SCIENCE FAIR FOUNDATION OF BC ALUMNI MENTORSHIP PROGRAMME

GUIDE TO COMPLETING YOUR SCIENCE FAIR PROJECT

Science Fair Foundation of British Columbia | Churmy Fan, Clara Westwell-Roper

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I. Introduction to the guide

So! You are doing a science fair project. How do you feel? Enthusiastic? Fearful? Adventurous? For some of you, it is an assignment given by a very keen teacher; for some of you, it is the pursuit of an idea that you have been passionate about since you were two; and for others, it was a kitchen disaster, turned into a scientific problem. Whatever the case, you are now full of questions and ideas. This booklet will help guide you through your project and calm your nerves!

II. Type of Project

The project that you choose will fall into one of a number of scientific categories and may be an experiment, innovation, or study.

A. Experiment

An investigation undertaken to test a specific hypothesis using experiments. Experimental variables, if identified, are controlled to some extent.

An outstanding experiment devises and carries out original experimental research which attempts to control or investigate most significant variables. This would include statistical analysis in the treatment of data.

For example: Can Windex kill cancer cells?

B. Innovation

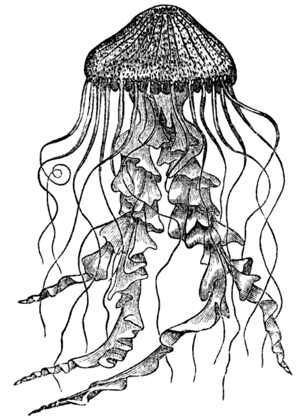
The development and evaluation of innovative devices, models, techniques or approaches in technology, engineering, or computers (hardware or software).

An outstanding innovation integrates several technologies, inventions or designs and constructs an innovative technological system that will have human and/or commercial benefit.

For example: The invincible rubber car – it will never crash!

C. Study

A collection and analysis of data to reveal evidence of a fact or situation of scientific interest. It could include a study of cause and effect relationships or theoretical investigations of scientific data.



An outstanding study synthesizes information from a variety of significant sources which may illustrate cause and effect or original solutions to current problems through synthesis. It identifies significant variables with an in-depth statistical analysis of data.

For example: The mysteries of the Bermuda Triangle revealed! Ship disappearances correspond to giant jellyfish migratory routes.

The originality of your project is extremely important as well. An outstanding project is highly original or has a novel approach to an existing question. The project should show resourcefulness, creativity in design and the use of equipment and/or construction of project.

III. The Process

A. Research your topic

Read books from the library; observe related events; gather existing information; look for unexplained or unexpected results. Talk to professionals; write to companies; and obtain or construct needed equipment. Academics and professionals are not scary! You need to get past your inhibitions and email or call these people. You may be surprised by how approachable they are.

There are many websites that provide you with hundreds of science fair project ideas. These are more like fun "template projects such as potato batteries, While a website can give you a general gist of project ideas, do not limit yourself. You want your project to be unique and you want to actually care about it! Think about your interests and hobbies! What do you do outside of school? There have been great projects in the past about different hockey stick designs, more effective running shoe sole for walking in the snow!

B. Organize and theorize

Organize your research. Narrow down your hypothesis by focusing on a particular idea. You can start is a broader topic then narrow it down. Just remember, you have a very limited timeline to find an answer to your question, so don't try to find the Answer to Life, the Universe, and Everything.

For example, we can build on the rubber car idea. There are many factors that can be used to judge whether a car is safe, such as how well the car holds its shape and, more importantly how much damage the driver and passengers suffer in the event of an impact. I now have the choice of measuring all of these factors to judge the safety of my rubber car, or I can focus on one factor which I think is the most important, how well are the passengers protected? Even now, there are many variables to test. I can make models to simulate the head and brain of an average person and see how impact affects brain structure, or I can make models to simulate the skeletal integrity of an average person.

