

3 · Practical Skills in Biology I

Pearson Edexcel · International A-Level · Biology

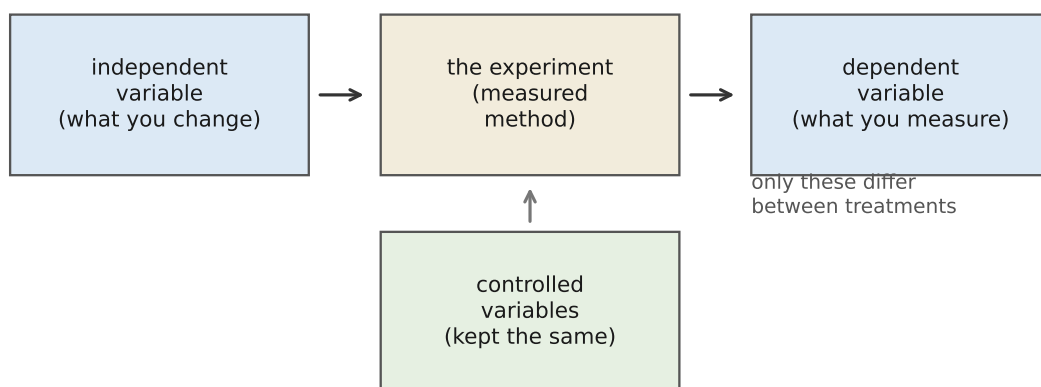
The paper that tests your hands – without your hands

You have pipetted Benedict's onto glucose, squashed a root tip, and rinsed beetroot until the water ran clear. WBI13 asks you to write about exactly that work: why each step was done, what makes it fair, how the numbers are turned into tables and graphs, and what the result honestly shows. Nothing in the paper is new theory – it is Units 1 and 2 seen through the eyes of someone who actually did the practicals.

WBI13/01 Practical Skills in Biology I is the third IAS unit: 1 hour 20 minutes, 50 marks, all compulsory, usually three long questions built on core-practical contexts. Calculators and rulers are required. The specification lists what is assessed: solving problems in practical contexts, commenting on design and methods, presenting data, evaluating results with reference to **uncertainties** and errors, identifying variables, plotting and interpreting graphs, processing data with the mathematical skills of Appendix 6, knowing the apparatus and techniques, and planning an investigation to test a **hypothesis**.

A question word to respect: *justify* – every step must be paired with the reason it makes the data valid (rinsing beetroot removes pigment from cut surfaces, so measured absorbance reflects membrane leakage, not slicing damage).

Variables and a fair test



Beetroot example: alcohol changed, pigment lost measured; temperature, size, volume, time fixed; a water-only treatment is the control.

The **independent variable** is what you deliberately change (presence or concentration of trifluralin; alcohol concentration). The **dependent variable** is what you measure (percentage of cells in each mitotic stage; absorbance of leaked pigment). Everything else that could affect the dependent variable is a **control**.

variable , kept the same with a reason: temperature, because it changes membrane fluidity and enzyme action; volume of solution, because it dilutes pigment differently. Say the variable *and* the reason – the mark scheme needs both.

A **control treatment** is a whole treatment left unchanged (solvent with no trifluralin; water instead of methanol) so that any difference can be attributed to the independent variable alone. Repeat readings give reliability, a mean, and a measure of spread; they do not remove a **systematic error** such as a balance zero error, which shifts every reading the same way.

