Writing Biology at University

GUIDES FOR WRITING IN SPECIFIC DISCIPLINES

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1 What is biology?

Biology (from the Greek bios "life" and logos "treatment") is an integrative science that studies the phenomena of life and living organisms. To deal with the great diversity of life at very different scales, biology is divided into separate branches, covering molecules, cells, organs, organisms, populations, communities and ecosystems. In addition, biology's close interaction with physics, mathematics, computing, engineering and medicine has led to the emergence of multidisciplinary scientific environments.

Who has never heard of issues studied in biology, such as HIV and AIDS, genetically modified organisms, assisted reproduction and species conservation? Knowledge of biology is seen as a form of social participation in that anyone interested may debate these important social issues, with responsibility and under equal conditions, in search of social, scientific and technical progress. Therefore, facilitating non-specialist access to scientific culture must be a priority. At the same time, biologists should attain a certain mastery of written expression to better disseminate knowledge of their field of expertise and ensure that it is clearly understood among specialists in other areas.

2 General features of writing in biology

Biology texts are characterized by specific linguistic and pragmatic features. The variety of text types (see section 3) should be respected. Nonetheless, clarity, precision and objectivity are characteristics shared by all of them.

Clear writing

Biology texts often describe complex phenomena and processes. To facilitate understanding of such difficult language, writers should strive to be orderly and coherent. For example, if three hypotheses (1, 2, and 3) are presented in the introduction, the same order of presentation must be followed in both the material and methods and the results sections. In addition, short and simple sentences help clarify concepts (phenomena, results, species, etc.). Avoiding imprecise adjectives (the *most optimal*,

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the *least appropriate*, etc.) and stating that *something is X* instead of saying *it is not Y* (for example, *is true* instead of *is not false*) is also recommended.

Precise terminology

Every biological concept has a precise, universally accepted term. This precision often requires writers to repeat the same words even though that repetition can make the reading a little more monotonous or tedious. For example, although the terms *species richness* and *species diversity* are closely related, they do not express the exact same meaning and, therefore, they are not interchangeable. In more informational, popular science texts, terminology can be accompanied by examples understood by non-specialist readers. In these types of text, it is important to define the terms used because slightly different meanings may be common in non-specialized language. Examples are *fitness, mutation, DNA, evolution, diversity* and *ecology*.

Objectivity

Descriptions of biological processes can vary as a result of the intrinsic complexity of the process in question, which may be difficult to reproduce exactly in the study. Although experimental results in biology are sometimes divergent and not exactly comparable, they help detect general tendencies used to predict future results. Therefore, everything stated in a biology text must be objectively supported by proven facts. The results and discussion sections of scientific texts should clearly differentiate between facts that have been demonstrated (in the results) and the reasoned interpretation of those results (in the discussion).

Text structure

The following paragraphs describe how to write each of the sections of a scientific text. Special emphasis is placed on the distinctive features that must be taken into account when writing texts in the field of biology (see section 3).

Title

Titles should capture the interest of readers and, at the same time, inform them of the text content without promising more than what is really described. For example, the title of an article should not be *Diversity of species in the Mediterranean* if it only studies birds (not all living species) of a specific area of the Mediterranean (not the entire region). In addition, titles should be as short as possible, without unnecessary words like *Study of, Analysis of* or *Comparison between*.

Abstract

An abstract is like a brief cover letter that will hopefully encourage readers to read the entire text. As abstracts contain the most important information from each section, they should be written only after the rest of the text is completed. In addition, they should be written in the present tense and contain, in this order, an introductory sentence demonstrating the relevance of the work, the study's main objective, methodological approaches, the most relevant results, the main conclusions and any implications derived from the research.

Introduction

Introductions, which are also written in the present tense, provide readers with background information, or previous knowledge, about the topic. Progressing from a general to a specific review of the phenomenon studied, the introduction puts the subject of the work in context and cites the most relevant references. After the presentation of previous knowledge, the objectives (*What do we want to know?*) are formulated, either in sentences beginning with an infinitive verb or in questions. The objectives are often followed by hypotheses (*What results are expected?*) that contemplate the expected results in light of previous knowledge.

Material(s) and methods

This section provides some details about the research process (*How was the research carried out?*). Despite the reference to materials, it should not include a list of all the materials needed to conduct the research. The main objective is to briefly describe the methodology used to perform the research (laboratory or sampling protocols, statistical analysis, etc.) in such a way that another researcher can repeat the steps. Although protocols are often given in summary form, the exact wording, which follows certain standards, is usually provided in an annexe. In research conducted in the natural environment, the study area should be carefully described and any relevant information mentioned before the methodology is presented. In the field of cell biology or physiology, the type of sample used (semen, blood, oral mucosa, etc.) and the characteristics of the individuals included in the study (age, karyotype, etc.) should be described.

