The Biology Extended Essay Guide from IB

Overview
An extended essay 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. The nature of an extended essay in biology is characterized by a particular biological emphasis within the more general context of a scientific investigation.

Choice of topic
It is important that the extended essay has a clear biological emphasis and is not more closely related to another subject. Biology is the science that deals with living organisms and life processes. A biology extended essay should, therefore, incorporate biological theory and emphasize the essential nature of this subject.

Although similar assessment criteria apply to all extended essays in the experimental sciences, for a biology extended essay, the topic chosen must allow an approach that distinctly relates to biology. Where a topic can be approached from different viewpoints, the treatment of the material must be clearly biological. For example, an extended essay in an interdisciplinary area such as biochemistry will, if registered as a biology extended essay, be judged on its biological content, not its chemical content.

Essays that deal with human diseases represent a particular case in point, as these can often be dealt with from a number of perspectives (such as biological, medical, social or economic). In particular, such essays should avoid an overly medical treatment and should focus on biological aspects of the disease rather than on diagnosis and treatment.

Some topics are unsuitable for investigation because of ethical issues. Investigations that are based on experiments likely to inflict pain on, or cause unnecessary stress to, living organisms are not appropriate for submission. Investigations that are likely to have a harmful effect on health (for example, culturing micro-organisms at or near body temperature), or those which may involve access to, or publication of, confidential medical information, are also not appropriate.

Some topics may be unsuitable for investigation because of safety issues. Experiments in which the student uses toxic or dangerous chemicals, carcinogenic substances or radioactive materials should be avoided unless adequate safety apparatus and qualified supervision are available. Other topics may be unsuitable because the outcome is already well known and documented in standard textbooks.

The following examples of titles for biology extended essays are intended as guidance only. The pairings illustrate that focused topics (indicated by the first title) should be encouraged rather than broad topics (indicated by the second title).

- “The effect of detergent toxicity on soil bacteria” is **better than** “Detergents in the environment”.
- “A study of malnourished children in Indonesia and the extent of their recovery after a period of supervised improved nutrition” is **better than** “Malnutrition in children”.
- “A study of the effect of differing pH levels on the growth of *Phaseolus vulgaris*” is **better than** “The effect of acidity on plant growth”.
- “The competitive and evolutionary nature of the symbiotic relationship in *Paramecium bursaria*” is **better than** “Symbiosis in animals”.
- “The effect of banana peel on seed germination” is **better than** “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” is **better than** “Uses of the gel electrophoresis technique”.

The topic chosen for study should be presented in the form of a research question, followed by a statement of intent outlining the research approach to be used in answering the question. In this way, the approach to the topic chosen may be even further clarified. Some examples of this could be the following.

<table>
<thead>
<tr>
<th>Topic</th>
<th>The distribution and growth of lichens on urban pavements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research question</td>
<td>How are the distribution and growth of lichens affected by sulfur dioxide and ozone levels in the atmosphere?</td>
</tr>
<tr>
<td>Approach</td>
<td>Thalus diameter and population density data is collected from selected sites in different parts of the city. This data is then correlated with published data on the levels of SO₂ and O₃.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Topic</th>
<th>The effectiveness of commercial antibacterial cleaning agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research question</td>
<td>Are commercially available antibacterial cleaning agents effective at controlling the growth of <em>E. coli</em> on nutrient agar under laboratory conditions?</td>
</tr>
</tbody>
</table>
**Approach**

Pure strain *E. coli* are grown on nutrient agar plates under controlled conditions. Filter paper discs soaked in samples of the antibacterial agents are placed on the agar plates and the zone of exclusion is measured and compared.

**Topic**

**Altitude and physical fitness**

**Research question**

Can a programme of training at high altitude have an impact on the fitness of an athlete?

**Approach**

Using a digital heart-rate monitor, pre- and post-exercise heart rates and recovery times are measured for four athletes. These athletes then carry out a programme of training at 2,500 metres above sea level, after which heart-rate and recovery time data is once again collected. The pre- and post-training data is analysed and compared to published data.

**Topic**

**Urease from soy beans**

**Research question**

Which method of extraction and which temperature conditions give the best levels of urease activity?

**Approach**

The enzyme is extracted from dried soy beans using three different methods, and the activity of the extract is measured and compared to a standard. Urease activity is measured by noting the time taken for a standard urea solution, with phenolphthalein indicator, to turn pink in the presence of the enzyme extract.

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**Treatment of the topic**

Students should point out early in the essay how the research question was arrived at and, if appropriate, how it was narrowed down, by briefly outlining related aspects that are not being considered 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. 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. Alternatively, essays may be based on data or information obtained from literature, ideally from primary sources, and manipulated or analysed in an original way by the student. 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 sufficient resources, in the form of data and information, can be obtained in order to allow the topic to be effectively researched.

Essays that involve practical work carried out in the laboratory, or fieldwork, should include a clear and concise description of the experimental procedure. Students should attempt to specify how the research approach and methodology were decided, and show any approaches that were considered and rejected. Ideally, students should carry out the research for the essay solely under the direction of a school supervisor. Some of the best essays have been written by students investigating relatively simple phenomena using standard school apparatus, and this approach is to be encouraged. Regardless of where, or under what circumstances, the research is carried out, 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.

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. Since this is often the longest single section of the essay, it is essential that it is well structured and has an obvious logical progression. A clear structure can be imposed on this section by dividing it into numbered and headed paragraphs. This evaluation should show an understanding of the results and an appreciation of their significance in light of the literature that has been consulted.

Students should provide some explanation of anomalies or unexpected outcomes but this should not form a major part of the discussion. If necessary, modifications to hypotheses presented earlier in the essay should be proposed and a research approach for testing these should be suggested. Some assessment of the outcomes of the research in a future or wider context should be made. Students must be encouraged to undertake a critical evaluation of the work they have done. In this analysis, the student 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. Biological limitations should be considered, such as those arising from the problem of repeatability and control when using living material, as well as the difficulties of generalizing from research based on a single type of organism or environment.