C. Make a timetable

Choose a topic that can be done in the amount of time you have. Identify important dates including school deadlines and science fair registration dates. You should also involve your mentor in this process as well. Your mentor may have more experience in predicting how long each part of your experiment will take. Also, by working out a timetable together, you can get a better idea of what your mentor's schedule is like and when they have the most time to help you. Your mentors are all very busy people so having this timetable will help them work out their schedules as well. Remember to leave plenty of time to collect and analyze data. They are equally important in producing an excellent project. Lastly, leave time to write a paper and put together a display. A good way to start on your timetable is to work backwards.

D. Plan your experiment, study or innovation

Write a research plan to explain how you will do your experiment.

E. Consult your teacher/supervisor/mentor

Discuss your work with an adult supervisor on an ongoing basis.

F. Conduct your experiments, study, innovation

Keep detailed notes of every experiment, measurement, and observation. Change only one variable at a time when experimenting. Include control experiments in which none of the variables are changed. Include sufficient numbers of test subjects in both control and experimental groups.

For many students, obtaining access to equipment beyond what is offered in their schools is a big challenge. For the most part, equipments found in your home kitchen and garage is sufficient. In fact, it is almost preferred that you construct your own equipment as this shows that you understand the whole process of what you are measuring and how the measurement is done. If you use more high-tech equipment, the process of measurement is hidden. All you have to do is put in a sample, and the machine will spit out a number. Judges at science fairs often encounter a situation where they see a very well-made poster with flawless data analysis, but when asked, the student does not understand what values were actually measured and what that meant. This would lead the judge to think that the student doesn't completely understand his/her project.

On the other hand, some projects just can't be completed with home-made equipment. In this case, students need to gain access to professional equipment, most likely at a university. Many students are afraid to approach professionals and professors. To students, these people seem like a whole different species of animal. Actually, most of them are very friendly and approachable. One student obtained access to a viscometer in a university lab. When I asked him how he approached the professor, he replied: "I simply phoned them and they are extremely nice so they agreed :D " (the smiley face was part of the original text)

G. Examine your results

When you complete your experiments, examine and organize your findings. Did your experiment give you the expected results? Was your experiment performed with the exact same steps each time? Are there other causes that you had not considered or observed? Were there errors in your observations? If possible, analyze your data statistically.

H. Draw conclusions

Which variables are important? Did you collect enough data? Do you need to conduct more experimentation?

IV. Written materials

A critical part of any scientific project is to record your results and conclusions properly. This section outlines the important steps for you and your project.

A. Abstract

An abstract is written once your research and experimentation are complete. It should include a statement of the problem/purpose of the experiment, the procedures used, your data and your conclusions. For the Canada-Wide Science Fair, your abstract must not exceed five double-spaced typewritten pages. Check locally for requirements of your regional fair. Abstracts are distributed to the judges to familiarize them with the project. The abstract is evaluated as part of the project. At the end of your abstract, and also in your research paper and poster, it's very crucial for you to thank your mentors and other people who helped you complete your project!

B. Project Data Book

A project data book should contain accurate and detailed notes to demonstrate consistency and thoroughness to the judges and to assist you with your research paper.

C. Research Paper

A good research paper is like a storybook. It should introduce the reader to the characters and the setting - the topic of your project and background information, then progress to the adventures and challenges that the characters face - the experiment, and finally how the characters overcome the challenges – the results and conclusion.

1. Title page

Centre the project title and put your name, address, school and grade at the bottom right.

2. Table of contents

Include a page number for the beginning of each section.

3. Introduction

Includes your hypothesis, an explanation of what prompted your research and what you hoped to achieve.

4. Hypothesis

The hypothesis is one of the most important parts of your project. It is your proposed explanation for a scientific question based on facts that you have gathered from literature. Your hypothesis will set the "theme" of your project. How you design your experiment and collect data, are all related to how you form your hypothesis.

Example: Dishcloth vs. Sponge. Is it better to use a dishcloth or a sponge to do the dishes?

> *Hypothesis A: My hypothesis is that it is better to use a dishcloth to do the dishes.*
>
> *Hypothesis B: Since bacteria tends to multiply in moist and protected places and sponges have many holes to protect the bacteria from being washed away, my hypothesis is that it is better to use a dishcloth than a sponge to do the dishes.*

In this example, Hypothesis B is better than Hypothesis A even though they predicted the same thing. On top of the prediction, Hypothesis B stated the variable, bacteria, that will be tested to determine what "better" means.