Results

The results section, written using either present or past tense verbs, informs readers of the findings. As results in biology should be quantified, many are expressed numerically. If it is possible to express them briefly in words, they can be included in the text; if the results are too long and complex, they must be presented separately, in a figure or a table (see section 4). Figures are used to emphasize the difference between several results (for example, if one is greater than another), not to present specific numerical values. Tables can be used for that purpose, or when there are too many results to present in a figure. Textual explanations of all the results presented in the figures and tables are not necessary, but the most relevant aspects of the results should be explained, and not presented again elsewhere in the article (see section 4).

Discussion

The discussion section should avoid presenting new information and be written in the present tense. It informs readers of the process involved in confirming or contradicting the knowledge established to date, and concludes by explaining what can be extracted from the results, often comparing them with results from previous research mentioned in the introduction. In addition, the discussion should express the impact of the results in relation to future research and applications (therapeutic treatments, environmental management practices, etc.).

3 Typical texts assigned in biology

Project or study proposals

Proposals are written to obtain funding to cover the technical and logistical costs of research. They are formal texts and, depending on the agency or institution considering them, the scientific language can be more or less complex in terms of terminology and the presentation of background information or concepts. In general, research proposals present a scientific or technical question and develop a plan to resolve it. They can be creative, original and innovative, but they must also be feasible and realistic. Proposals usually have the following parts: title, author(s), summary, introduction (including the justification of the proposal and the objectives), methodology, work plan, expected results, dissemination plan, timeline, budget proposal and references.

Field and laboratory notebooks

In biology, notebooks are essential to establish a record of processes carried out in the field or in the laboratory. They are documents for personal or internal use and may therefore include annotations, ideas or preliminary conclusions. It is important to correctly identify the author(s) of each notebook record and to make sure the information is legible, clear, rigorous and presented in chronological order (with precise dates). The main parts of any notebook are the index, the title, the author(s) and the date of each record, the purpose or aim of the entry, the location (in the case of field notebooks), the materials used, the sample coding, the procedure and the results (raw data).

Data analysis reports

In biology, data analysis is increasingly important for many procedures, including genome annotation, phylogeny construction, the analysis of population dynamics, the use of geographic information systems, modelling and the production of statistics. Often for internal use, data analysis reports record all the processes carried out and the data gathered from the beginning of a study until the results are obtained. R Markdown is a system that allows users to easily combine computing, statistics (for example, in R or Python) and analysis in a single, high quality document.

Scientific articles

More than any other text type, scientific articles are used by specialists to share knowledge with other members of the scientific community. They address a question

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or hypothesis in a precise, well-documented and detailed manner, with a high degree of formality. The main parts of a scientific article are the title, the author(s), the abstract, keywords, the introduction, the materials and methods, the results, the discussion and the references.

Technical reports

Technical reports present the results of a study to an external recipient, such as a company or a public institution that has commissioned or financed the project. Reports contain a title, the name(s) of the author(s), a brief introduction (background and objective), the results and a discussion. A summary is usually included, but it is not obligatory.

Popular science texts

Popular science texts aim to bring knowledge in the various fields of biology closer to different communication environments (ranging from education and professional sectors to the general public). The degree of formality, the use of scientific terminology and the parts of the text itself vary according to target readers and the communicative purpose (see section 5). The title must be engaging enough to encourage non-specialist readers to read the entire text. In addition, the conclusion or the main findings should be revealed at the beginning to increase interest and facilitate comprehension among readers. Specialized terminology should not be used excessively, but if unavoidable, it should be explained as clearly as possible.

4 Writing conventions in the field of biology

Why and how should citations be made? To recognize the work of other researchers and attribute responsibilities or authorships, scientific research must be well documented and contain rigorous citation of sources. Generally, paraphrasing or non-literal quotations (expressing in one's own words what has been written in the reference) are used to include the ideas of other authors.

Many different citation styles can be used in biology. In any given piece of work, a single, specific style should be used following the guidelines established (either by the teacher, for class work, or by the publisher, in the case of a publication). The full reference for in-text citations should be included in the list of works cited at the end of the article/text.

