Style Guide for Writing in Biology
compiled from
Jan A. Pechenik’s
A Short Guide to Writing about Biology 8th Ed.

Eleven Major Rules for Preparing a First Draft

1. Work to understand your sources.
2. Don’t quote from your sources.
   • Describe what others have done and what they found, but do so in your own words.
3. Don’t plagiarize.
   • Submitting anyone else’s work under your own name is plagiarism, even if you alter some words or reorder some sentences.
   • Presenting someone else’s thoughts or ideas as your own is also plagiarism.
   • Take notes in ways that minimize the likelihood of plagiarism.
4. Think about where you are going before you begin to write.
5. Practice summarizing information.
6. Write to illuminate, not to impress.
7. Write for your classmates and for your future self.
8. Support all statements of fact and opinion with evidence.
9. Always distinguish fact from possibility.
10. Allow time for revision.
11. Back up your drafts every few minutes to your hard drive.

Six Major Rules for Developing Your Final Draft

1. Stick to the point.
   • Delete any irrelevant information, no matter how interesting it is to you.
2. Say exactly what you mean.
3. Never make the reader go back and reread to understand what you are saying.
   • Try to take readers by the hand in your first paragraph and lead them through to the end, line-by-line, and paragraph-by-paragraph.
• Link sentences carefully, using transitional words, such as, therefore, in contrast, etc., or by repeating key words so that a clear and logical argument is developed.
• Avoid casual, inaccurate use of the words it, they, and their.

4. Don’t make readers work harder than they have to.
   • If there is interpreting to be done, you must be the one to do it. For example, never write something like:
     The difference in absorption rates is quite clearly shown in Table 1.

5. Be concise.
   • Give all the necessary information but avoid using more words than you need for the job at hand.

6. Don’t be teleological.
   • Don’t attribute a sense of purpose to other living things, especially when discussing evolution.

**Nine Finer Points: The Easy Stuff**

1. Abbreviate units of measurement that are preceded by numbers.
   • Do not put periods after unit symbols, and always use the same symbol for all values regardless of quantity: 1 mm, 50 mm; 1 hr.; 1 g

2. Always underline or italicize species names, as in *Homo sapiens*.
   • Genus is capitalized (*Homo*) and species is not (*sapiens*).
   • Once you have the full name in the report the name can be abbreviated (*H. sapiens*).

3. Don’t use formal scientific names to refer to individuals of a species.
   • “Black-tailed prairie dogs (*Cynomys ludovicianus*)...”

4. Do not capitalize common names.
   • Examples: monarch butterfly, lowland gorillas, and fruit fly.

5. When listing references at the end of a sentence, put the period after the references.

6. Capitalize the names of taxonomic groups (clades) above the level of genus, but not the names of the taxonomic categories themselves.
   • For example, insects belong to the phylum Arthropoda and the class Insecta.

7. Remember that the word data is plural.
   • The singular is datum.
   • “The data are lovely” (not “The data is lovely”).

8. Pay attention to form and format: Appearances can be deceiving.
   • Leave margins of about an inch and a half on the left and right sides of the page and about an inch at the top and bottom of each page.
   • Double-space your typing.
   • Use Times New Roman font, 12 pt.
9. Put your name and the date at the top of each assignment, and number all pages.

**The Last, but Main Part:**

Revise, revise, revise; edit, edit, edit; proofread, proofread...

**Components of the Research Report**

A research report is typically divided into 6 major sections:

1. **Abstract.** In the Abstract, you summarize the problem addressed, why the problem was addressed, your approach to the problem, and the major findings and conclusions of your study. This is probably the most difficult part of the report to write well and it summarizes the entire report, so save it for last.

2. **Introduction.** The Introduction tells the reader why the study was undertaken, gives a brief summary of the study or relevant background facts, and leads to a statement of the specific problem being addressed. If appropriate, also describe the specific hypotheses that you set out to test, and the basis for those hypotheses.

3. **Materials and Methods.** This section is your reminder of what you did, and it also serves as a set of instructions for anyone wishing to repeat your study in the future.

4. **Results.** *This is the centerpiece of your report.* What were the major findings of the study? Present the data or summarize your observations using graphs and tables to reveal any trends you found. Point out major trends to the reader. If you make good use of your tables and graphs, the results can usually be presented in only 1 or 2 paragraphs of text; one picture is worth quite a few words. Avoid interpreting the data in this section.

