

Cambridge OCR GCSE Biology A — Biology

Topic B7

Practical skills

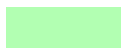
Specification J247 · Cambridge OCR

Free edition

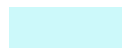
Revision notes for one topic, free to download.

These are the summary notes only. The full edition of this booklet also carries the worked examples, the required practicals and the formula sheets, with every topic in one place.

Colour Codes



Definitions



Diagrams



Notes and warnings



Sub-topic headings

This booklet is a study aid written from the published specification.
It is not affiliated with, endorsed by or approved by Cambridge OCR.

Free to download and share for personal study.
Please do not sell or republish it as your own.
For enquiries, please email pcfgyrdi@gmail.com

Define Prediction

- what you expect to happen, and why, stated before the experiment.

Define Dependent variable

- the variable you measure.

Define Control experiment

- a run with the independent variable absent, used for comparison.

Define Repeatable

- the same person, method and equipment give the same results again.

Define Resolution

- the smallest change an instrument can detect.

Define Systematic error

- an error that shifts every reading by the same amount or proportion.

Define Anomalous result

- a result that does not fit the pattern of the others.

Define Valid

- a conclusion drawn from data that actually measure what was intended, with only the independent variable changed.

Define Hypothesis

- a testable idea, based on a scientific theory, about how one variable affects another.

Define Independent variable

- the one variable you deliberately change.

Define Control variable

- a variable kept the same so that it cannot affect the result.

Define Accuracy

- how close a measurement is to the true value.

Define Precision

- how close repeated measurements are to each other.

Define Reproducible

- a different person, or different equipment, gets the same results.

Define Random error

- an unpredictable variation that differs each time a measurement is taken.

Define Zero error

- a systematic error caused by an instrument not reading zero when it should.

Define Uncertainty

- the range within which the true value is likely to lie.

Define Aseptic technique

- the methods used to prevent contamination when culturing microorganisms.

NOTE

Topic B7 is not extra content — it is how you are examined on practical work. There is no coursework. Instead, **15% of the marks** in the written papers assess practical skills, and Papers 1 and 3 (Topics B1–B3) and Papers 2 and 4 (Topics B4–B6) both include B7. You must complete a **minimum of eight practical activities**, covering **all** the apparatus and techniques listed here, and keep a **contemporaneous record** of the work and of what you learned from it. Your centre confirms this on the **NEA Centre Declaration Form practical science statement**. Centres may use OCR's suggested activities or devise their own, provided they cover the same apparatus and techniques.

B7.1 The eight Practical Activity Groups

Cambridge OCR does not set a numbered list of named required practicals. Instead it splits the Department for Education's requirements into eight **Practical Activity Groups (PAGs)**, each defined by the **apparatus and techniques** it must cover. Any activity that uses those techniques counts towards that PAG, so different schools legitimately do different experiments.

PAG	Title	OCR's example activity	Sub-topics where it appears
B1	Microscopy	Investigate different magnification techniques to draw scientific diagrams from a number of biological specimens	B1.1, B2.1, B2.2, B3.1, B4.1, B6.1, B6.3
B2	Testing for biological molecules	Test a range of foods for the presence of biological molecules	B1.2, B1.3, B3.2, B3.3
B3	Sampling techniques	Investigate the differences in habitats using ecological sampling techniques	B4.1, B6.1
B4	Rates of enzyme- controlled reactions	Investigate the factors that can affect the rate of enzyme activity	B1.2, B1.3, B1.4, B4.1
B5	Photosynthesis	Investigate the factors that can affect the rate of photosynthesis in <i>Cabomba</i>	B1.3, B1.4
B6	Physiology, responses, respiration	Investigate the effect of exercise on pulse rate, ventilation rate and recovery	B1.1–B1.4, B2.1, B2.2, B3.1–B3.3, B6.1
B7	Microbiological techniques	Investigate the effectiveness of antimicrobial agents on the growth of a bacterial lawn	B1.1, B2.1, B4.1, B6.3
B8	Transport in and out of cells	Investigate the effect of different water potentials on the length and mass of potato chips	B2.1, B2.2, B3.3

What each group involves:

