Chapter 1: SELECT A TOPIC

A successful science fair project is dependent on the selection of a topic that works for you!

Ask yourself:

1) Is the topic of interest to you?
2) Do you have some basic knowledge of this topic already?
3) Is it realistic to your abilities?
4) Do you have the resources (supplies, space, locations, money) to accomplish your Science fair goals,
5) And, how much time do you want to invest in this project?

Science Fair projects should lend themselves to expansion over several years. Start small your first year and expand your research in the years to come.

Your science fair project should fit into one of these five categories.

I. Animal Systems

- The study of animal systems, including life processes, health, nutrition, genetics, management and processing, through the study of small animals, aquaculture, livestock, dairy, horses and/or poultry.

Examples:

- Compare nutrient levels on animal growth
- Research new disease control mechanisms
- Effects of estrous synchronization on ovulation
- Compare effect of thawing temperatures on livestock semen
- Effects of growth hormone on meat/milk production

II. Environmental Services/ Natural Resource Systems

- The study of systems, instruments and technology used in waste management; the study of the management of soil, water, wildlife, forests and air as natural resources and their influence on the environment.

Examples:

- Effect agricultural chemicals on water quality
- Effects of cropping practices on wildlife populations
- Compare water movements through different soil types

III. Food Products and Processing Systems

- The study of product development, quality assurance, food safety, production, sales and service, regulation and compliance and food service within the food science industry.

Examples:

- Effects of packaging techniques on food spoilage rates
- Resistance of organic fruits to common diseases
- Determining chemical energy stored in foods
- Control of molds on bakery products

IV. Plant Systems

- The study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as well as growth and cultural practices, through the study of crops, turf grass, trees an shrubs and/or ornamental plants.

Examples:

- Determine rates of transpiration in plants
- Effects of heavy metals such as cadmium on edible plants
- Compare GMO and conventional seed/plant growth under various conditions
- Effects of lunar climate and soil condition on plant growth
- Compare plant growth of hydroponics and conventional methods

V. Power, Structural and Technical Systems

- The study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures.

Examples:

- Develop alternate energy source engines
- Create minimum energy use structures
- Compare properties of various alternative insulation products
- Investigation of light/wind/water energy sources

VI. Social Systems

- The study of human behavior and the interaction of individuals in and to society, including agricultural education, agribusiness economic, agricultural communication, agricultural leadership and other social science applications in agriculture, food and natural resources.

Examples:

- Investigate perceptions of community members towards alternative agricultural practices
- Determine the impact of local/state/national safety programs upon accident rates in agriculture/natural resource occupations
- Determine the economical effects of local/state/national legislation impacting agriculture/natural resources

Chapter 2: REVIEW of LITERATURE

The review of literature review is an investigation to determine what kind of information currently exists about the research topic you have chosen. You will want to gain background information about your topic before you begin. A good review of literature will lay the foundation for your project. It will help you understand the project better. A review of literature will give you direction and insight on your topic. In fact, your project might contribute to the "volume of knowledge" that currently exists about your topic.

To begin, dissect the topic area into three different parts or sub-questions. For each part, you will research and write a one paper on that sub-topic.

Topic-pH of Water

What effect does pH have on seed germination?

What is pH?
What factors affect seed germination?
How does a seed germinate?

Topic-Runoff

What effect does *nutrient runoff* have on the **health of Lake Trout**?

What is Runoff?
What nutrients are found in Runoff?
What are healthy Lake trout?

Topic-Fermentation

How does *time of fermentation* affect the **quality and quantity of ethanol**?

What are the different fermentation processes?
What are the contributing factors to high quality ethanol?
What are the critical factors influencing the quantity of ethanol production?

Topic- Corn Growth

What is the effect of *temperature* on **corn plant growth?**

What factors affect corn plant growth?
What are the stages of corn plant growth?
How does temperature affect plant metabolism?

Chapter 3: PURPOSE

The purpose will introduce the reader to the subject you will investigate. The purpose will discuss the current changes in science that make this area of research important. Once the scientific importance is explained, the financial or economic impact on agriculture should be described. The purpose is summarized with a statement of the specific problem that will be addressed and the objectives that explain how the problem will be solved. The problem and objectives explain exactly what your research project is intending to answer and how they will be accomplished.

Answering the questions in the space provided below, as an aid in writing a purpose. Be sure to write the purpose in third person (no I's or you's.) Organize these answers in a one to one and one-half page paper.

1) What is the subject that you researched?

2) What scientific changes or trends are important to your research?

3) What financial impact will this research have on agriculture?

4) What is the problem that this project will attempt to solve?

5) How is the problem going to be solved?

6) What will determine if the problem is solved?

Chapter 4: HYPOTHESIS

A hypothesis is an educated guess or prediction of what will happen as a result of doing your experiment. There is no right or wrong way to derive a hypothesis. It is what you think will be the answer.

A good hypothesis takes the form of: "If I do this, the, that will happened."

Examples:

- When flower seeds are fed an organic, natural fertilizer; they will germinate faster than those that are fed a synthetic, chemical fertilizer.
- Lab rat activity will increase when sugar is added to their daily diet.