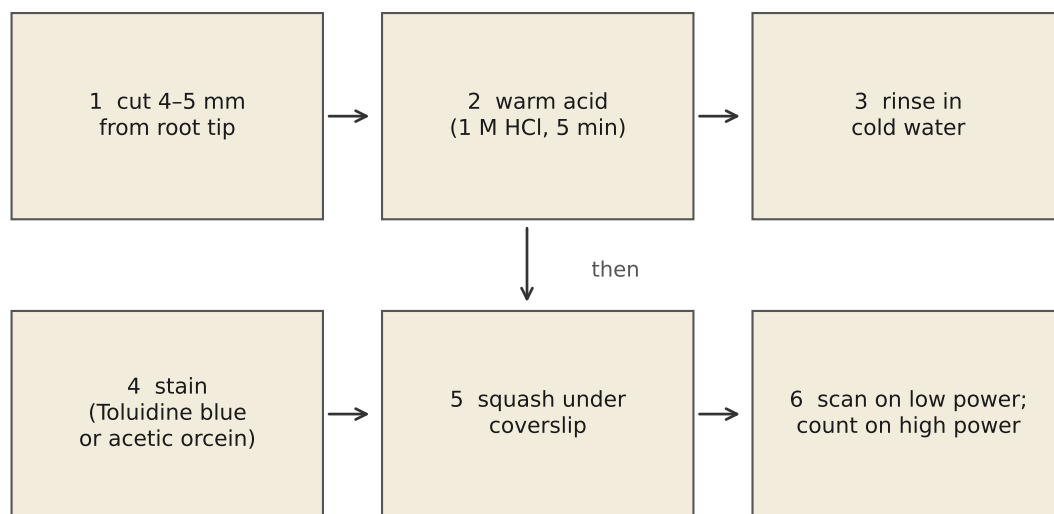
The nine IAS core practicals

The paper's contexts come from these. Know each method, its measurements and its pitfalls.

Core practical	Method core	What is measured
1 Sugar and starch concentrations	Colour standards made by serial dilution; Benedict's heated with standards and samples; iodine for starch	Colour match against standards – semi-quantitative
2 Vitamin C content	DCPIP titration: drops (or volumes) of sample that decolourise the indicator	Volume at endpoint; compare with a known ascorbic-acid standard
3 Membrane permeability	Equal beetroot pieces, rinsed, in alcohol or temperature treatments; pigment loss into the medium	Absorbance in a colorimeter (zeroed on plain solvent)
4 Enzyme rate	Substrate + enzyme at controlled pH buffer and temperature; samples tested at fixed intervals	Initial rate from time course; 1/time as a rate proxy
5 Microscopy and scale	Prepared slide, low to high power; labelled drawings; graticule calibrated against a stage micrometer	Cell dimensions, magnification, scale
6 Root-tip squash	Tip cut, warm acid, rinse, stain (Toluidine blue, acetic orcein), squash, scan and count	Cells in each mitotic stage; mitotic index

Core practical	Method core	What is measured
7 Plant sections	Plan diagrams (no cells) and cellular drawings of root, stem and leaf transverse sections	Tissue arrangement and identification
8 Fibre tensile strength	Same-length fibres hung with increasing masses until breaking	Mass at break, compared between treatments
9 Antimicrobial plants	Aseptic technique: flame loops and necks, agar plates seeded, filter-paper discs of plant extract; incubate inverted below 30 °C	Zone of inhibition around discs

For Core Practical 9, aseptic technique protects you and the culture: work near a Bunsen updraught, open plates briefly, tape (do not seal) lids, use the school-approved cultures and incubation conditions. A lower incubation temperature does not guarantee that pathogens cannot multiply.



mitotic index = cells in mitosis ÷ total cells counted

Planning an investigation

The specification's planning list is your mark scheme. A full-credit plan names: the apparatus; the independent, dependent and controlled variables (each control with its reason); how each variable is measured with the appropriate instrument and technique; whether repeats are appropriate; the safety issues and how they are dealt with; how

the data will be used (table headings planned, graph type chosen); and the sources of **uncertainty** or systematic error with how each is reduced.

Safety in biology is about the specific risk and the specific control: methanol is flammable, so keep it from flames; bacteria are cultured at low temperature so human pathogens do not grow; sharp scalpels cut away from the body.

