At A Level the marks move from recall to reasoning and arithmetic: magnification and scale bars, water potential, statistics, and the multi-step explanations examiners break into separate marking points. These are those tasks written out in full – the working visible, the units carried, the reasoning in the order the mark scheme reads it. 这里把计算与长答题的每一步都写出来。

Scale, magnification and units

An electron micrograph has a scale bar labelled 2 µm which measures 25 mm on the page. A mitochondrion on the same micrograph is 40 mm long. Calculate its actual length in micrometres. [3]

First find the magnification from the scale bar. Convert to one unit: 2 μm = 0.002 mm, so magnification $= \dfrac{25}{0.002} = 12\,500$. Then the mitochondrion: actual length $= \dfrac{40}{12\,500} = 0.0032$ mm $= 3.2$ μm.

Use the scale bar to get the magnification FIRST. Trying to scale the organelle directly against the bar in one step works but hides the method, and the method carries two of the three marks.

1 mm = 1000 µm and 1 µm = 1000 nm. Most lost marks here are conversions, not biology.

A student measures a cell as 62 µm across using an eyepiece graticule calibrated so that one division is 4.0 µm at ×400. State how many divisions the cell spans and give the answer to an appropriate number of significant figures. [2]

Divisions $= \dfrac{62}{4.0} = 15.5$, so the cell spans about 15.5 divisions. The calibration is given to two significant figures, so the answer should be quoted to two: 16 divisions (or 15.5 if half-divisions can be read).

Significant figures follow the LEAST precise measurement used. Quoting more figures than the data supports is penalised in the practical papers.

Water potential and transport

Explain, in terms of water potential, what happens to a plant cell placed in a concentrated sucrose solution. [4]

The external solution has a lower (more negative) water potential than the cell sap. Water therefore moves out of the cell down the water potential gradient, by osmosis across the partially permeable cell surface membrane. The protoplast shrinks and pulls away from the cell wall, so the cell becomes plasmolysed; its pressure potential falls to zero, and the cell is flaccid.

Water potential is NEGATIVE – 'lower' means more negative. Writing 'higher water potential outside' reverses the answer and loses every mark.

$\Psi = \Psi_s + \Psi_p$. Naming the pressure potential falling to zero is a distinct mark from naming plasmolysis.

A solution has a solute potential of −450 kPa and a cell in it has a pressure potential of +200 kPa and a solute potential of −800 kPa. Determine the direction of net water movement. [3]

Cell water potential $\Psi = \Psi_s + \Psi_p = -800 + 200 = -600$ kPa. The external solution is open, so its pressure potential is zero and its water potential is −450 kPa. Since −450 is higher (less negative) than −600, water moves from the solution INTO the cell, down the water potential gradient.

Compute both water potentials before comparing. Comparing a solute potential with a water potential is the standard trap here.

Say which way and why: 'down the water potential gradient' is the reasoning mark.

Statistics and experimental design

A student counts stomata in 10 fields of view and obtains a mean of 24.6 with a standard deviation of 3.2. Explain what the standard deviation tells the student, and state one advantage of also calculating standard error. [3]

The standard deviation measures the spread of the individual counts about the mean: a value of 3.2 means most fields lie roughly within 3.2 stomata of 24.6, so the data are fairly consistent. The standard error estimates how precisely the sample mean represents the true population mean, and it allows error bars to be drawn: if the error bars of two means do not overlap, the difference between them is likely to be significant.

Standard deviation describes the DATA; standard error describes the reliability of the MEAN. Confusing them costs both marks.

The non-overlapping error bars point is what the mark scheme rewards on the 'why calculate it' part.

State the null hypothesis for a chi-squared test on the offspring of a dihybrid cross, and state how the calculated value is used to reach a conclusion. [3]

The null hypothesis is that there is no significant difference between the observed and the expected numbers of offspring, and that any difference is due to chance. Compare the calculated χ^2 with the critical value at $p = 0.05$ for the correct number of degrees of freedom. If the calculated value is greater than the critical value, reject the null hypothesis: the difference is significant. If it is less, there is no significant difference and the null hypothesis is retained.

Degrees of freedom = number of classes − 1; for a 9:3:3:1 cross that is 3. Using the wrong value changes the critical value and the conclusion.

'Reject the null hypothesis' must be stated in those words – a conclusion in ordinary language alone does not earn the statistical mark.

Extended explanation

Explain how the structure of a red blood cell adapts it to its function. [4]

It is a biconcave disc, which gives a large surface area to volume ratio for rapid diffusion of oxygen. It has no nucleus and no mitochondria, so there is more room for haemoglobin and it does not consume the oxygen it carries. It is small, about 7 µm across, so it can pass through the narrowest capillaries. Its membrane is flexible, so it can deform to squeeze through vessels narrower than itself.

Every mark is a PAIR: a structural feature and the functional consequence. A list of features with no consequences scores nothing beyond the first mark.

Explain how a change in one DNA base can have no effect on the protein produced. [3]

The genetic code is degenerate: most amino acids are coded for by more than one triplet. If the substitution changes the triplet to another one coding for the SAME amino acid, the primary structure of the polypeptide is unchanged. The protein therefore folds identically, so its tertiary structure and its function are unaffected.

Name degeneracy explicitly. 'The code has spares' does not earn the term mark.

Substitution only – an insertion or deletion causes a frameshift, and saying so shows the contrast the examiner is looking for.