

# Biology Project –

This research project was developed with several objectives in mind. As a scientist you question things that are going on around you and the best way to get an answer is to design and conduct an experiment. As a scientist you also need to develop and practice your skills of observation, analysis and communication. This project will provide the opportunity for you to practice what a scientist does on the job. Your experience with research will help you in your other high school science classes and your college lab classes, in addition to other courses now and in the future.

This assignment is not to be completed in one evening. In order to do a good job with this assignment you will need to start early and not procrastinate. Think of this as an English term paper combined with a Biology lab activity. You need to complete sufficient background research before you can design your experiment. Then you need to set enough time to conduct your experiment at least one time - as you are designing your schedule be realistic with your previous time commitments. After your experiment is finished you then need time to analyze your results so that you can communicate your findings and conclusions.

## Selection of Topic

When you pick a topic please take the time to find something that interests you. Consider the amount of time that you will be able to give daily once your experiment begins. You need to be able to make thorough observations at roughly the same time each day. Make sure you are considering safety when selecting a topic!

Due to the complexity of vertebrates you are not allowed to conduct any experiments with them.

## Researching

When you start the research process, start with general references. This will give you a good background of some of the terms and concepts. Once you have a better understanding of your topic you can use more detailed sources specific to your topic. As you are researching, keep detailed records. Record the sources you have used, whether helpful or not, and the keywords that you worked with. This will help you if you have to do more research.

Notes – Be very careful to avoid plagiarism. This is simply copying information word for word from a source. Though it may be ok in just your notes, after all you may be the only one to see them, when it is time to write your paper you may forget that those are not your own words. Just copying information also leads to a poor understanding of it. You are better off writing everything in your own words. If you have to copy something use quotation marks and give the needed information about the source.

\*\*\* Your written material will be submitted digitally so that it can be evaluated by a plagiarism checking website.

# Introduction

This is the part of the paper that sets the stage for your reader. In this section you will offer a rationale for your experiment as well as provide background information starting with the general and becoming more specific. Keep in mind that this section will end with your hypothesis and you need to leave a logical trail that will lead to your hypothesis.

## Rationale:

This is where you explain why you are doing the experiment. Go beyond the obvious, that you are doing this as part of a class assignment; instead explain why you selected this specific topic. Stay away from saying you selected working with hamsters because you think they are cute or that you are working with bacteria because it is easy. Concentrate on the benefit of your results; how can your results be used in the future?

**Example:** If you are testing the effects of acid rain on the health of a plant a rationale is to learn what the effects are so the plants can be protected from acid rain. Acid rain continues to be a problem since it is a product of our pollution and unfortunately it is easier to treat the effects than it is to stop the production of acid rain.

## Background information:

In this part of the introduction you are laying the foundation for your hypothesis. You need background information on both the organism used and the environmental factor changed. For the organism you are concentrating on what is normal behavior/growth/color, etc. **Example:** I would find background information on the plant that I used. This information would include what the normal growth requirements are, such as, kind and amount of light, temperature, quantity and frequency of water, proper pH, and type of soil. I would also look for information to describe normal color and growth – paying attention to the factors that I measured during the experiment.

The information on the environmental factor should explain what it is and how it is supposed to affect organisms. If you can find examples of how it affects other organisms, include it. **Example:** I would get information on the formation of acid rain to explain why it is important to study – this helps to support the rationale. I would also need information on the harmful effects of acid rain – its corrosive properties, giving examples of how acid rain affects nonliving materials such as marble and brick, as well as living things as it lowers the pH of the environment. I could bring in information on ways to combat the effects of acid rain (using something to neutralize it), but it might work better in the discussion section.

## Hypothesis:

The last thing you need in the introduction is the hypothesis. Make sure your hypothesis is –

- clear
- testable
- supported by the information preceding it

**Example:** The weekly application of acid rain (pH 4.5) will make the plant lighter in color and will stunt the growth.