5. **Discussion.** How do your results relate to the goals of the study, as stated in your Introduction, and how do they relate to the results that might have been expected from background information obtained in lectures, textbooks, or outside reading? Do your results support or argue against the hypothesis presented in your Introduction? What new hypotheses might now be formulated, and how might these hypotheses be tested? This section is typically the longest part of the report.

6. **Literature Cited ("References").** This section includes the full citations for any references that you may have cited in your report. Double-check your sources to be certain they are listed correctly; this list of citations will permit the interested reader to confirm the accuracy of any factual statements you make and, often, help them to understand the basis for your interpretations of the data.
**Where to Start:** Start by working on either the Materials and Methods section or the Results section. Because the Materials and Methods section requires the least mental effort, completing it is a good way to overcome inertia.

**Writing the Materials and Methods Section**

Results are meaningful in science only if they can be obtained over and over, whenever the experiment is repeated. And because the results of any study depend to a large extent on the way the study was done, it is essential that you describe your methods so that your experiment can be repeated in all its essential details.

- Mention each new material as you discuss what you did with it.
- Begin by listing all the factors that might have influenced your results.
- You must say what you did, but you should freely refer to your laboratory manual handouts in describing how you did it.
- Mention why particular steps were taken whenever you think it might not be obvious.
- It is usually appropriate to include any formulas used in analyzing your data.
- Use informative subheadings to help organize and present your material by topic.
  - Uninformative: Field experiment
  - Informative: Occupancy of damaged and intact shells in the field
  - Uninformative: Shell choice
  - Informative: Effect of shell condition on shell choice in the laboratory
- Two subsections commonly included at the end of the Materials and Methods section are “Data Analysis” and a description of your study system or organism.
- Make sure it is written in past tense.

**Model Materials and Methods Section**

**Obtaining and Maintaining Worms**
The polychaete worms used in this study were *Nereis virens*, freshly collected from Nahant, MA, and ranging in length between 10 and 12 cm. All treatments were performed at room temperature, approximately 21 °C, on April 15, 2011. One hundred ml of full-strength seawater was added to each of six 200-ml glass jars these jars served as controls, to monitor worm weight in the absence of any salinity change. Another 6 jars were filled with 100 ml of seawater diluted by 50% with distilled water.

**Monitoring Water Gain and Loss**
Twelve polychaetes were quickly blotted with paper towels to remove adhering water and were then weighed to the nearest 0.1 g using a Model MX-200 Fisher/Ainsworth balance. Each worm was then added to one of the jars of seawater. Blotted worm weights were later determined 30, 60, and 120 minutes after the initial weights were taken.

**Determining Osmotic Concentration**
The initial and final osmotic concentrations of all test solutions were determined using a Wescor VAPRO vapor pressure osmometer, following instructions provided in the handout (Podolsky, 2010).

**Data Analysis**
The rate of weight gain over time was examined by linear regression analysis, after log-transforming the independent variable (time). A series of Student’s *t*-tests were used to assess the effect of salinity on rate of weight gain, by comparing mean weights of worms in the 2 treatment groups at 30, 60, and 120 minutes.
Writing the Results Section

The Results section is the most important part of any research report. In this section, you summarize your findings. The results section is:

1. Not the place to discuss why the experiment was performed.
2. Not the place to discuss how the experiment was performed.
3. Not the place to discuss whether the results were expected, unexpected, disappointing, or interesting.

Simply present the results, drawing the reader's attention to the major observations and key trends in the data. Don’t interpret them here.

What is a “Figure”?

“Figures” include graphs of all types; photographs of all types, whether of an organism or of electrophoresis gels; drawings; maps (showing the location of a study site, for example); and flowcharts. Anything and everything, in fact, that is not a “table” is a “figure.” Most of your data will probably be presented in the form of tables and graphs.

- Always indicate the species studied, the sample size, and the number of replicates.

To Graph or Not to Graph

- Don’t automatically assume that your data must be graphed.
- In any event, never present the same data in both a graph and a table.

When graphing, make sure:

- Symbols chosen facilitate interpretation of the graph.
- Symbols are large and easy to tell apart.
- Each axis of the graph is clearly labeled and includes units of measurement.
- Tick marks on both axes are at intervals frequent enough to allow readers to estimate the value of each data point.
- The meaning of each symbol is clearly indicated.
- A detailed explanatory caption (figure legend) is below the figure.
- Your graph is self-contained.
- You always use the same system of symbols throughout a report.
- The independent variable is plotted on the x-axis, and the dependent variable is plotted on the y-axis.