- Fungal growth will be greater on home made bread as compared to store bought bread.

- Shredded bark will retain more moisture than wood chips as a garden mulch.

Many researchers (especially those just beginning to do scientific research) choose what is known as a **"null-hypothesis,"** which states that there will be no differences measured when comparing the groups used in the experiment. A null hypothesis is selected because it is easier to explain why differences occurred than to explain why there were no differences (should this occur) between groups in an experiment.

Chapter 4: HYPOTHESIS and NULL HYPOTHESIS

Once the purpose of your project has been stated, you must then have a **hypothesis** (which is considered an educated guess) concerning the outcome of the experiment before the experiment actually begins. Many researchers (especially those just beginning to do scientific research) choose what is known as a **"null-hypothesis,"** which states that there will be no differences measured when comparing the groups used in the experiment. A null hypothesis is selected because it is easier to explain why differences occurred than to explain why there were no differences (should this occur) between groups in an experiment.

Example Hypothesis:
Corn grown in soil with 150 pounds of nitrogen added per acre will have a yield over 150 bushels per acre.

Example Null-Hypothesis:
Corn grown in soil with 150 pounds of nitrogen added per acre will yield the same as corn grown in soil without nitrogen added.

Write a hypothesis and null hypothesis in the space provided below. Be sure to write them in third person (no I's or you's.)

Hypothesis:_____
_____
_____
_____
_____
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_____

Null Hypothesis: _____
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Chapter 5: PROCEDURE and MATERIALS

A well-written procedure and materials section will enable others to duplicate the same study. It should be written in third person, past tense, include **all** of the materials needed, and explain the technical and experimental procedures used. Use good judgment when presenting the details of the experiment. Tests or procedures should be noted but not described in extreme detail. It is best to assume that other researchers are familiar with techniques for handling equipment, taking basic measurements, logging information, etc.

The procedure should also explain the **controls** and **variables** in your experiment. A **control** is something that will remain constant in your experiment. The **variable** is what you are testing in your experiment, there should be only one **variable**. A **control** is essential so a comparison can be made with the **variable**.

- **Example Question:** What are the effects of nitrogen on root development of soybeans?

- **Example Controls:** Temperature, water, soil, light, phosphorus, seed planting depth.

- **Example Variable:** Plants grown with 15 lbs, 50 lbs, 100 lbs, and 150lbs per acre of nitrogen applied**.**

Repetitions are also important in an experiment. The experiment should be repeated at least **5 times**. When growing plants, the experiment should include multiple numbers of plants.

A negative control should be done as well. This would be a repetition where you do not apply your variable.

- **Example Negative Control:** Grow corn plants with no nitrogen added.

Complete these questions to help you write the procedure and materials section of your science fair report.

What is the question for the experiment?

_____
_____
_____

What are the controls for the experiment?

_____
_____
_____

What is/are the variable(s) for the experiment?

_____
_____
_____
_____

How many repetitions will be made?

_____
_____

What is the negative control?

_____
_____
_____

List all of the materials including the amounts, cost and suppliers use for the experiment.

Material	Cost per Unit	Number of Units	Total Cost	Supplier

What is the step by step procedure for the experiment?

1. _____
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Chapter 6: RESULTS/CONCLUSIONS

The **results** section is like a news story, it just gives the facts, while the **conclusion** section is like an editorial, it may contain personal thoughts.

The conclusion is an extremely important part of the paper. Begin by drawing conclusions from the results of the study and relating them to the original hypothesis. If the results were unexpected, take this opportunity to explain why. Next, draw conclusions why the results turned out the way they did. It is helpful to refer to some of the research that was done to explain why the results turned out the way that they did.

The **conclusion** should include the following points (in the order listed below):

- State the hypothesis and whether or not the results supported it.
- Briefly recap the results of the experiment
- If the experiment did not work out the way planned, explain why.
- Draw conclusions from your research that indicates why your results turned out the way that they did. THIS IS VERY IMPORTANT. You may

express your opinions (based on facts) and personal reason to make your conclusions.

The **results** should be a summary of the results your project has produced, even if they were not what you expected. Do not include discussion or conclusions about the data. In this section, describe trends and the results produced. Tell the reader exactly what you discovered and what patterns, trends or relationships were observed. Furthermore, decide on the most meaningful way to present the data (tables, figures, graphs) and refer to them in your text. Results are facts and data!

A science fair paper, must have at least 1 table AND 1 graph. However, do not limit yourself to one of each. If there is enough data to construct more tables and/or graphs—use it!

Each figure and table should have a descriptive caption. Tables should have clearly labeled columns, rows or axes and include units of measure. In the text, the word "table" is spelled out and in parenthesis as part of the sentence, e.g. (Table 1). The word "figure" is abbreviated and in parenthesis, e.g. (Fig. 1). The caption for a table is placed above the table: the caption for a figure (graph or chart) is placed below the figure. Both are at least 2 point sizes smaller then the point size of the text and are single-spaced.

An example table is shown below:

The growth of the corn plants that had fertilizer added to the water during growth showed significant increases in their growth patterns (Table 1).

