InkBiology

ANSWER BOOK

Variables and controls: what an experiment can show

Scientific method and quantitative biology · Unit B00

AQA Practical skills PS 1.1-1.2, 2.1-2.4, 3.1-3.3 · OCR A Module 1.1.1-1.1.3
Edexcel A Working as a biologist; core practical requirements
CAIE Paper 3 and Paper 5 (planning, analysis and evaluation)

5 questions · 18 marks

NAVY EDITION

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SECTION A · Short, 1 to 2 marks

A1 **B1** a negative control, in which the factor being tested has been removed or destroyed, rules out a false positive: an effect produced by the apparatus, the solvent or the handling rather than by the factor. **B1** a positive control, using something already known to produce the effect, rules out a false negative: a method that failed, so that flat readings mean nothing. [2]

SECTION B · Standard, 3 to 5 marks

B1 **B1** temperature is a confounding variable here: a filament lamp is mostly a heater, so bringing it closer raises the temperature of the water as well as the light intensity. **B1** either the light or the warmth could have raised oxygen production, and the readings collected cannot separate the two effects. **B1** every repeat changes both quantities together in exactly the same way, so more repeats trace the same two routes again rather than telling them apart. **B1** repeats improve precision, not validity; the fix is a change of design, such as a water-filled flask acting as a heat filter or an LED source, with the temperature measured at each distance to show it stayed put. [4]

B2 **B1** accuracy is closeness to the true value, whereas precision is how closely repeat readings agree with one another. **B1** a random error such as misjudging a meniscus scatters readings either side of the true value and damages precision, whereas a systematic error such as an unzeroed balance shifts every reading the same way and damages accuracy. **B1** readings can therefore be precise and inaccurate at the same time, which is why agreement between repeats is no evidence at all of being right. **B1** repeatability is the same person getting the same results with the same method and apparatus, whereas reproducibility is somebody else, or different apparatus or a different method, getting them. [4]

B3 **B1** a negative control: a disc soaked in the solvent the extracts were made up in, and nothing else. **B1** if that disc produces a zone, the solvent was killing the bacteria and any zone around an extract could not be credited to the seaweed. **B1** a positive control: a disc carrying an antibiotic the bacterium is known to be sensitive to. **B1** a zone around it shows the bacteria were alive, the plate was seeded properly and a zone would have been visible had there been one to see; with no zone anywhere the honest conclusion is that the investigation failed, not that the extracts have no effect. [4]

B4 **B1** the study is observational rather than experimental: nobody set how much fish each person ate, so the groups differ in many ways at once and the correlation is consistent with the conclusion without establishing it. **B1** a common cause is the obvious alternative, since people who can afford oily fish and cook at home also tend to differ in income, exercise and smoking, any of which could lower heart attack rate on its own. **B1** reverse causation deserves a sentence: people already diagnosed with heart disease may have been told to change their diet, which would put the arrow the other way round. **B1** the argument the paper needs is a stack of separate points: a mechanism, a dose response, survival of adjustment for the known confounders and repetition elsewhere. On this evidence alone the causal claim is not yet supported. [4]