**A Reminder…a good conclusion and evaluation section for a Biology IA**

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**Abstract:**

Keywords are explained.

A conclusion explains what you have found out.

An evaluation explains all the niggling doubts you have about the data, suggests ways to fix them, and goes into the interesting theoretical ramifications of your findings and observations – including linking with other published research.

**Keywords:**

**Accurate:** Data is close to the ‘true value’

**Reliable:** Data is re-producible, in that the various trials were similar to each other

**Instrument Precision / precision** : the instrument used generated data to a high specifity eg. Three decimal places

**Uncertainty:** the degree by which a measurement may be innacurate, based on the limitations of the instrument precision eg. +-0.5ml means that a reading of 12ml could actually be anywhere from 11.5ml to 12.5ml

**Correlation:** Showing a pattern such that as the independent variable increases, the dependent variable increases also (positive correlation); or as the independent variable increases, the dependent variable decreases (negarive correlation)

**Variability:** the amount of fluctuations in the data (so highly variable data is not very reliable ie. The different trials are very different to each other)

**Variant:** A run of the experiment where the independent variable has changed.

**Trial:** A repeat of the same variant

**Golden rule of data collection:**

5 variants with 5 trials each, or 25 individuals = enough data by IB standards.

**Conclusion:**

-Makes direct reference to the research question

-There are four options: 1) the data supports the hypothesis

 2) the data does not support the hypothesis

 3) the data doesn’t offer any evidence in support or against

 4) some of the data supports the hypothesis, but not all of it. Or

 the data supports part of the hypothesis, but not all of it.

-The research question and aim are re-visited, and linked to the overall findings

**Evaluation:**

-The strengths of the investigation should be summarized (eg. The data showed high reliability, the method worked smoothly and did not generate procedural difficulties).

-The degree of confidence in the conclusion should be expressed (eg. There are many factors which limit my confidence in the conclusion reached, such as sources of error)

-This leads to an explanation of why the level of confidence is as stated (which may be highly confident or otherwise)

-Sources of error, are factors which may cause the individual data readings to be inaccurate. These may be human (eg. Not noticing a colour change in time), instrumental (eg. Data drifting on a pH meter) or procedural (the method has a time-delay in it which is not consistent).

-Sources of error may cause systematic error (affects the data points by the same amount, eg. The pH meter measured everything at +2 from what it really was) or random (in that they affected every data point differently and cannot be adjusted for.

-What effect do you think the sources of error had on your data, did it affect the accuracy or relability?

-How could you overcome these difficulties, by modifying the procedure or instruments used?

-Consider the instrument precision and uncertainty. Is the uncertainty high relative to the change you are observing? Does that affect you confidence. (eg. If the difference between trial 1 and 2 is 1g, and the uncertainty is +-1g, this undermines your confidence that there is any significant difference).

-Was the amount of data sufficient to make a statistically significant claim. If not, what happened and how would you take steps to avoid this issue in future (eg. The procedure followed took too long to generate results, etc.)

-If the uncertainty was uncomfortably high, does this mean that you could have used a measuring instrument with greater precision? Or is this not necessary.

-How does your scientific findings fit in with the research of other scientists. Does it agree / disagree, or help to fill in a gap in knowledge? Are there any theoretical issues to discuss, for example does your data fly in the face of accepted wisdom? Did your data suggest any new interesting scientific ideas, or could it provoke discovery? (note, use the appropriate scientific language here specific to the area of biology you are covering).

-Are there any unexplained interesting observations that you would like to discuss (don’t be afraid to use qualitative data here).

-What would you want to do next, as a possible extension of your work. This must be connected to the discussion of your findings (eg. I discovered that the photosynthetic pigment profiles of plants varies according to the presence of calcium in the soil, but to be more sure I would want to use the same method to test the effect of varying calcium soil levels over a wider range of values, to see if the trend which I identified is still supported.

-Are there any unforeseen safety or ethical issues associated with your data collection. How could these be repaired or avoided? Are the paradoxes or difficulties in dealing with these ethical dilemmas (eg. My data suggested that hygiene products sold by a particular company do not do what they claim to do – is it right to inform people, or is it right to approach the company requesting clarification of their claims).