5. Experiment

Describe in detail the methodology used to collect your data or make your observations. Include enough information for someone to repeat the experiment. Include detailed photographs or drawings.

Clearly state your variables and controls. This is something that many students overlook in their projects. The variable is one element or detail that you are manipulating and changing to test for your hypothesis.

For example, in the Dishcloth vs. Sponge project, the variable is the materials used to wash dishes: sponge and dishcloth. The variable is NOT the amount of bacteria because you are not manipulating this element of your study; you are merely observing how this element is affected.

The purpose of a control is to make sure that the observations you make from your experiments are the result of changing your variable, and ONLY that variable.

Using the same example, if we just compare the amount of bacteria in a dishcloth and sponge, we will not get a valid result because a dishcloth has a larger surface area than a sponge and a sponge is thicker than a dishcloth, which can greatly impact your results. Keeping in mind that you are testing for a difference between the materials only, a control that you can do would be cutting the sponge so that it is the same thickness and area of a dishcloth, and then compare the amount of bacteria in those two materials. You can also cut the two materials so that they are the same weight, and then compare their bacterial content.

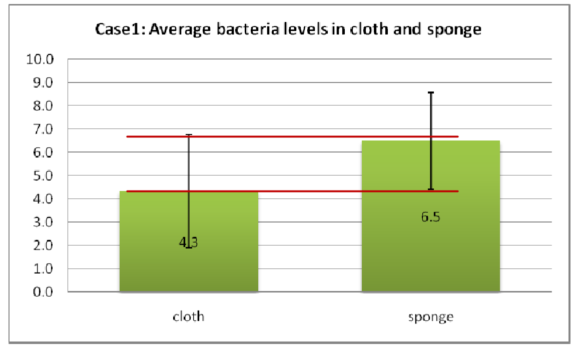
6. Results

Your results should include raw data that have not been altered, as well as analyzed data. In your data analysis, it is crucial to include statistics. Without statistics, you cannot say for sure whether the differences you observed were significant differences or were simply out of luck.

For example, my raw data would include the size and thickness of each piece of dishcloth and sponge, the temperature of the room when I conducted my experiment, how long I soaked my materials in dirty water, and how much bacteria was found in each piece of material. For my data analysis, I can average out the amount of bacteria in all of my cloth samples and compare that to the average from sponge samples. If, say, the amount of bacteria in sponges was higher than in cloths, I can use standard deviation to determine whether the difference is significant or not.

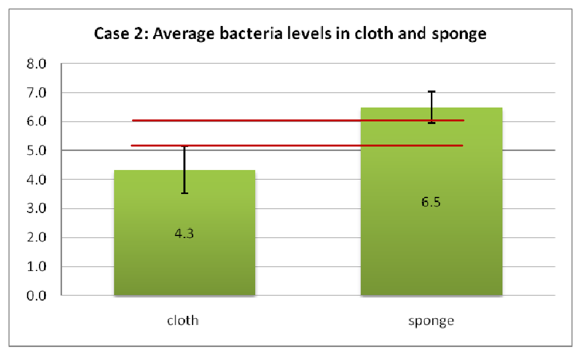
Case 1. Amount of bacteria

Sample	cloth	sponge
a	2.0	4.0
b	2.0	7.0
c	3.0	6.0
d	6.0	5.0
e	5.0	7.0
f	8.0	10.0
Average	4.3	6.5
STDEV	2.4	2.1