Putting your Figures and Tables in Order

- Arrange them logically, in the order that you will discuss them.
Verbalizing Results

You must use words that draw the reader’s attention to the key patterns in your data. But do not simply redraw the graphs in words. Your task is to summarize the most important findings displayed by the graphs and then to indicate briefly the basis for the statements you made.

- Always present results in past tense.
- Do not make your reader interpret the data.
- You cannot exclude data simply because they violate a trend that would otherwise be apparent or because the data contradict a favored hypothesis.

Writing about Numbers

- Use numerals rather than words when writing about counted or measured items, percentages, decimals, magnifications, and abbreviated units of measurement.
- When writing about numbers smaller than zero, precede the decimal point with a zero.
- When writing about very large numbers or very small numbers use scientific notation.
- Always follow any number you write down with appropriate units.

Writing the Discussion Section

Expectations

State your expectations explicitly, and back up your statements with a reference. Scientific hypotheses are not simply random guesses.

Explaining Unexpected Results

Experiments cannot prove anything; they can only support or not support specific hypotheses. If your results don’t fit your expectations, or if they don’t disprove your null hypothesis, base your discussion on the data you actually obtained.

The discrepancy in results cannot be explained by the unusually low temperature in the laboratory on the day of the experiment, since the control animals were subject to the same conditions and yet behaved as expected.

- Always be careful to distinguish possibility from fact.
- Continue your discussion by indicating possible ways that the differences might be tested.
Writing the Introduction Section

Briefly present background information that leads to a clear statement of the specific issue or issues that will be addressed in the remainder of the report. Every topic that appears in later sections of your report should be anticipated clearly in the Introduction, and the Introduction should contain only information that is directly relevant to the rest of the report.

- Be specific.
- Make the basis for the hypothesis clear.

Providing the Background

1. Support all statements of fact with a reference.
2. Define specialized terminology.
3. Never set out to prove, verify, or demonstrate the truth of something.
4. Be brief; every sentence should be designed to directly prepare the reader for the statement of intent.
5. Include, in your Introduction section only, information that prepares the reader for the final statement of intent.
6. Write an Introduction for the study that you ended up doing.
7. Talk about your study organism or field site.

Deciding on a Title

A good title summarizes, as specifically as possible, what lies within the Introduction and Results sections of the report. For this reason, write your title after you have written the rest of your report. The more revealing your title, the more easily potential readers can assess the relevance of your paper to their interests.

Examples:

1. No: Metabolic rate determinations
   Yes: Exploring the relationship between body size and oxygen consumption in mice
2. No: The role of a homeobox gene
   Yes: The homeobox gene *Irx5* is needed for retinal cell development in mice

Writing and Abstract

The Abstract is placed at the beginning of your report, immediately following the title page. Yet it should be the last thing you write, other than the title, since it must completely summarize the entire report, explain why the experiment was undertaken, what problem was addressed, how the problem was approached, what major results were found, and what major conclusions were drawn. In compact form, your abstract
must present a complete and accurate summary of your work, and that summary must be fully self-contained.

Developing Hypotheses

Your goal is to pose a specific question that follows in some logical way from what has already been published in your area of interest and that can be addressed by available techniques and approaches.

![Figure 1. The trick of developing a valid research question. Many questions are easy to answer but are meaningless or too trivial to be worth asking. Many other questions are important but unapproachable by existing methods.]

Writing Research Proposals

Writing the Proposal

Introduction: Give a brief overview of the research being considered, and indicate the nature of the specific questions you will pursue, as in the following example:

Endurance exercises such as running and swimming can affect the reproductive physiology of women athletes. Female runners (Dale et al., 1979; Wakat et al., 1982), swimmers (Frisch et al., 1981), and ballet dancers (Warren, 1980) menstruate infrequently (i.e., exhibit oligomenorrhea) in comparison with nonathletic women of comparable age, or not at all (amenorrhea). The degree of menstrual abnormality varies directly with the intensity of the exercise. For example, Malina et al (1978) have shown
that menstrual irregularity is more common, and more severe, among tennis players than among golfers.

The physiological mechanism through which strenuous activity disrupts the normal menstrual cycle is not yet clear; inadequate fat levels (Frisch et al., 1981), altered hormonal balance (Sutton et al., 1973), and physiological predisposition (Wakat et al., 1982) have each been implicated.

- It helps to write the last sentence of your introduction first.
- Every factual statement is supported by a reference to one or more papers from the primary literature.
- The introduction section of any well-written, published, research paper can serve as a model for what you are trying to accomplish in the Introduction section of your proposal. Only the tenses will differ.

