AP Biology

Practical Skills · 实验技能

AP Biology asks you to design and interpret investigations, not to recall a protocol. Nearly all of the marks below come from four habits: naming the independent and dependent variable, saying what is held constant, quoting data with units, and stating whether a difference is statistically significant. 生物实验题考的是设计与分析: 变量、对照、数据引用与显著性判断。

Designing an investigation

Name the independent variable, the dependent variable and at least two controlled variables. A question that says "design an experiment" awards a point for each, and they are the cheapest marks on the paper.

Describe the CONTROL GROUP, not just "a control". It must be identical in every way except the independent variable – say so explicitly.

State how the dependent variable will be MEASURED, with units. "Measure growth" scores nothing; "measure height in mm every 24 hours" earns the point.

Include replication and say why: repeated trials reduce the effect of random error and let you calculate a mean.

Predict the result in the form "if … then … because …", and make the reasoning biological rather than a restatement of the prediction.

Handling data

Quote data when you are asked to justify a claim: cite the actual numbers and units from the table or graph, not "the graph goes up".

Read error bars correctly. Overlapping error bars mean the difference is probably NOT significant; non-overlapping bars support a real difference.

Standard error decreases as sample size increases – that is why more trials give a stronger conclusion.

Plot the independent variable on the x-axis and the dependent on the y-axis, label both with units, and use a scale that fills the grid.

Do not draw a line of best fit through data that show no trend, and never extrapolate beyond the range you measured.

Statistics on the formula sheet

Chi-square test 卡方检验 — compares observed with expected counts; calculate $\chi^2 = \Sigma(\text{observed} - \text{expected})^2/\text{expected}$ and compare it with the critical value at the correct degrees of freedom

Degrees of freedom 自由度 — the number of categories minus one – a common lost mark is using the sample size instead

Null hypothesis 零假设 — the statement that any difference between observed and expected results is due to chance alone

p = 0.05 显著性水平 0.05 — the threshold used in this course; if χ^2 exceeds the critical value, reject the null hypothesis and call the difference significant

Standard error 标准误 — an estimate of how far a sample mean is likely to lie from the true population mean; plotted as error bars

The investigations you must be able to reason about

Diffusion and osmosis: use percent change in mass, not raw mass, so that dialysis bags or potato cores of different starting size can be compared.

Enzyme catalysis: rate is measured as product formed per unit time; identify whether the limiting factor is substrate concentration, temperature or pH.

Photosynthesis (floating disk): the rate measure is the time for half the disks to rise, and the control is disks in water without bicarbonate.

Cellular respiration (respirometer): the control vial with no organism corrects for changes in temperature and air pressure – say what it corrects FOR.

Transpiration: relate the rate to the environmental variable through stomatal opening, not simply to "more water lost".

Population genetics: use Hardy-Weinberg only after stating that its five conditions are assumed, and remember $p + q = 1$ while $p^2 + 2pq + q^2 = 1$.