

Recommendations from IB:

May 2019–

- Original and Inventive investigations. Reliance on classic investigations, some of which are prescribed in the core of the programme, with little or no attempt to modify impacts Personal Engagement.
- Investigations should be of appropriate level for the IB biology course with focus on biological content than other realms.

○

- The following guidelines should be applied:

Only culture known non-pathogenic strains of microbes. For example, do not culture from hands or swabs of door handles.

Do not test for antibiotic resistance. There are enough antibiotic resistant strains circulating in the environment without more being selected for.

Apply strict rules of hygiene and aseptic techniques.

Do not culture microbes at 37°C. Incubation should be carried out below 30°C.

Always label cultured plates so they can be clearly identified and never open them for inspection.

Tape the lids on but do not tape all the way round a Petri dish. Taping all around the dish encourages anaerobic conditions that are best avoided.

Never assume that what is growing in the culture is the strain that was inoculated, even if non- pathogenic strains have been used.

Always sterilize used cultures and dispose of the cultures using local health and safety regulations.

Milk is a body fluid and, as such, needs to be treated with precaution. Milk from other animals should be processed so it is fit for human consumption then it would be considered safe for use in the lab. Human milk, if it is obtained commercially, should also be safe.

- **Personal engagement**– Assessed holistically. PE could be reflected in the following:
 - ☐ A statement of purpose
 - ☐ There is a relationship with the real world
 - ☐ The originality of the design of the method(choice of materials and methods)
 - ☐ Evidence of trial runs
 - ☐ The difficulty of collecting data(evidence of tenacity)
 - ☐ The quality of the observations made
 - ☐ The care in the selection of techniques to process the data
 - ☐ There is a reflection on the quality of the data
 - ☐ The type of material referred to in the background or in the discussion of the results
 - ☐ The depth of understanding of the limitations in the investigation
 - ☐ The reflections on the improvement and extension of the investigation

❖ **Exploration** –

- ❖ The research question should be focused. For example, a candidate whose question read, “What is the effect increasing concentrations of an iron supplement on pancreatic enzymes?” should have considered including the name of the iron supplement selected, the range of concentrations used and which specific enzyme(s) were used. The source of the lipase could also be included (e.g. porcine pancreatic lipase) and its substrate (in this case bovine milk fats). A research question can also include how the measurements will be taken by introducing the dependent variable. In this case it was by monitoring changes in pH levels.
- ❖ Background Information– Focused and contain relevant information that is clearly linked to the research question. Cite material from reliable scientific sources.
- ❖ In the background, the independent variable also needs to be justified. For example, e.g. why was the distance 0–30m from the low water mark used? The dependent variable needs to be explained and linked to the investigation. For example: How is the change in pressure that is measured, related to the activity of catalase? The discussion of controlled variables is needed to demonstrate that the student appreciates the other factors that may impact on the experiment.

- ❖ Focus on the following when writing this criteria:
 - ☐ The protocol for collecting the data
 - ☐ The range and intervals of the independent variable
 - ☐ The selection of measuring instruments(where relevant)
 - ☐ Techniques to ensure adequate control(fair testing)
 - ☐ The use of control experiments
 - ☐ The quantity of data collected, given the nature of the system investigated
 - ☐ The type of data collected
 - ☐ Provision for qualitative observations

- ❖ Consideration of safety and ethics to be taken particularly in work with microbes. The use of human body fluids, especially blood and saliva is not authorized at all. In the written reports evidence for the consideration of safety, ethical practice and environmental impact can be found as follows:
 - Evidence of a risk assessment, even if the investigation is considered “safe”.
 - An appreciation of the safe handling of chemicals (e.g. the use of protective clothing and eye protection)
 - An appreciation of the particular safety issues when working in the field
 - Consideration of basic hygiene
 - The application of the IB animal experimentation policy
 - A reasonable consumption of materials
 - The use of consent forms in human physiology experimentation and a consideration of the welfare of the volunteers
 - The correct disposal of waste
 - Attempts to minimize the impact of the investigation on field sites.

Analysis:

- ❖ Data:

Raw data should have both Qualitative and Quantitative data.

A candidate should present a representative sample of the raw data, for example, when large amounts of data have been collected using data logging.

Raw data from data logging may be expressed as a graphical readout. It should be accompanied by the necessary information such as units and degrees of precision (if relevant) in the axis titles.
- ❖ Standard error of the mean is best used on large samples only ($n > 30$).
- ❖ Significance tests (from t-test to ANOVA) need to be appropriately applied and there needs to be sufficient explanation for the processing to be followed.
- ❖ The use of programmes, such as Microsoft Excel, which produce a statistic, such as a p-value or a correlation coefficient, are fine but the candidate needs to

know what the value actually represents. Correlation coefficients should be accompanied with a significance test as the significance of the correlation will depend upon the sample size.

- ❖ Measurement uncertainties to be presented and also to be discussed.
- ❖ Candidates are expected to appreciate the limitations of their instruments and, where they may have a choice, to select the appropriate one.
- ❖ In biology, the biggest issue for uncertainties is in the variation in the biological material (expressed as standard deviations, standard error or max-min range). Error bars showing variation can be used on graphs and their significance, to be discussed.
- ❖ Do not remove outliers from the data during processing.
- ❖ It is not expected that full calculations be shown, examples will suffice and a worked example from a calculation carried out on a spreadsheet or a programmable calculator will not be expected. However, screen shots should be considered especially when using databases or simulations.

Evaluation:

- ❖ This criterion requires ample emphasis. Recommendations:
Conclusions to be supported by the data and explanations to be provided. The candidates to refer back to their research question at this point.
Evaluate the data in the light of a statistical result like the standard deviation.
Candidates to interpret statistical significance tests and refer back to the research question. Explanation of the results in a scientific context is needed.
Evaluation of methodology.
The level of impact of the weaknesses on the conclusion to be discussed.
Proposed improvements to be realistic and precise.
Extensions to be logical, following on from the investigation.

- ❖ Consider the following for this criteria:
 - A conclusion that is supported by the data.
 - A conclusion that refers back to the research question.
 - An explanation based upon a scientific context.
 - A discussion of the strengths – this might be quite general or implicit or it might refer to specific parts that worked well or data that was consistent.
 - Discussion of the reliability of the data.
 - Identified weaknesses in the method and materials.
 - The evaluation of the relative impact of a weakness on the conclusion.
 - Sensible, realistic improvements

Details on the improvements (e.g. not just that the investigation needs to be repeated but how many times)

Communication:

❖ To be considered:

Use scientific nomenclature.

Bibliography, footnotes, end notes and in text citations to be used.

Graphs could be combined in place of multiple graphs, when possible and as applies.

Raw data not to be relegated in appendix, if it is not required.

Data table format to be religiously followed.

For graphs that result from data logging that are used to derive a value (e.g. a rate) one example can be presented to explain the processing then the rates derived can be organised in a table and it can then be treated as the raw data.

Use metric units.

Candidates should not add on appendices in addition to a write up of about 12 pages and should not send in excessive quantities of raw data from data loggers (although showing an example of how these raw data have been processed will be needed).