Table 1: The growth of Plant A, in which fertilizer was added, is compared to the control, in which no fertilizer was added. This table shows a significant increase in growth of Plant A as compared to the control due to the fertilizer added.

	Growth of Plant A (cm)	Control (no fertilizer)
Day 1	0	0
Day 5	1	0
Day 10	6	2
Day 15	15	8

Chapter 7: WORKS CITED

This section of the paper lists all of the resources used to help write the Review of Literature and/or complete the experiment. This can include anything from magazines to internet to books. Each resource has its own method of how it is cited, and is cited using the **APA format**. The web page, shown below, will provide direction in citing sources.

http://webster.commnet.edu/apa/index.htm
Go to: Student's Questions About References
Simply Click on the reference used.

Example: Used an internet page, click on citing INTERNET AND CD-ROM RESOURCES

Works Acknowledged

This section of the paper lists the resources that were referenced but not used in writing the paper. These are cited like the *Works Cited*, using APA format and the above website. These would be the resources that helped gain additional information about the topic, but were not used when writing the Review of Literature.

Questions When Writing the Works Cited and Works Acknowledged:

How many references do I need?
5-10 references are required under *Works Cited*. They should be from various sources, for example two from internet, three from books, and two from magazines.

Do I need a Works Acknowledged?
The *Works Acknowledged* is optional, while the *Works Cited* is REQUIRED.

What is the format for the Works Cited and Works Acknowledged?

1. Single Space between lines on SAME reference
2. Double Space between DIFFERENT references
3. Every line after the first on the same reference is indented one TAB space.
4. Pay attention to bold, underline, italic and grammar in examples.

Example:

Linden, E. (1986). Silent partners: The legacy of the ape language experiments. New York: Random House.

Seyfarth, R.M. (1982, March-April). Talking with monkeys and great apes. International Wildlife, pp. 1, 14-16.

Chapter 8: ACKNOWLEDGEMENTS AND RECOMMENDATIONS

What are acknowledgements?
This is an optional section where individuals are recognized who significantly helped you in completing your project. Write the name or business, as well as well 1-2 sentences on how the help made your project easier or better.

Example:
University of Minnesota, Soils Lab: *Thank you to the U of M and Dr. Jensen for allowing the use of the lab for the experiment. It was the use of the lab equipment that allowed me to complete the experiment in a timely manner as well with less margin of error.*

What are recommendations?
This is also an optional section that would be included on the same page as the acknowledgements. Recommendations are solid, justified plans for how this project can be changed, expanded or improved in any way.

Example Project: How Can the Presence of Algae Be Reduced on Commercial Wetlands?

Results: By increasing oxygen levels with a bubbler, the algae amount was decreased. However the bubblers were not natural, causing decrease of wildlife and aesthetic beauty to the wetland.

Example of what recommendation would look like with above project:

Recommendation: It is found that waterfowl decay (from geese and other waterfowl) can be a crucial contributor to the decreased oxygen levels in wetlands. Therefore, instead of fixing the water, if the waterfowl can be "trained" to inhabit other areas, the water quality may be improved. If this project were to be expanded, natural grasses would be planted near the wetland to attract the waterfowl, causing less decay in the water.

Chapter 9: ABSTRACT

What is an abstract?

An abstract is a brief summary of the paper and project. The abstract will describe the purpose, procedure and results in a brief form. The abstract is most often the first and only part of the paper read during judging. It is from the abstract that an opinion is formed of your research and experiment.

What are the "rules" of writing an abstract?

1. No longer than one page, usually just one paragraph.
2. Single spaced
3. 12 cpi (characters per inch)
4. No first or third person
5. Keep it concise and clear, briefly summarize the experiment and research.

What is the format or order of the abstract?

1. Introduce the topic in 1-2 sentences without using the title.
2. Describe the purpose of project in 1-3 sentences. Be concise; do not just paste the other written purpose into the abstract.
3. Summarize the procedure or experiment in 2-4 sentences. It is important that the control and variables are mentioned in this. Remember; be concise!
4. Describe what the results were. This will be 1-2 sentences describing what happened overall.
5. Summarize the conclusion in 1-2 sentences. Verify if the hypothesis was or was not supported.

What does an abstract look like?

Example #1:

This study was conducted to determine if supplemental nutrition (above what the plant receive from the nutrient rich water) has an effect on growth and production when plants were grown hydroponically. The study utilized a commercial hydroponic unit, one control, and three experimental groups. The control group received only a traditional water/nutrient supply, while the variable groups received the following: 1) water/nutrients/granular fertilizer at the time of planting, 2) water/nutrients/powdered plant food added weekl, and 3) water/ nutrients/plant spikes added every eight weeks. The results were that the experimental group, which received the supplemental plant spikes, out performed all other groups for plant growth rate, time to first flowers, time to first fruit and total production. The weekly addition of plant food proved to be too strong, killing two plants and severely stunting and reducing the production of the third plant in this group. No differences existed between the control group and those plants that had granular fertilizer added at the time of planting. Therefore, supplemental nutrition had both a positive and negative effect on hydroponically grown plants.