

## Treatment of the topic

Students should explain early in the essay how they arrived at their research question and narrowed it down, by briefly outlining aspects they are not considering in the essay.

Students should be encouraged to formulate one or more hypotheses based on the research question. A single well-formulated question may give rise to a small number of precise hypotheses.

## Primary research

Essays in biology may be based on data collected by the student through:

- experimentation
- survey
- microscopic observations
- biological drawing
- fieldwork
- or some other appropriate biological approach.

Essays that involve practical work carried out in the laboratory, or fieldwork, should include a clear and concise description of the experimental procedure.

Students taking an experimental approach must also consult secondary sources.

## Secondary research

Alternatively, students can base their essays on data or information obtained from literature. Ideally they can use the data and manipulate or analyse it in an original way. Essays that simply restate facts or data taken directly from the sources are of little value.

Whichever approach is chosen, the student must ensure that they have access to sufficient data or information to research the topic effectively.

Students should attempt to specify how the research approach and methodology were decided, and show any approaches that were considered and rejected.

## Supervision

Ideally, students should carry out the research for the essay solely under the direction of a school supervisor. Some of the IB's best essays have been written by students investigating relatively simple phenomena using standard school apparatus and this approach is to be encouraged.

All students must provide evidence in the essay of their personal contribution to the research approach and to the selection of the methods used.

Essays based on research carried out by the student at a research institute or university, under the guidance of an external supervisor, must be accompanied by a [covering letter](#) outlining the nature of the supervision and the level of guidance provided.

## Writing the essay

Generating and presenting data should not be an end in itself; analysis using appropriate scientific techniques is essential.

The main body of the essay should consist of an argument or evaluation based on the data or information presented. Here, the student should point out the significance of any graphs, tables or diagrams.

Students should ensure that the main body of the essay is well structured and has an obvious logical progression. They can use numbered and headed paragraphs to impose a clear structure. Their evaluation should show they understand the results and their significance in the context of wider academic reading on the topic.

Students should provide some explanation of anomalies or unexpected outcomes as well as explore alternative explanations for their findings. If necessary, they should propose modifications to hypotheses presented earlier in the essay and suggest a research approach for testing these.

Students must be encouraged to undertake a critical evaluation of the work they have done. In their analysis, they should describe and explain the limitations imposed on the research by factors such as:

- the suitability and reliability of the sources accessed
- accuracy and precision of measuring equipment
- sample size
- validity and reliability of statistics.

They should also consider biological limitations such as:

- those arising from the problem of repeatability and control when using living material
- the difficulties of generalizing from research based on a single type of organism or environment.

## Examples of topics, research questions and suggested approaches

Once students have identified their topic and written their research question, they can decide how to research their answer. They may find it helpful to write a statement outlining their broad approach. These examples are for guidance only.

Topic	<b>The effect of soil salinity on the distribution and abundance of a halophyte in a salt marsh community</b>
Research question	To what extent is the distribution and abundance of the sea aster ( <i>Tripolium pannonicum</i> ) dependent on soil salinity?
Approach	Survey of vegetation using ecological techniques such as quadrat sampling to measure distribution and abundance, and a conductivity meter to measure salinity in soil samples.

Topic	<b>Urease from soy beans</b>
Research question	How does the level of urease activity differ between dried and fresh soy beans?
Approach	The enzyme is extracted from dried and fresh soy beans. Urease activity is measured by monitoring the pH of the solution using a suitable approach such as a pH probe or indicator.

Topic	<b>Antibacterial effects of a plant extract</b>
Research question	What evidence is there for the antibacterial properties of commercially available mouthwash on <i>Streptococcus mutans</i> (or other safe/approved strain) grown at 20°C?
Approach	Cultures of <i>S.mutans</i> are grown on agar plates with a suitable growth medium. Filter paper discs soaked in various concentrations of mouthwash are placed on inoculated plates and zones of inhibition are measured after a period of incubation.

### An important note on “double-dipping”

Students must ensure that their EE does not duplicate other work they are submitting for the Diploma Programme. For example, data collected for experiments undertaken as part of science lessons or the internal assessment task cannot be used as the basis of the EE in biology.

### The biology EE and internal assessment

An EE in biology is not an extension of the internal assessment (IA) task. Students must ensure that they understand the differences between the two.

- The IA is more likely to focus on the syllabus content, whereas the EE could explore aspects of biology not covered in the syllabus.
- The IA must include data collection and analysis (from hands-on experiments, databases, simulations or modelling) and cannot purely be a literature review.
- The EE must construct a theoretical framework for the underlying biology of the chosen topic, whereas the IA focuses on the application of the scientific method to a problem of interest and will only include some background information.
- The EE explicitly assesses the students’ ability to analyse and evaluate scientific arguments.

**Supervisors play an important role in guiding students on these distinctions. Students risk their diploma if academic misconduct is detected.**