Case 2. Amount of bacteria

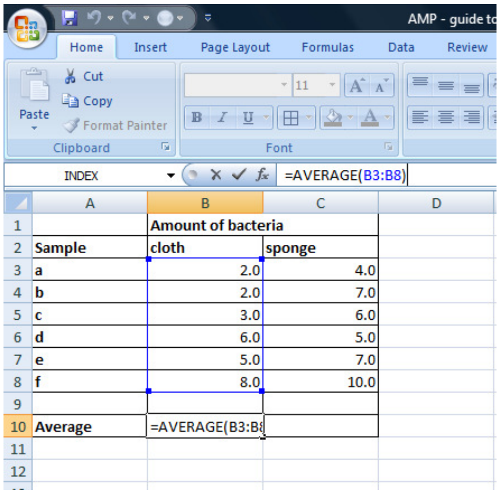
Sample	cloth	sponge
a	4.0	6.0
b	5.0	7.0
c	5.0	6.0
d	4.0	6.0
e	5.0	7.0
f	3.0	7.0
Average	4.3	6.5
STDEV	0.8	0.5



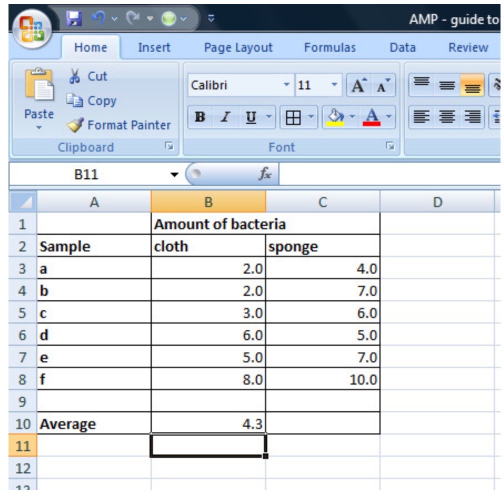
Notice how the average amount of bacteria found in cloth is the same in case 1, likewise for sponge. However, the standard deviation in case 1 is much bigger than in case 2. Visually, you can see that the error bars overlap in Case 1 but do not in Case 2. Thus the data that we have for case 1 is less reliable than in case 2. In case 2, we can say that the difference in bacterial content between cloth and sponge is SIGNIFICANTLY different.

How do we calculate for standard deviation? Here's the shortcut using Microsoft Excel…

