GUIDELINES FOR RESEARCH PROPOSALS

Research proposals serve two functions. First, they allow you to plan your scientific work in a systematic way. This forward planning greatly increases the efficiency and efficacy of your work. Second, proposals allow you to communicate your plans to others – particularly to research collaborators, supervisors and funders. The latter category, funders, is very important. Most professional science is grant-based, and these grants are awarded on a competitive basis following the submission of research proposals. Therefore, writing good proposals is an essential skill for most scientists.

The format of research proposals will vary somewhat among classes, so the following guidelines should serve as a general template which may be modified by your professor.

**General guidelines:**

- Use the future tense consistently throughout the text when referring to your proposed research. Note that lab reports are written in the past tense.
- We prefer the active voice. For example, “We propose to test the following hypothesis…” is better than “The following hypothesis will be tested…”
- All the text within your proposal, including the methods, should be written in concise, but complete, sentences and organized into paragraphs (i.e., avoid bulleted lists like this one).
- When providing the scientific name of an organism, use upper case the first letter of the genus, but leave the specific name in lower case. In addition, either underline or italicize both the genus and species. After the first citation, you may simply refer to the abbreviated scientific name. For example: “We propose to examine the enzyme tyrosinase isolated from the potato, *Solanum tuberosum*. Thereafter you can just refer to the organism as the potato or as *S. tuberosum*.

**Proposal content:**

The proposal does not have to be long, but it should be complete, and include all of the following components: Title, Introduction, Hypotheses, Methods, Expected Results, Literature Cited, Data Record Sheet.

**Title**

The title should be brief but specific. For example: “The effects of lowering pH on the rate of activity of the enzyme, tyrosinase,”, or “Flower production in full sunlight- and shade-grown sunflowers (*Helianthus*)”. You should not include the title as a separate page (save the trees!), but it should head the first page of your proposal. Also include your name, group member names, date and pledge on the proposal.
Introduction

In this section you provide a review of the previous scientific literature on the topic that you are examining. Your aim is to put your research into context and to explain why you have formulated your hypotheses. The depth of this review will vary considerably among classes and projects, depending on the goals of your professor. A basic review would provide five to ten sentences on the theoretical context for the proposed research, citing a textbook that discusses the topic. A more in-depth review would involve several pages summarizing papers from the scientific literature, using this previous work to explain your hypotheses and the significance of your work.

Your introduction should start with a general review, then focus in to the more specific objectives and hypotheses of your experiment. It should be clear to the reader how the general literature review connects to the objectives of the study.

Hypotheses

Hypotheses are possible explanations for observed phenomena. The following examples show the general format of a hypothesis – a clear, testable statement about a biological phenomenon.

Example 1: The enzyme tyrosinase reacts more slowly with the substrate catechol to produce a colored product when buffered at pH 6 than it does at pH8.

Example 2: The species richness and evenness of beetle communities on the southern Cumberland Plateau is higher in cove forests than it is in upland forests.

Methods

In this section, you will describe, in a logical order, exactly what you propose to do.

Study site – If you are proposing a field study, you will begin the methods section with a concise description of the study site. It may be appropriate to mention approximately what time of year the study will take place.

Experimental Design – Here, you describe as clearly and concisely as possible, the steps necessary to complete your procedure, and to collect and analyze your data. Write this out in paragraph form, not as a list.

Your experimental design will outline your variables and treatments, as well as the number of replications per treatment, often referred to as “n” or “sample size” (e.g., n = 10). As you describe your methods, you will refer indirectly to the materials (equipment, instruments, sample collection materials, etc); do not simply list what you will use. Summarize all necessary equations in numerical format. Do not include unnecessary details that would not
be expected to influence the study’s outcome. Some examples of unnecessary details include:

- the data will be compiled in an Excel spreadsheet
- the color of flagging tape used to mark the plants in the field
- the size of the test tube into which you mixed your enzyme and buffer solution
- the fact that you push the blue button to turn on the spectrophotometer
- the length of the measuring tape used to run a transect
- the type of knot used to tie off a strip of dialysis tubing
- the number of each tube. The important detail here is what is in each tube (e.g. the solution, and/or its concentration) or its treatment (e.g. boiled, frozen, untreated)

Note that it is acceptable in some cases to cite methods from another scientific paper or from a manufacturer’s protocol in your methods. This saves space and allows you to focus on the “bigger picture” of the particularities of your experimental design. Check with your professor about whether or not these forms of citation are acceptable in your class.

Your methods should be clear about what variables you will be manipulating and measuring. A variable is a characteristic that may differ from one entity to another. In general, we test the effect of an independent variable (plotted on the x axis of a graph) on a dependent variable (plotted on the y axis of a graph). Technically speaking, the magnitude of the dependent variable (Y) is assumed to be a function of the independent variable (X). For this reason, the dependent variable is also referred to as the response variable.

For example, if you studied the effect of temperature on enzyme activity, temperature would be the independent variable (on the x axis) and activity would be the dependent variable (on the y axis). Or, if you compared the abundance of two different species of beetles, species would be the independent variable and abundance would be the dependent variable.

Independent variable treatments are the various levels or values of independent variable that you plan to test. They should be specified in your proposal along with the independent variable. For example, if you tested enzyme activity at several discreet pH levels, each level would be a “treatment” (e.g., pH 6.0, 7.0, 8.0, 9.0 and 10.0 are all different treatments).

**Statistical Analysis**

Write a concise statement about the specific statistical test(s) that will be performed on your data.

**Expected Results**

In this section you will provide a concise written statement about each predicted result, along with either a summary table or a summary figure depicting the trends you expect from your data. Obviously, you do not yet have any data, so these are merely predicted results to help visualize the types of graphs and tables that you will need to use in the final report. Note also that science is often more interesting and fruitful when our results confound our expectations – unexpected results yield previously unanticipated insights.
Statements about expected results should be concise but informative and make reference to the appropriate table or figure. Some examples:

- "Mean flower production will be significantly higher in sun-grown plants than in shade-grown sunflower plants (Figure 1; t-test, p < 0.05)"
- "The rate of enzyme action will be higher in a solution of pH 8 than in a solution of pH 6 (Table 1)"
- “Within the temperature ranges examined, there will be a significant positive linear relationship between the rate of enzyme activity and the temperature of the solution (R^2 = ____, P < 0.05)"

The format of the tables and figures should follow the accepted format for your particular class. In general, tables will have a descriptive title above the table. Figures have a figure legend below. The following generic examples illustrate these formats.

Table 1. Mean (±standard error) of the abundance of American Crows (Corvus brachyrhynchos) and Blue Jays (Cyanocitta cristata) in forested and suburban habitats on the Cumberland Plateau, TN.

<table>
<thead>
<tr>
<th>Species</th>
<th>Abundance (individuals detected per sample point)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forested habitat</td>
</tr>
<tr>
<td>American Crow</td>
<td>2.3 ± 0.2</td>
</tr>
<tr>
<td>Blue Jay</td>
<td>1.8 ± 0.3</td>
</tr>
</tbody>
</table>

Figure 1. Enzyme activity and temperature. Rate of enzyme activity plotted against temperature, with best fit line (linear regression, R^2 = 0.94, p = 0.01).