**Background:** Where you demonstrate your complete mastery of the relevant literature.

- This section will end with a brief summary statement of what is now known and what is not yet known.
- This section will include a clear, specific description of the research question(s) you propose to investigate.

**Example:**

Thus many fish, echinoderm, polychaete, mollusk, and crustacean species are highly sensitive to a variety of fuel oil hydrocarbon pollutants, and the early stages of development are especially susceptible. However, many of these species begin their lives within potentially protective extra-embryonic egg membranes, jelly masses, or egg capsules (Anderson et al., 1977; Eldridge et al., 1977; Kînehcép, 1971). The ability of these structures to protect developing embryos against water-soluble toxic hydrocarbons has apparently never been assessed. The egg capsules of marine snails are particularly complex, both structurally and chemically (Fretter, 1941; Bayne, 1968; Hunt, 1971). Such capsules are typically several mm to several cm in height, and the capsule walls are commonly 50-100 μm thick (Hancock, 1956; Tamarin and Carriker, 1968). Depending on the species, embryos may spend from several days to many weeks developing within these egg capsules before emerging as free-swimming larvae or crawling juveniles (Thorson, 1946).

Little is known about the tolerance of encapsulated embryos to environmental stress, or about the permeability of the capsule walls to water and solutes. Kînehcép (1982, 1983) found that the egg capsules of several shallow-water marine snails (*Ilyanassa obsolete*, *Nucella lamellosa*, and *N. lapillus*) are permeable to both salts and water, but they are far less permeable to the small organic molecules glucose. Capsules of at least these species are thus likely to protect embryos from exposure to many fuel oil components.

In the proposed study, I will (1) document the tolerance of early embryos of *N. lamellosa* and *N. lapillus*, both within capsules and removed from capsules, to the water-soluble fraction of Number 2 fuel oil; (2) determine the general permeability characteristics of the capsules of these 2 gastropod species to see which classes of toxic
substances might be unable to penetrate the capsule wall; and (3) use radioisotopes to directly measure the permeability of the capsules to several major components of fuel oil.

Proposed Research:
- Indicate clearly what specific question each experiment is designed to address, as in the following example:
  To see if there is a seasonal difference in the amount of hormone present in the bag cells that induce egg-laying in *Aplysia californica*, bag cells will be dissected out of mature individuals each month and...
- If the proposed research has several distinct components, it is helpful to separate them using subheadings.
- Model your Proposed Research section on the Material and Methods section of any well-written, published research article.
- Only the tenses will differ.

Example of Materials and Methods:
We *created* genetic mosaics between wild-type and mutant embryos essentially as described (Ho and Kane, 1990). Donor embryos *were injected* at the 1- to 4-cell stage with lysinated rhodamine dextran (10,000 kDa, Molecular Probes). Between 3 h and 5 h, 10-50 cells *were transplanted* from these embryos into similarly staged embryos. Transplant pipettes *were made* on a standing disk constructed from a discarded hard drive coated with diamond lapping film. Transplantations *were done* using an Olympus SZX12 dissecting microscope. At 24 f, the smu / embryos *were identified* on the basis of partial cyclopia and the U-shape of their somites. Embryos *were fixed* and sectioned on a cryostat; sections *were then labeled* with F59 to identify muscle fiber type (Devoto *et al.*, 1996). Slow and fast muscle fibers derived from donor cells *were counted* in every third section in all cases.

Example of Materials and Methods rewritten as it would appear in a proposal:
We *will create* mosaics between wild-type and mutant embryos essentially as described (Ho and Kane, 1990). Donor embryos *will be injected* at the 1- to 4-cell stage with lysinated rhodamine dextran (10,000 kDa, Molecular Probes). Between 3 h and 5 h, 10-50 cells *will be transplanted* from these embryos into similarly staged embryos. Transplant pipettes *will be made* on a standing disk constructed from a discarded hard drive coated with diamond lapping film. Cells *will be transplanted* using an Olympus SZX12 dissecting microscope. At 24 f, the smu / embryos *will be* on the basis of partial cyclopia and the U-shape of their somites. Embryos *will be* sectioned on a cryostat; sections *will then be labeled* with F59 to identify muscle fiber type (Devoto *et al.*, 1996). Slow and fast muscle fibers derived from donor cells *will be counted* in every third section in all cases.

Proposed Results and Discussion:
If instructors make this section mandatory they will provide you with a guide for the information expected to be within this section.