

## Subject-specific guidance

### Overview

This section covers individual subjects' requirements for the extended essay (EE) in terms of:

- Choice of topic
- Treatment of topic
- Assessment:
  - Criterion A: focus and method
  - Criterion B: knowledge and understanding
  - Criterion C: critical thinking
  - Criterion D: presentation
  - Criterion E: engagement.

It assumes that teachers are already familiar with the EE generic guide and the EE teacher support material, in particular the process whereby students choose a subject area and topic, write their research question and select the research method(s) they will use to explore and answer it.

For a full summary, see the process diagram and the generic assessment criteria.

Or for a quick refresher, read [Extended essay: general requirements](#) .

## General requirements

The EE is an in-depth study of a focused topic. It gives students the opportunity to:

- engage in independent research with intellectual initiative, creativity and rigour
- develop research, thinking, self-management and communication skills
- reflect on what they have learned throughout the research and writing process.

All students must:

- provide a logical and coherent rationale for their choice of topic
- review what has already been written about the topic
- formulate a clear research question
- offer a concrete description of the methods they use to investigate the question
- generate reasoned interpretations and conclusions based on their reading and independent research in order to answer the question.

## Choice of topic

See also *Initial guidance on research and writing*

Students first need to identify the broad area of inquiry they are interested in.

Sources of ideas may include:

- work already undertaken as part of the course
- preliminary reading of academic journals and reputable scholarly e-resources, eg conference papers, essays, book chapters or journal articles. A school librarian can advise on this
- conversations with teachers, fellow students and librarians.

## Literature review

Students should try to read as much as they can of what has already been written about their topic. Time spent on a literature review early on in the research process will guide and improve their work. It will help them to:

- contextualize their research question and subsequent findings
- meet criterion B: demonstrating knowledge and understanding .

While conducting their literature review, students may find it useful to compile an annotated bibliography and to record their responses to what they read in their researcher's reflection space (RRS).

If using the internet, students are encouraged to use specialized academic search engines that will find resources appropriate for citation in the EE.

Students must be aware of their responsibilities to cite properly the resources they use and to check their work for plagiarism. Their citations should adhere to [the requirements of the IB](#) and be consistently applied.

## Research question

Students should identify a **working** research question early on but be prepared to change, eg if too little information is available to permit the intended investigation.

Students should be guided by the idea that what they are writing is important because:

- it seeks to fill a gap in understanding their chosen topic, or
- it offers a resolution to some controversial argument.

The research question should therefore be non-trivial and follow from the existing body of literature on the topic. It must be:

- specific, sharply focused and capable of being answered within a 4,000-word essay
- stated clearly in the introduction of the essay and on the title page
- related to the chosen topic.

Students need to avoid researching questions that are too narrow or too obvious as this will limit their ability to formulate reasoned arguments.

Their answer to the question must be analytical rather than descriptive.

## Title

The title is a formal requirement on the title page of the essay. If the title is missing, it will be considered on balance with the other formal requirements against criterion D. While there is no explicit penalty in criterion A, the title will help address the requirements as it expands on the student's intended focus. Without a title, students lose an opportunity to clarify their focus.

## Treatment of the topic

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.

The definition of "research" and terms such as "primary data" and "secondary data" varies from subject to subject.

In some subjects, students must use both primary and secondary data. In others, students may, or even must, rely exclusively on secondary data.

However, all students must carry out secondary research in terms of a literature review for their topic.

## Two important reminders

1. Undertaking an extended essay is a challenge. Planning is crucial. Students need to start writing their papers early and discuss any emerging difficulties with their supervisor. As well as their supervisors, librarians are a great source of information, advice and support for students.
2. Students risk their diploma if found guilty of academic misconduct:

## The sciences

An overview of writing an extended essay in the sciences, see [The sciences: An introduction](#).

Environmental systems and societies guidance is in the interdisciplinary essays section.

# Biology: Subject-specific guidance

See also: EE generic guide and EE teacher support material

## Overview

An extended essay (EE) in biology provides students with an opportunity to apply a range of skills while researching a topic of personal interest in the field of biology.

Biology is the science that deals with living organisms and life processes. A biology EE should incorporate biological theory and emphasize the essential nature of this subject

## Choice of topic

The topic must allow an approach that relates specifically to biology. Where a topic can be approached from different viewpoints, the treatment of the material must be clearly biological. For example, an EE in an interdisciplinary area such as biochemistry will, if registered under the subject of biology, be judged solely on its biological content.

Essays that deal with human diseases can often be dealt with from a number of perspectives, such as biological, medical, social or economic. Such essays should focus on biological aspects of the disease rather than on medical diagnosis and treatment.

Similarly, essays that deal with sports physiology and physical fitness must have a clear biological emphasis. They must explore the issues from a biological viewpoint and provide biological explanations for the results.

## Topics contravening safety protocols or IB policies

Some topics may be inadmissible because their means of investigation are unethical. For example, investigations that:

- are based on experiments likely to inflict pain on, or cause stress to, living organisms
- are likely to have a harmful effect on health, eg culturing micro-organisms at or near body temperature (37°C)
- involve access to, or publication of, confidential medical information.

In all cases where human subjects are used as the basis for an investigation, clear evidence of informed consent must be provided in accordance with the IB guidelines.

Some topics may be unsuitable because of safety issues. Adequate safety apparatus and qualified supervision is required for experiments involving dangerous substances such as:

- toxic or dangerous chemicals
- carcinogenic substances
- radioactive materials.

Other topics may be unsuitable because the outcome is already well known and documented in standard textbooks.

## Examples of topics

These examples are just for guidance. Students must ensure their choice of topic is focused (left-hand column) rather than broad (right-hand column).

✓	✗
Focused topics	Broad topics
The effect of detergent toxicity on soil bacteria	Detergents in the environment
A study of malnourished children in Indonesia and the extent of their recovery after a period of supervised improved nutrition	Malnutrition in children
A study of the effect of differing pH levels on the growth of <i>Phaseolus vulgaris</i>	The effect of acidity on plant growth
The competitive and evolutionary nature of the symbiotic relationship in <i>Paramecium bursaria</i>	Symbiosis
The effect of banana peel on seed germination	Factors that affect the germination of seeds
Gel electrophoresis: The construction of an apparatus and the separation of proteins in heat-treated cow's milk	Uses of the gel electrophoresis technique

## 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.**

## Interpreting the assessment criteria

### Criterion A: Focus and method

(Strands: Topic, Research question, Methodology)

The topic of the biology EE must be outlined at the start of the essay and should clearly establish the context of the research question. This should include the area of the research and the purpose and focus of the essay.

It is usually appropriate also to include the general background biological theory required to understand how the research question has arisen. For example, an essay's topic may be "Factors affecting the distribution of seagrass in Californian bays". The explanation of this topic may include reference to inshore ecosystems, pollution, the decline in seagrasses and the possible relationship to sea otter populations.

The research question is best expressed in the form of a question. It should be the precisely formulated question that the research will attempt to answer. The research question based on factors affecting the distribution of seagrass in Californian bays could be: "How do different concentrations of ammonium nitrate in sea water tanks affect the growth of seagrass (*Zostera spp*) over a three-month period?"

The research question must be:

- answerable within the limitations of resources, time and words at the student's disposal
- identified clearly
- clearly set within the academic framework of biology
- set out prominently at the start of the essay.

The student can then use the research question to formulate a hypothesis, or hypotheses, which can be tested.

Students need to demonstrate within the essay that the research has been well planned. They should show that they have researched the topic and selected an appropriate biological approach to address the research question. This applies both to their literature research and to practical data collection.