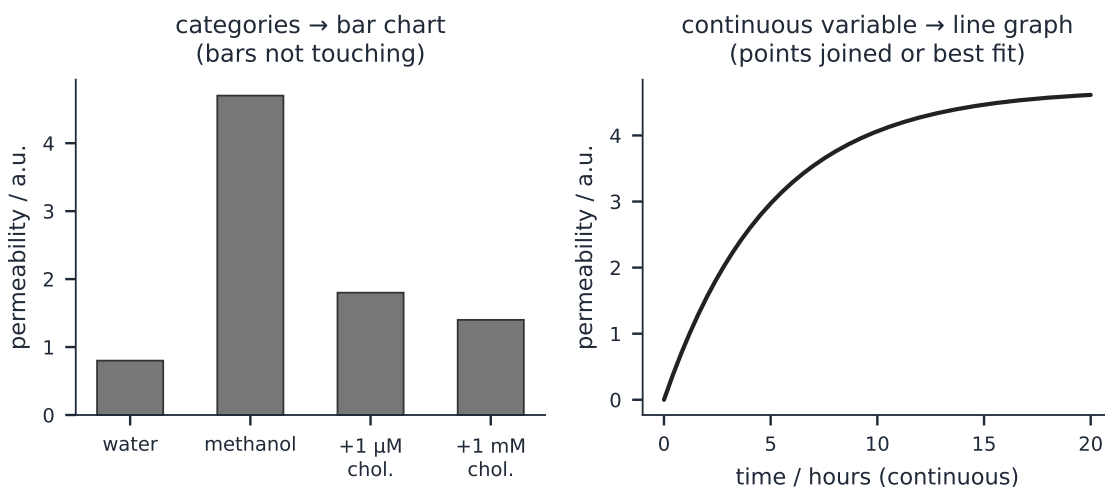
Making measurements honestly

Choose the instrument that matches the quantity: a graticule for microscope lengths, a ruler for bench lengths, a colorimeter for colour intensity, a stopwatch for time, a syringe or graduated pipette for small volumes. Quote only the figures the instrument supports: a ruler graduated in millimetres gives a length to the nearest millimetre, with an **absolute uncertainty** of $\pm$ half a division (± 0.5 mm) or $\pm$ one division by the conservative course convention – state which you use.

Percentage uncertainty = (absolute uncertainty $\div$ measurement) $\times 100\%$. For the maximum-uncertainty model used here, add percentage uncertainties for products or quotients, and absolute uncertainties for sums or differences. **Significant figures** must be justified by the measured inputs and the stated uncertainty. Both 12.67 and 12.70 have four significant figures; a trailing zero can be significant. Whether either value is correct depends on the calculation, not on the zero alone.

Presenting data: tables and graphs

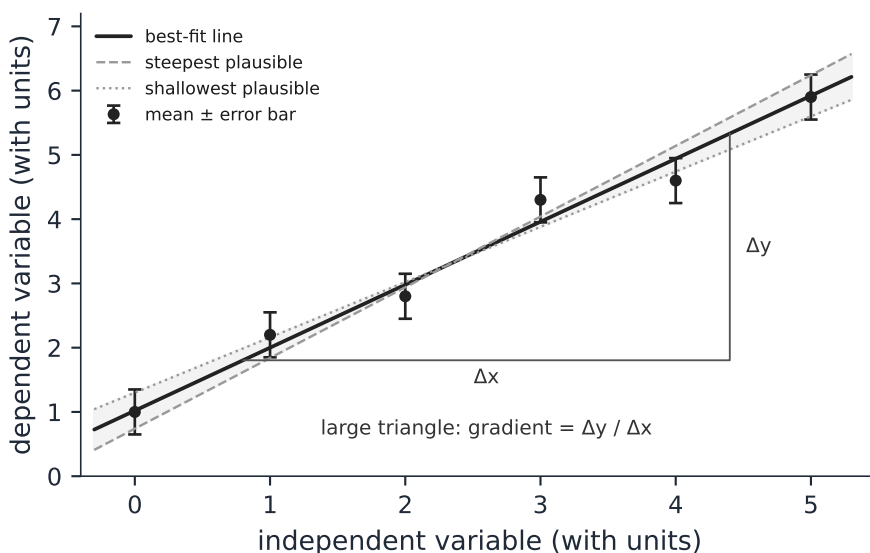
A table earns its marks by rule: each column headed with quantity *and* unit (permeability / a.u.), units never written inside cells, all data entered exactly, and no units or units-symbols invented for arbitrary instrument readings – the paper supplies a.u. (arbitrary units). Draw the table before entering values so nothing is squeezed in.



Graph rules earn marks the same way: axes labelled with quantity and unit, the independent variable on the x-axis, a scale that uses most of the grid without awkward fractions, no broken axis, points plotted with a sharp cross, and the right form – a **bar chart** for categoric treatments (bars not touching), a **line graph** for a continuous variable. A best-fit line or curve shows the trend; joining every dot claims a pattern the data may not have.

Analysing: gradients and percentages

A **gradient** comes from a large triangle drawn on the best-fit line, at least half the line's length: $\text{gradient} = \Delta y / \Delta x$, with the y-unit and x-unit divided out in the answer. Read values off the line (not a data point) when interpolating.



