates. Energy released can support ATP formation. ATP hydrolysis can be coupled to processes such as active transport and muscle contraction.



Anaerobic processes allow ATP production when oxygen supply cannot support the required aerobic rate, but give less ATP per glucose. In humans lactate can accumulate; yeast can produce ethanol and carbon dioxide.

A respirometer can measure oxygen uptake when carbon dioxide is absorbed. Control temperature with a water bath and use a comparison containing inert material. Keep absorbent separated from organisms and follow the school risk assessment.

■ Checked worked case

Known: oxygen uptake is 0.80 cubic centimetres in 4.0 minutes for 2.0 g of tissue. Rate per mass = volume / (time × mass). Rate = $0.80/(4.0 \times 2.0) = 0.10$ cubic centimetres per minute per gram. Normalizing allows a fairer comparison of samples of different mass.

■ Common error

Breathing ventilates the lungs; respiration consists of chemical reactions in cells. A moving respirometer marker can also reflect temperature or pressure changes.

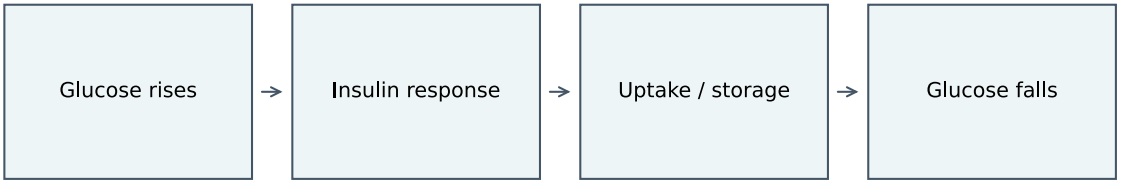
Feedback and internal conditions

Official-unit focus: 5 Respiration, Internal Environment, Coordination and Gene Technology

Blood glucose rises after a meal, but usually does not keep rising indefinitely. A control system responds to the change in internal conditions.

Homeostasis maintains internal conditions within suitable limits. Receptors detect changes, coordination centres process information, and effectors respond. Negative feedback opposes the original change.

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When blood glucose is high, insulin helps increase glucose uptake and storage as glycogen. When it is low, glucagon supports release of glucose from stores. These responses are coordinated, not identical effects of two hormones.

Interpret a time graph by identifying the initial disturbance, the response and the return toward the normal range. Mark the delay before a response. Do not assume a graph shows an instantaneous correction.

■ Checked worked case

Known: glucose changes from 5.0 to 7.0 arbitrary concentration units. Increase = final - initial. Increase = 7.0 - 5.0 = 2.0 units. Percentage increase = 2.0/5.0 × 100 = 40%. The numerical change is evidence of a disturbance, not a diagnosis on its own.

■ Common error

Negative feedback does not mean the response is harmful or the measured value becomes negative. Diabetes has different mechanisms; do not treat every case as a failure to make insulin.

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