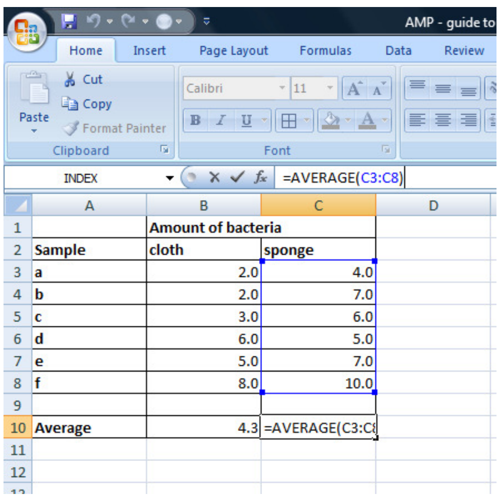
1


=AVERAGE(B3:B8)
Amount of bacteria
Sample
cloth
sponge
Average

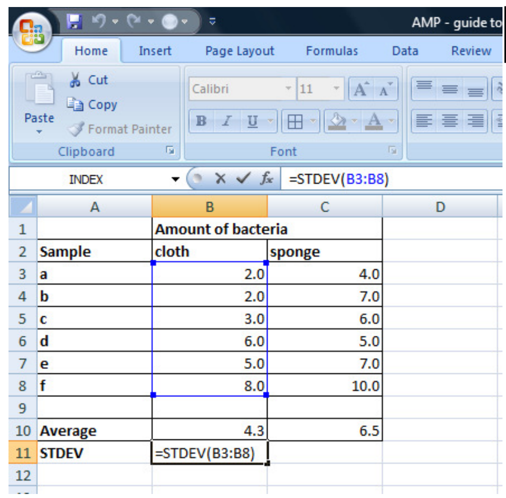
2


Amount of bacteria
Sample
cloth
sponge
Average
4.3

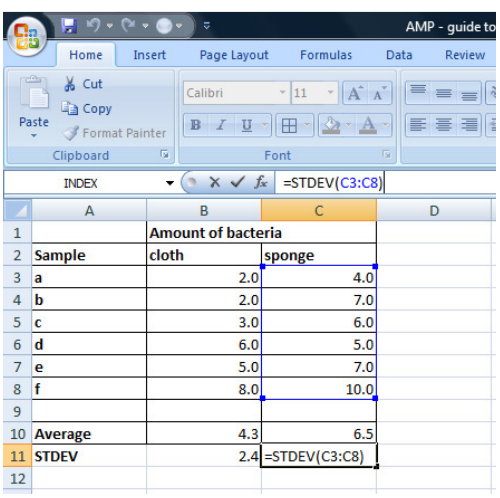
3


=AVERAGE(C3:C8)
Amount of bacteria
Sample
cloth
sponge
Average

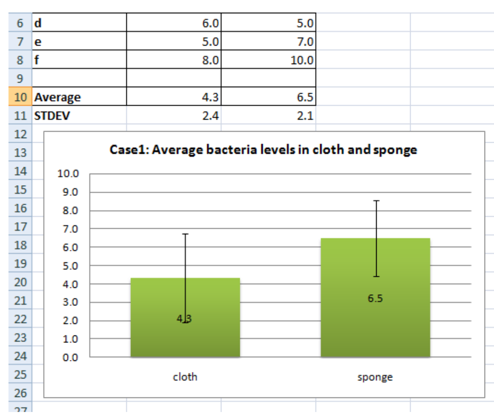
4


=STDEV(B3:B8)
Amount of bacteria
Sample
cloth
sponge
Average
STDEV

5


=STDEV(C3:C8)
Amount of bacteria
Sample
cloth
sponge
Average
STDEV

6


Average
STDEV
Case1: Average bacteria levels in cloth and sponge
4.3
6.5
cloth
sponge

7. Discussion

Thoroughly discuss exactly what you did in your project. Your results should be compared with theoretical values, published data, commonly held beliefs and/or expected results. Did you results support or disprove your hypothesis? A discussion of possible errors should be included as well as how the data varied between repeated observations, how your results were affected by uncontrolled events, what you would do differently if you repeated the project, and what other experiments should be conducted.

Also! Research up on similar experiments that have been published online, in books, in journals, etc. Compare your results and discuss if they are similar, different, and why. If you can't get access to certain articles, you can ask your mentor or a regional science fair coordinator for help.

Remember, if your hypothesis is disproved, it's not the end of the world! Many exciting discoveries are based on disproved hypotheses.

For example: Which would make ice cubes faster? Hot water, or cold water? Instinctively, your hypothesis would be that cold water freezes faster than hot water, that is, if you haven't heard of the Mpemba effect. This phenomenon is the observation that hot water freezes faster than cold water. It was not discovered by a famous physicist or chemist. The phenomenon was discovered by a Tanzanian highschool student named Erasto B. Mpemba. Mpemba was making ice cream in cooking class but fell behind on schedule. So instead of freezing his ice cream after it's been chilled, he froze it while it's still hot and it froze before everyone else's!

8. Conclusion

The conclusion is not just a summary of your results; it is the answer to your question. It is what you have shed sweat and tears, and possibly blood, for over the past few months. So, write it wisely. You are tremendously proud of what you have written! So display it to your audience clearly and to-the-point. You don't want to hide your genius discoveries behind run-on sentences and poetic verses. You want to very simply tell your audience: "This is what I found and it tells me that my hypothesis is true/false. From this I learned that …"

In your conclusion, you should also mention whether your data was reliable. If you did the same experiment again, would you come up with the same results?

9. Acknowledgements

Accredit individuals, businesses and educational or research institutions who assisted you. Identify financial support or in-kind donations.