- **PAG B1 Microscopy** — preparing slides, using low and high power, staining, using an eyepiece graticule or a scale bar, calculating magnification and actual size, and producing labelled scientific drawings with a stated magnification.
- **PAG B2 Testing for biological molecules** — qualitative reagents and their colour changes: iodine for starch, Benedict's for reducing sugars, biuret for protein, the ethanol emulsion test for lipids; DNA extraction; continuous sampling.
- **PAG B3 Sampling techniques** — quadrats, transects, capture–recapture, pooters, nets and keys, used in the field to investigate the **distribution and abundance** of organisms, including the **biotic and abiotic factors** that affect them.
- **PAG B4 Rates of enzyme-controlled reactions** — measuring how temperature, pH, substrate concentration or enzyme concentration change the rate, by timing to an end point or by measuring product formed, then calculating rates and plotting graphs.
- **PAG B5 Photosynthesis** — measuring the rate of photosynthesis, usually as oxygen released by pondweed or immobilised algae, and investigating light intensity, carbon dioxide concentration and temperature, including testing leaves for starch.
- **PAG B6 Physiology, responses, respiration** — safe and ethical use of living organisms to measure physiological functions and responses: pulse and ventilation rate, reaction time, reflexes, germination, respiration in yeast, plant responses.
- **PAG B7 Microbiological techniques** — culturing microorganisms using **aseptic technique**: sterilising, flaming a loop, working around a Bunsen burner, taping and inverting plates, incubating at 25 °C in school laboratories, and measuring zones of inhibition.
- **PAG B8 Transport in and out of cells** — investigating osmosis, diffusion and active transport, typically by change in mass or length of plant tissue in different concentrations, or diffusion in agar.

B7.2 Planning an experiment

1. **Start from a scientific idea.** Use a theory or explanation to develop a **hypothesis**, then a **prediction** with a reason (WS1.2a).
2. **Identify the variables.** Name the **independent**, **dependent** and **control** variables. If more than one variable changes, the result is not **valid**, because you cannot say which change caused the effect.
3. **Choose the range and interval** of the independent variable — enough values (usually at least five), spread widely enough to show a pattern, with sensible gaps.
4. **Select apparatus and techniques** suited to the measurement, with a **resolution** fine enough for the size of change expected (WS1.2c). A balance reading to 0.01 g is pointless if you cut the tissue to the nearest centimetre; a stopclock reading to 0.01 s cannot beat a human reaction time of about 0.2 s.
5. **Decide how many repeats** you will do — normally at least three at each value, so a mean can be calculated and anomalies spotted.
6. **Include a control** where one is meaningful: boiled enzyme, distilled water, a disc soaked in sterile water.
7. **Write the method as numbered steps** that someone else could follow exactly, quoting volumes, concentrations, masses, times and temperatures.
8. **Risk-assess:** name the hazard, the risk and the control measure — not simply "be careful".
9. **Sampling.** Where you cannot measure everything, apply **sampling techniques** so the sample is **representative** — random coordinates, a large enough sample, and repeats (WS1.2d).

NOTE

A common exam task is to **improve or correct a given method**. Look for: no repeats, no control, only two or three values of the independent variable, an uncontrolled variable, an instrument of the wrong resolution, and a step that cannot be timed or measured reliably. Say what is wrong, *and* what to do instead.

B7.3 Apparatus and techniques

Across your eight or more practicals you must have used **all** of the following. Numbers are those used in the DfE subject content, which OCR quotes.

1. **Use of appropriate apparatus to make and record a range of measurements accurately**, including length, area, mass, time, temperature, volume of liquids and gases, and pH — rulers, balances, stopclocks, thermometers, measuring cylinders, syringes, gas syringes, pH probes and indicators.
2. **Safe use of appropriate heating devices and techniques**, including a Bunsen burner and a water bath or electric heater — a water bath for flammable liquids such as ethanol, and for holding a steady temperature.
3. **Use of appropriate apparatus and techniques for the observation and measurement of biological changes and/or processes** — colour changes, mass or length change, gas volume, turbidity, colorimeters and data loggers.
4. **Safe and ethical use of living organisms** (plants or animals) to measure physiological functions and responses to the environment — informed consent, no distress or harm, animals returned to their habitat, and no personal data recorded.
5. **Measurement of rates of reaction by a variety of methods**, including production of gas, uptake of water and colour change of an indicator.
6. **Application of appropriate sampling techniques** to investigate the distribution and abundance of organisms in an ecosystem, by direct use in the field, including **biotic and abiotic factors**.
7. **Use of appropriate apparatus, techniques and magnification, including microscopes**, to make observations of biological specimens and produce **labelled scientific drawings**.
8. **Use of appropriate techniques and qualitative reagents to identify biological molecules and processes** in more complex and problem-solving contexts, including **continuous sampling** during an investigation.