How are figures and tables included? Figures and tables from sources other than the author(s) should be cited in the text and numbered according to the order in which they appear in it (for example, *table 1, figure 1*). As separate units of the main text, they must be accompanied by a caption with a brief but adequate description of the content. The way figures and tables appear is very important. How would readers react to a graph with axes that cannot be identified because the font is too small, or to a photograph of a cell without a scale of reference?

How are the units of measure chosen? The units of measure should follow the International System of Units (SI, abbreviated from the French *Système international d'unités*). Finding the appropriate scale to refer to the measurement is essential. For example, the size of a chromosome should be expressed as 20 µm instead of 2×10^{-8} km.

How are the names of genes and proteins, and of species, written? Both genes and genotypes are written in italics (or with the word underlined when handwritten), and the proteins and phenotypes they encode in roman type (for example, "the protein that encodes the *Shh* gene in *Xenopus* is Shh"). Each model organism follows specific orthographic rules for the names of genes and proteins. A common database facilitates the naming.

The scientific names of species always appear in italics (in computer-written texts) or underlined (in handwritten texts). The name of the genus is written with a capital letter, and the specific epithet in lowercase letters (for example, *Quercus ilex*). After the first use in the text, the genus can be abbreviated with the initial capital letter followed by a full stop (for example, *Q. ilex*). The supraspecific taxa have a formal Latin name and a common name (for example, *Mollusca* and molluscs). As with the naming of genes, four international codes of nomenclature are used to name the different groups of living beings: the ICZN for zoology; the ICN for algae, fungi and plants; the ICNB for bacteria; and the ICTV for viruses.

Which ethical principles govern the research? Many studies are governed by ethical principles regarding the manipulation of biological materials from humans or other living beings (for example, the manipulation of human oocytes or the use of protected or invasive species). The text must specify that the necessary licences or permissions have been obtained and that the protocols have been approved by the authorized ethics committees. Mention should also be made of any conflict of interest.

5 Selected works and websites for writing in biology

1. *Biblioteca terminològica,* Termcat
   http://www.termcat.cat/ca/Biblioteca/Biblioteca_Terminologica/Arees_Tematiques/

   Glossary organized by thematic area in the fields of life sciences, botany, zoology and the environment. Terminology in Catalan with English-language equivalents.

2. *A Student's Guide to Writing in the Life Sciences,* Harvard University
   http://hwpi.harvard.edu/files/hwp/files/life_sciences.pdf

   A guide for university students with extensive information on the features of writing in the field of biology.

3. *Writing biology laboratory reports,* Tufts University
http://writing2.richmond.edu/training/project/biology/biology.html

General guide to writing technical reports or scientific articles in biology.

4. *Writing Lab Reports and Scientific Papers,* Iowa State University
http://www.mhhe.com/biosci/genbio/maderinquiry/writing.html

General description of scientific writing in all fields, not only biology.

5. *Writing in the Disciplines: Biology,* University of Richmond Writing Center
http://writing2.richmond.edu/writing/wweb/biology/index.html

A general guide for writing most basic biology laboratory reports, with specific information on each separate section (abstract, introduction, etc.).

6. *Writing for Different Disciplines,* Southwestern University
https://www.southwestern.edu/offices/writing/writing-for-different-disciplines/index.php

Guides intended to provide an introduction to the conventions, or rules, of writing in different subjects, including biology. Click on Guide to Writing in Biology to view the PDF document.

7. *Reading and Writing in Biology,* Kenyon College
http://www.kenyon.edu/academics/departments-programs/biology/resources-for-students/reading-and-writing-in-biology/

A website offering links to pages with information covering several aspects of writing (and reading) biology texts.

8. *Writing for Specific Fields: Sciences,* the Writing Center at the University of North Carolina at Chapel Hill
https://writingcenter.unc.edu/tips-and-tools/sciences/

A handout detailing the most critical aspects of scientific writing and providing strategies for evaluating and improving scientific prose.

9. *Specific Writing Assignments or Contexts: Scientific Reports,* the Writing Center at the University of North Carolina at Chapel Hill
https://writingcenter.unc.edu/tips-and-tools/scientific-reports/

A general guide to writing scientific research reports, with descriptions of conventional rules about format and content.

10. *Writing Guides,* Colorado State University
https://writing.colostate.edu/guides/index.cfm?categoryid=15&title=3

A website offering links for writers in the sciences. Of particular interest are the first two guides in the list: *Writing the Scientific Paper* and *Abstracts*.

Servei de Llengües (UAB) and Servei de Llengües Modernes (UdG)

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