

Biomedical Science Experimental Design

Purpose

Scientific research requires a logical progression of steps that clearly define and focus the work being done. These steps are guided by a specific question or a problem. Research is rarely linear. Instead, scientists must be flexible, creative, and willing to change strategies. Persistence is essential as there are many more failures than successes in research. These failures often result in new strategies and new questions re-focusing research.

When designing an experimental procedure there are guidelines that will help you keep a logical progression of steps. Experiments have controls which allow for comparison and help prevent incorrect conclusions being made due to inconsistent conditions impacting the data.

The following experimental design is a guideline to be used when creating experiments in the PLTW Biomedical Science courses. It is not a strict “scientific method” protocol. It is a guide to help you create logical, thoughtful and clearly defined procedures for investigative work. You are expected to follow these guidelines when designing experiments.

Use your Lab Journal for recording all experimental design work. When recording your work write the number and title of each section as shown below. Following each design step is an explanation (shown in italics), of the format that is to be used in your lab journal for that specific step. The evaluation rubric is based on following the steps of design and using the correct format to record the information in your journal.

Steps of Experimental Design

1. Identify the Problem or Question

- State the research problem or question in one sentence.
- The problem should be very specific and measurable.

Write one sentence in the form of a question or problem statement.

2. Predict a solution to the problem or an answer to the question.

- This will be in the form of a hypothesis.
- This solution design or hypothesis should be based on previously obtained knowledge or research and be supported by scientific evidence.
- Identify the independent and dependent variables.
- The independent variable is the variable that is varied or manipulated by the researcher. The dependent variable is the measurable effect, outcome, or response in which the researcher is interested. In other words, the independent variable is the presumed cause, whereas the dependent variable is the presumed effect. In an experiment, the independent variable is the variable that is controlled and manipulated by the experimenter; the dependent variable is not manipulated but instead is observed or measured for variations.

Write a one or two-sentence statement predicting the outcome of the experiment. In a separate statement specify the independent and dependent variables.

3. Design the experiment to be used to test your hypothesis.

- Include a list of all materials used.
- Be specific.
- Take all safety concerns into account.
- Identify a control to be used for comparison if applicable.
- Control all outside variables that could affect the outcome of the experiment.
- Clearly define how the data will be collected and recorded, including measurement units.
- Design a data table to use to record information.
- Plan the strategy that will be used to summarize the data. For example, a graph might be used to summarize the data.

Write a series of numbered steps and include a list of required materials. The data table should include units that will be used to collect data.

4. Carry out the experiment.

- Collect data.
- Make observations.
- Complete multiple trials. (Do the procedure many times, collecting data each time).

Complete the data table including units and labels on each section.

5. Analyze the data and observations.

- Make graphs or charts of the data.
- Check that the independent and dependent variables are properly placed on any graphs.
- Be logical and clear.
- Look beyond the obvious.

Make graphs and charts to visually and logically present the data. Write in paragraph form and include calculations showing all work. All analysis should be explained clearly and concisely.

6. State the conclusion.

- Use a one sentence statement.
- Be clear and concise.

Write a one sentence statement directly related to the original hypothesis. It might start with “The hypothesis was correct...”

7. Summary Paragraph

- Write a brief paragraph.
- Explain the rationale for your conclusion.
- Clarify details.

Write a one paragraph of text explaining the rationale for the conclusion.

After step #7 there could be several options including but not limited to:

- Changing your hypothesis.
- Re-designing the procedure because of design flaws
- Developing new questions based on the work in this experiment.
- Moving on to a new or related research topic.