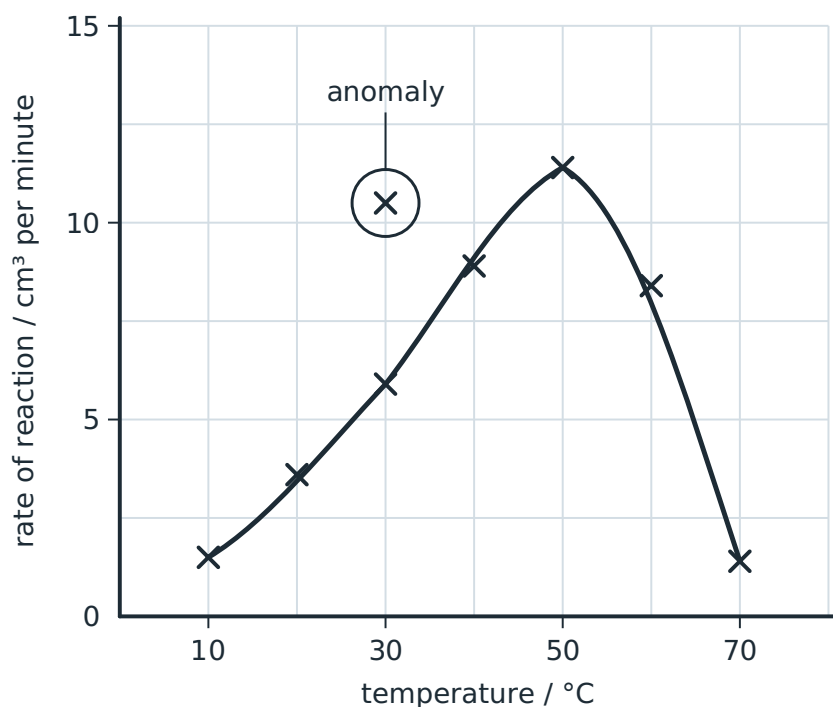
Techniques 1, 2, 3, 4, 5 and 7 may be met in any of the PAGs; technique 6 belongs to PAG B3 and technique 8 to PAG B2.

Scientific drawings are assessed and have their own rules: a sharp pencil, clear continuous unshaded lines, no sketching or crosshatching, drawn large, label lines horizontal and touching the structure, no arrowheads, and a title with the **magnification or a scale bar**. Diagrams of apparatus are drawn in section, as simple 2D outlines.

B7.4 Recording, processing and presenting data

- **Tables** are drawn **before** the experiment starts. The **independent variable goes in the first column**, then repeats, then the mean. Put the **quantity and unit in the heading** (e.g. "Time / s"), never beside each number, and give every value in a column to the **same number of decimal places**, matching the resolution of the instrument.
- **Process the data** — calculate means, rates, percentage change or percentage cover as the question requires (WS1.3c).
- **Graphs.** Independent variable on the x-axis, dependent on the y-axis. Choose scales that use **at least half the grid**, in sensible steps of 1, 2, 5 or 10. Label both axes with quantity and unit. Plot small neat crosses. Draw a **line of best fit** — straight or a smooth curve — with roughly equal numbers of points either side; **do not join the dots**, and do not force the line through the origin unless the data support it.
- **Bar charts** are for **discontinuous (categorical)** data, **histograms** for **continuous** data grouped into classes, and a **scatter diagram** to look for a **correlation** between two variables.
- **Anomalies** are circled and **excluded from the mean**, and identified on the graph — never quietly erased.
- **Significant figures.** Give a calculated answer to the same number of significant figures as the least precise measurement it came from; do not copy out every digit from the calculator.

The conventions for plotting a graph, drawing a line of best fit and marking an anomaly.



Drawing the graph

- Independent variable on the x-axis, dependent on the y-axis.
- Label both axes with the quantity and its unit.
- Choose scales that use at least half the grid, in steps of 1, 2 or 5.
- Plot small neat crosses.
- Draw a line of best fit, straight or a smooth curve — with roughly equal numbers of points either side. Do not join the dots.
- Circle any anomaly and leave it out of the line and out of the mean.
- Do not force the line through the origin unless the data support it.

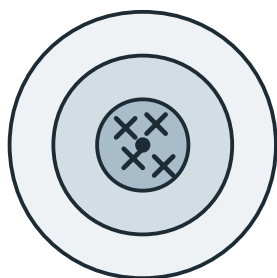
B7.5 Analysing and evaluating

- **Describe the pattern first**, using the data: state the trend, quote figures with units, and give the range over which it holds — "the rate rises from 2 cm³/min at 10 °C to a maximum of 9 cm³/min at 40 °C, then falls to zero by 60 °C".
- **Then explain it** with biology — the reason enzymes denature, or why a limiting factor produces a plateau.
- **Conclude by referring back to the hypothesis**: does the evidence support it, and how far?
- **Correlation is not cause**. A correlation supports a causal claim only if there is a **mechanism**, ideally a **dose-response** relationship, and independent studies agree.
- **Evaluate the method, not your care**. Comment on the **range and interval**, the **number of repeats**, the **resolution** of the instruments, the variables that could not be fully controlled, and whether anomalies suggest a particular step is unreliable. Then suggest a **specific** improvement and any **further investigation** (WS1.2e).
- Avoid empty evaluation such as "human error" or "I should have been more accurate". Name the measurement, say why it was unreliable, and say what you would use instead.
- **Communicate** your rationale, method, findings and conclusions clearly, in words, tables, graphs and calculations (WS1.3i, WS2d).