# Materials and Methods

This is basically the procedure that you followed. You need to write it with enough detail so anyone could do the experiment just like you did. Follow the guidelines below:

- provide details, especially of those methods that are unique to your experiment
- write in past tense (you have already done the experiment) and use passive voice  
**example:** use “The plant was watered every day . . .”  
instead of “I watered the plant every day . . .”
- identify the organism used with the scientific and common names, also mention age if appropriate and where you obtained it
- describe an apparatus/chemical that is unique to your experiment – don’t assume that your reader is familiar with all equipment/chemicals
- identify the difference between the control and the experimental organisms
- describe the normal care of the organisms (this is typically the care of the control) such as feeding/watering schedule, temperature and humidity of habitat, living accommodations, light source and distance from organism (if applicable)
- explain when you will make observations and what those will be – measure length/height/width/mass, behavior, color changes, respiration changes, performance of a task
- do not provide a list of materials – these will be obvious in your explanation of the steps followed
- also avoid using “First”, “Second,” “Then,” “Next,” “Finally” as it can be assumed that the steps are written in the order they were conducted
- provide a sketch of the set up – this is a good place to use the photos you have of your experiment. This part helps to show the organism in its habitat.
- include any safety precautions that you need to follow – address any possibilities, no matter how insignificant you feel they are.
- identify the ways that you will be disposing of the materials after they have been used; include clean up procedures for when the experiment is in progress.
- make sure your experiment tests your hypothesis

# Data and Analysis

This is the section where you will present your data. You need to make sure the presentation of your data/observations is clear and easy to read. Don’t assume that your reader knows exactly what you were doing. You can clear up any potential confusion by avoiding the use of abbreviations (except units for measurements), writing a detailed title for any figure or table, using units with each measurement, and providing a reference point for any descriptions (exactly what is meant by “big” or “greenish?”).

## Tables and Figures

- a table is what you might call a chart – it is information presented in rows and columns
- tables get numbers and titles at the top
- if it is a picture/diagram or a graph then it is a figure
- figures get numbers and titles at the bottom – leave space for it
- make sure the axes of the graph are spaced evenly (one square has the same value all along the axis) and labeled
- put units with all measurements – at the top of the columns in a table and along the axes of a graph
- use a grid around the information in a table – this makes it easier to read
- group similar data in a column, not a row

# Conclusions

In this part of the paper you will be pulling all the parts together. You will readdress your hypothesis and relate your results to it. You will determine the success of the experiment and will support this with specific results. When you are discussing the success of your experiment consider the significance of your results. If your experimental is only 0.1 cm bigger than your control, this is not significant. This would be a good place to calculate percent difference/error. If a calculation is not possible, use your best judgment on what is a significant difference.

Perhaps your decision could be that the experiment was successful, but did not significantly support the hypothesis and more experimentation is needed to be certain of success. When discussing your success/failure start with specific information – the important results of your experiment by referring to the data and the table/figure in which the information can be found. Remember, it is ok if your experiment did not support your hypothesis. You have not failed the assignment you just have to provide a reasonable explanation for your results. **Example:** The plant watered with acid rain (pH 4.5) grew considerably less than the control plant (2 inches compared to 5 inches) as shown in Table 1.

As you are explaining your results you should refer to information gathered while you were doing your background research – you can pull in points mentioned in your introduction. You should also refer to similar experiments. This will help to support your results by agreeing with your findings or showing that your hypothesis was correct but results were flawed. **Example:** Acid rain stunted the growth of the plant because the acid burned the roots, making it more difficult for them to pull in the necessary minerals and water. The acid also reacts with the minerals and nutrients in the soil making them unavailable to the plant. A study conducted by Jane Doe (15) showed pine trees exposed to acid rain (pH 5.0) grew 3 times slower than those watered with normal rain water (pH 6.5)

Discuss possible sources of error. These could include

- design errors – not having the right living conditions
- sampling errors – sample size, population/organism selected

Only mention errors that are most likely to have affected your experiment. One error that should always be included is sample size. You are not using enough organisms and need to consider individual differences and their influence on your results. For each error you mention you should offer a reasonable and detailed improvement. Don't just say "The sample size should be larger" but give a specific sample size.

End your discussion by referring back to the rationale in your introduction. Discuss whether or not your results can be used in the way you stated. Give other examples of how you can use your results. A good experiment also generates more questions than it answers. This would be a good place to make suggestions for future experiments – those that will expand on your findings.

# Bibliography

The sources are to be written in MLA format and submitted in alphabetical order by the author's last name. You may find citationmachine.net helpful in this. You are not allowed to cite a general encyclopedia – it can be used to help you find background information, but you need to find more specific details in a different source. Also single space within an entry but double space between them and have the first line start at the left margin while indenting the other lines. You need a minimum of **five** sources that you cite in your paper.