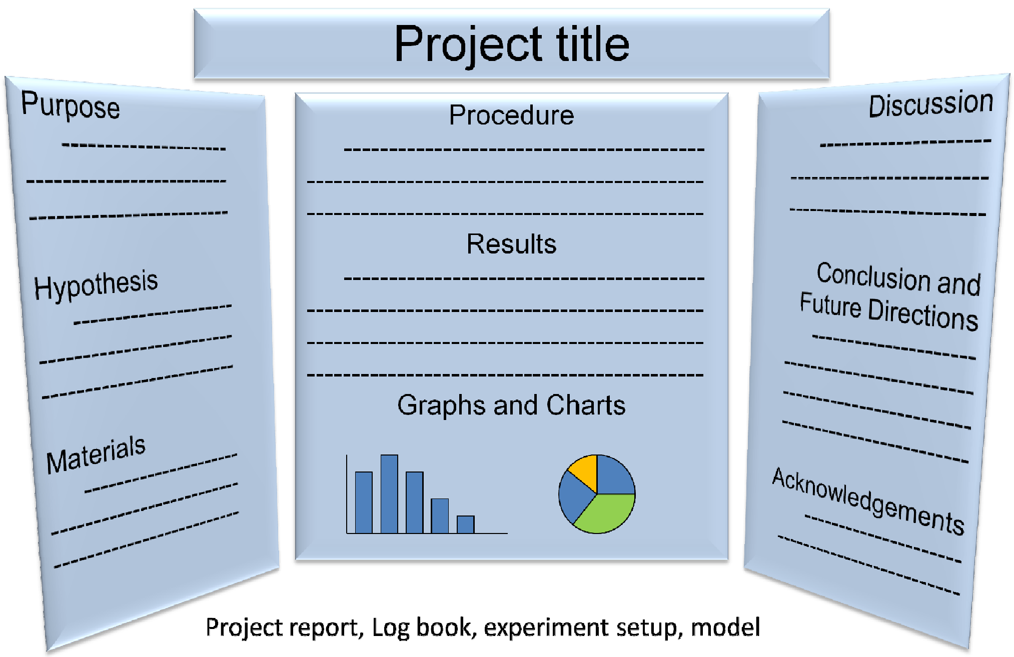
10. References

List any documentation that is not your own (ie books, journals articles, websites). See below.

V. Display

Your display is the first impression that the audience (the public and judges) has of your project. It is important to have a poster that is easy to read and has a logical flow. Conventionally, the audience will read your poster from left to right, thus this is the most logical way to present your poster.

Remember, your poster display is NOT your research paper. Avoid putting too much text on it, rely more on diagrams and graphs to communicate your message. Use larger fonts to make life easier for your audience.



VI. References

Include literature and websites that you read, whether or not you directly quoted them. You can have two sections for references: Sources Cited for those that are directly referenced to in your poster and report, and Sources Consulted for other references. Sources that are directly referenced in your text should have the name of the author and date immediately after the text as well as an entry in the Sources Cited section.

For example: "Scientists at the Giant Jelly Research Station detected massive migration movements around the Bermuda region on December 6, 1986, which corresponds to the date when the ship disappeared. (Smith, J., 1999)"

Generally, we use the APA (American Physchological Association) format for citations. The reason??? I'm not too sure! The point of it is to give proper credit for sources where you borrowed ideas from. Don't hesitate to give credit! You will not be penalized for doing too much research into your topic! If you are not sure whether you sort-of maybe perhaps borrowed an experiment design from a magazine, or used a picture online and modified it to put on your poster, cite it!

Different kinds of sources will require different citation format. Below are citation formats for books, encyclopedias and dictionaries, magazine and newspaper articles, and websites. (Format and examples taken from Science Buddies (2010)).

A. Books

1. Format

Author's last name, first initial. (Publication date). *Book title*. Additional information. City of publication: Publishing company.

2. Examples

Allen, T. (1974). *Vanishing wildlife of North America*. Washington, D.C.: National Geographic Society.

Boorstin, D. (1992). *The creators: A history of the heroes of the imagination*. New York: Random House.

Nicol, A. M., & Pexman, P. M. (1999). *Presenting your findings: A practical guide for creating tables*. Washington, DC: American Psychological Association.

Searles, B., & Last, M. (1979). *A reader's guide to science fiction*. New York: Facts on File, Inc.

Toomer, J. (1988). *Cane*. Ed. Darwin T. Turner. New York: Norton.