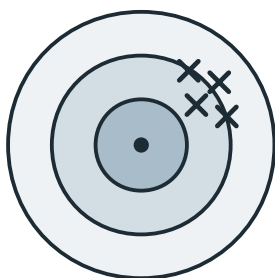
B7.6 Accuracy, precision and error

- **Accuracy** — closeness to the **true value**. Improved by using calibrated instruments and a suitable technique.
- **Precision** — closeness of **repeated readings to each other**. Improved by using instruments of finer **resolution** and a consistent method. Results can be precise but inaccurate: a balance with a 2 g zero error gives the same wrong answer every time.
- **Repeatability** — the **same** person, method and equipment give the same results on repeating.
- **Reproducibility** — a **different** person, or a different set of equipment, gets the same results. Reproducibility is stronger evidence, which is why results are published and **peer reviewed**.
- **Random error** — unpredictable scatter, differing every time: reaction time on a stopclock, judging a colour change, bubbles of unequal size, natural variation between organisms. **Reduce it by repeating and taking a mean**, and by using instruments with better resolution.
- **Systematic error** — every reading shifted the same way: a **zero error** on a balance or force meter, a badly calibrated thermometer, always reading a meniscus from above, or a stopclock started late every time. **Repeats do not remove it** — check and correct the instrument, or use a control.

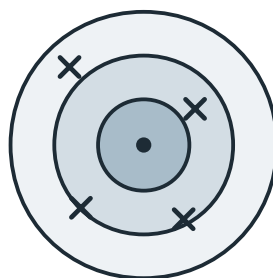
Accuracy and precision compared, and the errors that produce each pattern of results.



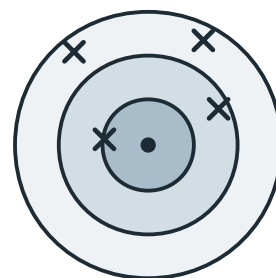
Precise and accurate
the readings agree with each other and with the true value



Precise, not accurate
the readings agree with each other but are all shifted the same way — a systematic or zero error



Accurate, not precise
widely scattered, but the mean is close to the true value — random error



Neither
scattered and shifted: random and systematic error together

Each cross is one repeat measurement; the dot at the centre of the target is the true value.

- **Uncertainty** — a measurement is only as good as the instrument's resolution, so it should be quoted with a range. Where repeats are taken, the spread of results indicates the uncertainty.

B7.7 The maths skills Cambridge OCR lists

At least **10%** of the marks in GCSE (9–1) Biology assess mathematical skills, at a level appropriate to the tier. Skills flagged for biology in the specification's own table:

Code	Skill
M1a–d	Expressions in decimal form and in standard form ; ratios, fractions and percentages ; making estimates of the results of simple calculations
M2a–c	An appropriate number of significant figures ; arithmetic means ; constructing and interpreting frequency tables and diagrams, bar charts and histograms
M2d–f	The principles of sampling as applied to scientific data; simple probability ; the terms mean, mode and median
M2g–h	Using a scatter diagram to identify a correlation between two variables; order of magnitude calculations
M3a, M3d	Using the symbols =, <, <<, >>, >, α, ~; solving simple algebraic equations
M4a–d	Translating information between graphical and numeric form; understanding that $y = mx + c$ represents a linear relationship; plotting two variables from experimental data; determining the slope and intercept of a linear graph
M5c	Calculating areas of triangles and rectangles, surface areas and volumes of cubes — and, in this course, the cross-sectional area of a colony or clear zone using πr^2
• • •	Each sub-topic in the specification also lists its own maths outcomes, coded BM1.1i , BM5.1ii and so on; these are the calculations most likely to appear in that topic's questions. Foundation Tier maths questions are no less demanding than Key Stage 3 mathematics; Higher Tier questions are no less demanding than Foundation Tier GCSE Mathematics. Units. Learn the SI base units — metre, kilogram, second, kelvin, ampere, mole — the derived units used in biology, and the prefixes tera, giga, mega, kilo, deci, centi, milli, micro and nano , and be able to interconvert them (WS1.4d–e). Most lost marks in calculations come from a missing unit or an

unconverted prefix.