

AQA A-Level Biology – How Science Works Glossary

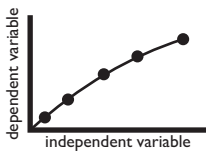
Types of Variable

Dependent Variable

The variable you *measure*, to see how it is affected by the independent variable.

Independent Variable

The variable you *choose to change*, to see how it affects the dependent variable. You may also measure it when you change it.



Confounding Variables

Any variables that could also affect the dependent variable. Confounding variables should be controlled in a fair test.

Control variables

Confounding variables that are kept constant (controlled) during the experiment. If you can't control a variable (such as weather in a field investigation), you should at least monitor it.

Experimental Design

Controlled Experiment (Fair Test)

When all relevant variables are controlled, so that observed changes in the dependent variable must be due to changes in the independent variable.

Control Experiment (Control)

An additional experiment designed to eliminate alternative explanations for the main experiment and so show that observed changes in the dependent variable must be due only to changes in the independent variable.

Control Group

A group or sample treated in the same way as the experimental group, except for the factor being investigated e.g. a placebo group in a drugs trial. By comparing the results for two groups it can be shown that observed changes in the dependent variable must be due only to changes in the independent variable.

Placebo

A dummy pill, injection or treatment that has no physiological effect (e.g. a sugar pill or saline injection). Used in a clinical trial to allow for the **placebo effect** - the observation that symptoms can improve when patients believe they are being helped.

RCT

The best experimental design for a drug trial. RCT stands for Randomised Controlled Trial, or in more detail, a Randomised, Placebo-Controlled, Double-blind Trial. This design ensures that the trial is **valid** free from **bias**.

- **Randomised** means the study and control groups are allocated randomly
- **Placebo-controlled** means the study group (taking the drug to be tested) is compared to a placebo group (who are given a placebo).
- **Double-blind** means that neither the subjects nor the investigators know who is in the study or placebo groups. This avoids bias.

Protocol

A method or technique that has been shown to produce valid and reliable results.

Hypothesis

A suggested explanation of observations or results that can be tested. Also known as a scientific hypothesis. A good hypothesis can be used to make **predictions**.

Quality of Data

True Value

The real value of a measurement, if it could be measured with no errors at all.

Precise Data

1. Measurements that give similar values when repeated. The replicates therefore have a small **range**.
2. Data measured on sensitive equipment with a suitably fine scale, e.g. 20 mm is more precise than 2 cm.

Reliable Data

Findings that can be repeated. This includes by the original investigator; by other scientists; by other techniques; or those that agree with secondary sources.

Accurate Data

Measurement that are close to the **true value**.

Valid Data

The best quality data, i.e. data that is **precise** and **reliable** and obtained from an **unbiased, controlled** experiment that addresses the stated aim. Valid data is assumed to be accurate.

Evidence

Any data or observations that are used to support a particular hypothesis.

Anecdote

An observation or story from real life. Anecdotes are not evidence and cannot be used to support a hypothesis, but they can be useful to suggest a new testable hypothesis.

Types of Data

Data

(measurements, singular datum)

Quantitative or Numeric Data (numbers)

Continuous Data

can have any value
e.g. 7.34, -294.6, 2×10^5

Discrete Data

only whole numbers
e.g. no. of atoms

Qualitative or Categorical Data (words)

Ordered Data

can be ranked
e.g. small, medium, large

Nominal Data

can't be ranked
e.g. male, female

Errors

Random Errors

Inaccuracies due to mistakes, poor technique, or random variation. Random errors are very common, but can be improved by taking many replicates. Data with a small random error is said to be **precise**.

Systematic Errors

Inaccurate measurements in one direction only, due to poor **calibration** or poor technique. Systematic errors can **not** be improved by taking more replicates. Data with a small systematic error is said to be **reliable**.

Zero Error

A particular kind of systematic error, where the instrument does not return to zero.

Bias

When the observer chooses some results and ignores others, to support a particular view. Also called **cherry picking**.

Anomaly or Outlier

A measurement that falls far outside the expected range and is therefore probably due to experimental error. Anomalies should be rejected, since they skew the mean, but it is very difficult to distinguish between anomalies and normal biological variation.

Calibration

Ensuring that a measuring instrument gives correct readings by fixing known points then construction a scale between them.

Simple Analysis

Replicates

Repeats of a measurement.

Raw Data

The original measurements or recordings before any manipulation or processing.

Mean or Average

The mid-point of the replicates.
$$= \frac{\text{sum of replicates}}{N}$$

Range

The highest and lowest replicates, or the interval between them.

Standard Deviation (SD)

A measure of the dispersal of the replicates about the mean. In a normal distribution 68% of the replicates will be within 1 standard deviation of the mean, and 95% will be within 2 standard deviations of the mean.

Standard Error of the mean (SEM)*

A measure of the uncertainty, or error, of a calculated mean. The smaller the standard error, the more reliable the mean.

95% Confidence Interval (CI)*

Another measure of the error of the mean. We can be 95% confident that the true mean lies in the range (mean \pm CI). The top and bottom of this range are called the **confidence limits**.

Statistical Analysis

Correlation (or Association)

When one variable changes with another variable, so there is a relation between them. However it may not be a **causal relation**. The strength of a correlation can be measured using the Pearson or Spearman test.

Causal Relation

When changes in one variable cause the changes in another variable. Can only be shown by a controlled experiment.

Statistical Test*

Something that tests whether observed differences or associations are significant, or just due to chance.

Null Hypothesis*

The statement that is tested by a statistical test. The null hypothesis is fixed for each test, but always says that there is no difference or no association. The null hypothesis has nothing to do with a scientific hypothesis.

P-value*

The result of a stats test, expressed as a probability. It is effectively the probability that the null hypothesis is true. If $P < 0.05$ then we reject the null hypothesis, otherwise we accept it.