B. Encyclopedias and reference books

1. Format

Author's last name, first initial. (Date). Title of Article. *Title of Encyclopedia* (Volume, pages). City of publication: Publishing company.

2. Examples

Bergmann, P. G. (1993). Relativity. In *The new encyclopedia britannica* (Vol. 26, pp. 501-508). Chicago: Encyclopedia Britannica.

Merriam-Webster's collegiate dictionary (10th ed.). (1993). Springfield, MA: Merriam-Webster.

Pettingill, O. S., Jr. (1980). Falcon and Falconry. *World book encyclopedia*. (pp. 150-155). Chicago: World Book.

Tobias, R. (1991). Thurber, James. *Encyclopedia americana*. (p. 600). New York: Scholastic Library Publishing.

C. Magazine and newspaper articles

1. Format

Author's last name, first initial. (Publication date). Article title. *Periodical title, volume number(issue number if available)*, inclusive pages.

2. Examples

Harlow, H. F. (1983). Fundamentals for preparing psychology journal articles. *Journal of Comparative and Physiological Psychology, 55*, 893-896.

Henry, W. A., III. (1990, April 9). Making the grade in today's schools. *Time, 135*, 28-31.

Kalette, D. (1986, July 21). California town counts town to big quake. *USA Today, 9*, p. A1.

Kanfer, S. (1986, July 21). Heard any good books lately? *Time, 113*, 71-72.

Trillin, C. (1993, February 15). Culture shopping. *New Yorker*, pp. 48-51.

D. Websites

1. Format

Author's name. (Date of publication). *Title of work*. Retrieved month day, year, from full URL.

2. Examples

Devitt, T. (2001, August 2). Lightning injures four at music festival. *The Why? Files*. Retrieved January 23, 2002, from http://whyfiles.org/137lightning/index.html

Dove, R. (1998). Lady freedom among us. *The Electronic Text Center*. Retrieved June 19, 1998, from Alderman Library, University of Virginia website: http://etext.lib.virginia.edu/subjects/afam.html

Note: If a document is contained within a large and complex website (such as that for a university or a government agency), identify the host organization and the relevant program or department before giving the URL for the document itself. Precede the URL with a colon.

Fredrickson, B. L. (2000, March 7). Cultivating positive emotions to optimize health and well-being. *Prevention & Treatment*, 3, Article 0001a. Retrieved November 20, 2000, from http://journals.apa.org/prevention/volume3/pre0030001a.html

GVU's 8th WWW user survey. (n.d.). Retrieved August 8, 2000, from http://www.cc.gatech.edu/gvu/usersurveys/survey1997-10/

Health Canada. (2002, February). *The safety of genetically modified food crops*. Retrieved March 22, 2005, from http://www.hc-sc.gc.ca/english/protection/biologics_genetics/gen_mod_foods/genmodebk.html

Hilts, P. J. (1999, February 16). In forecasting their emotions, most people flunk out. *New York Times*. Retrieved November 21, 2000, from http://www.nytimes.com

If you like, you can separate references into:

- Text that you quoted or directly made reference to in your text – call this Sources Cited.
- Text that you consulted for background information but did not directly refer to in your text – call this Sources Consulted.
- Images that you copied and used in your research paper and poster, or images that you took and then edited before using in your research paper and poster – call this Images Cited.

Below are references for this handbook.

Author's name. (Date of publication). *Title of work*. Retrieved month day, year, from full URL.

VII. References

A. Sources

Science Fair Foundation BC. (2010). *For Students*. Retrieved March 4, 2010, from http://www.sciencefairs.bc.ca/students.html (consulted)

Science Buddies. (2010). Writing a Bibliography: APA Format. Retrieved March 16, 2010, from http://www.sciencebuddies.org/science-fair-projects/project_apa_format_examples.shtml (cited)

B. Other useful websites

AMP: http://www.sciencefairs.bc.ca/mentorship.html

SMARTS: http://www.ysf.ca/SMARTS/support/resources.aspx

Let's Talk Science: http://www.letstalkscience.ca/