Paper 3 marks microscopy, drawing and measurement; Paper 5 marks the design of an investigation and the statistics that judge it. Both are technique papers – the biology behind them is A-Level content you already have.

Microscopy and biological drawing

Focus with the low-power objective first, using the coarse focus, then move to high power and use the FINE focus only. Racking a high-power lens down with the coarse focus is how slides get broken and marks get lost.

Magnification 放大倍数 — image size ÷ actual size. Rearrange for whichever is asked, and make both sizes the same unit before dividing

Eyepiece graticule 目镜测微尺 — an arbitrary scale that must be calibrated against a stage micrometer AT EACH objective – the calibration changes when the magnification does

1 mm = 1000 µm = 1 000 000 nm. Most lost magnification marks are unit conversions, not arithmetic.

A plan diagram shows TISSUE BLOCKS with no individual cells; a high-power drawing shows a few cells in detail. Drawing cells on a plan diagram is a standard way to lose the mark.

Drawing rules, all separately credited: sharp pencil, single continuous unbroken lines, no shading, no sketching, occupying at least half the space given, label lines ruled and not crossing, labels written horizontally outside the drawing.

Include a magnification or a scale bar when the question asks, and give the drawing a title naming the specimen and the section (T.S. or L.S.).

Designing an investigation

State the independent variable with the range and interval you would use, the dependent variable with how it is measured, and at least three controlled variables with how each is controlled.

Control experiment 对照实验 — an identical run with the factor under test removed – it shows the effect is caused by that factor and not by the procedure. A control is not the same thing as a controlled variable

Say how many replicates and why: repeats let you calculate a mean and a measure of spread, which is what makes a difference judgeable.

For enzyme work, buffer the pH and use a water bath for temperature; state both, because leaving either uncontrolled invalidates the result.

Where the measurement is a colour change, standardise it – a colorimeter reading, or a printed colour standard, rather than 'until it looks the same'.

Ethical and safety points must be specific: eye protection with hot water baths, care with sharp scalpels cutting away from the hand, and for any work with animals a statement about minimising harm.

Handling and presenting data

Table headings carry the quantity and unit as a ratio: time / min, mass / g, rate / $mm^3\ s^{-1}$.

Raw data columns keep the precision of the instrument; calculated columns are rounded consistently.

A bar chart is for discrete or categoric data with gaps between bars; a histogram is for continuous data with no gaps; a line graph is for two continuous variables. Choosing the wrong one costs the mark before the data is even read.

Plot the independent variable on the x-axis, label both axes with quantity and unit, use over half the grid, plot as small crosses and draw the line the data supports.

Percentage change 百分比变化 — (final − initial) ÷ initial × 100. Use the INITIAL value as the denominator, and keep the sign – a negative change is a decrease and the sign is part of the answer

Rate 速率 — change ÷ time, with the unit built from the two: 'cm^3 of oxygen per minute'. From a curve, the rate at a point is the gradient of the tangent there

Standard deviation measures the spread of the data; standard error measures the reliability of the MEAN. Error bars of ±2 standard errors that do not overlap suggest a significant difference – and that is a suggestion, not a conclusion.

Statistics – choosing and using the right test

t-test t 检验 — compares the MEANS of two samples of continuous, normally distributed data

Chi-squared test 卡方检验 — compares OBSERVED counts with counts EXPECTED from a hypothesis – genetics ratios, distribution categories. It works on frequencies, never on percentages or means

Correlation coefficient 相关系数 — Pearson's for a linear relationship between two normally distributed variables; Spearman's rank when the data are ranked or not normal. Correlation is not causation, and saying so is worth a mark

Always state the null hypothesis: 'there is no significant difference between ⋯'. The test is performed on the null hypothesis, and answers that omit it lose marks even when the arithmetic is right.

Degrees of freedom for chi-squared is (number of categories − 1); for an unpaired t-test it is $(n + n - 2)$.

Compare your calculated value with the critical value at $p = 0.05$. If calculated exceeds critical, reject the null hypothesis – the difference is significant and there is less than a 5% probability it is due to chance.

Write the conclusion in full: reject or accept the null hypothesis, at what probability level, and what that means biologically. A bare 'significant' is half an answer.

Recurring errors

Confusing a control experiment with a controlled variable – they are different marks and examiners report this every session.

Quoting a magnification without a unit conversion, so the answer is out by a factor of a thousand.

Shading or sketching a biological drawing, which is explicitly penalised.

Running a chi-squared test on percentages. It requires raw counts.

Concluding causation from a correlation.

Describing an anomaly as ‘human error’ rather than naming the step where the error occurs and what it does to the reading.