The percentage family recurs every year. **Percentage change:** $\frac{\text{final} - \text{initial}}{\text{initial}} \times 100\%$.

Percentage difference (the 2025 formula): $\text{difference} \div \text{mean of the two values} \times 100\%$. From a bar chart, percentage of cells in a stage $\times$ total cells = cells in that stage – 80 % of 98 cells is 78.4, which reports as **78 cells**, because 0.4 of a cell does not exist.

Worked check. Highest cassava region 33.65, lowest 29.64 g per 100 g. Difference = $33.65 - 29.64 = 4.01$. Mean = $(33.65 + 29.64) / 2 = 31.645$. Percentage difference = $4.01 \div 31.645 \times 100 = 12.67\%$ (13 % at 2 s.f., 12.7 % at 3 s.f.; 12.70 % is not the correct 4 s.f. rounding of this calculation).

Evaluating and extending

An **anomalous result** is a reading inconsistent with the others – a point far from the line – checked by repeating that treatment, not silently deleted. Improvements must be realistic and named: a colorimeter instead of colour matching (quantitative, removes judgement); zeroing on plain solvent (removes a systematic offset); more concentrations within the range tested (narrows interpolation); repeating to compute a mean and **standard deviation** (SD), standard error or range, then drawing **error bars**. To extend a study to variability between organisms, repeat on *different* individuals under the same conditions – not more measurements on the same one – then report a mean and a named measure of spread.

State the conclusion inside the measured range: a graph is evidence for the model between the first and last data points, and a zero intercept or an unexpected offset is information about the method or the model, not a nuisance.

What written practice cannot do

This unit examines written practical skills. A full-mark answer here does not show that you carried out aseptic technique cleanly, focused a microscope patiently, or squashed a root tip without smearing it – the practical experience itself is developed in class while studying Units 1 and 2, and only written evidence is assessed here. Practise the real practicals; then describe them.

Check yourself

1. In a trifluralin investigation, state the independent variable and explain why some seedlings were placed in solvent without trifluralin.
2. List, in order, the steps for preparing and examining a root-tip squash, naming one acceptable stain.
3. 98 cells are seen; 80 % are in metaphase. How many cells is that? Why is your answer a whole number?
4. Highest region 33.65 and lowest 29.64 g per 100 g of tissue. Calculate the percentage difference using the mean of the two values.
5. A student's beetroot method reads: "cut pieces, put in alcohol, measure colour." Add the three justifications the mark scheme most needs.
6. Which graph type for: (a) permeability of four named liquids; (b) permeability against time over 20 hours?
7. Explain the difference between a quantitative and a semi-quantitative result, with one example of each from the core practicals.
8. State two things repeat readings improve and one thing they cannot remove.
9. Describe how to extend a starch-variability study from one cassava root to many, naming a statistic you would report.

10. Why is 12.70 % rejected when 12.67 % is accepted, in a percentage-difference answer?

Answers: 1 presence (or concentration) of trifluralin; the solvent-only treatment is a control, so any change can be attributed to trifluralin rather than the solvent; 2 cut 4–5 mm of root tip, warm dilute acid, rinse, stain (e.g. Toluidine blue or acetic orcein), squash under a coverslip, scan then count on high power; 3 $0.80 \times 98 = 78.4 \approx 78$ cells, because a fraction of a cell cannot be observed; 4 difference 4.01, mean 31.645, $4.01/31.645 \times 100 = 12.67\%$; 5 equal-sized pieces so surface area does not change pigment loss; rinse first so absorbance reflects membrane leakage not cut damage; a named control variable with reason (e.g. temperature – it affects membrane permeability); 6 (a) bar chart, (b) line graph; 7 quantitative gives an objective measured value (DCPIP volume; colorimeter absorbance), semi-quantitative gives an estimate by judgement against standards (colour matching in Benedict's); 8 reliability and an estimate of spread (mean, SD); a systematic error such as a zero offset; 9 measure roots grown under the same conditions, repeat measurements across different roots, report the mean with SD (or standard error/range/error bars); 10 the calculated value is approximately 12.6718 %, which rounds to 12.67 % at 4 s.f.; 12.70 % also has 4 s.f. but is not the correctly rounded result. The final zero is not itself the error.