



## CoursePak for descriptive labs—Lab experiments based on observation and procedure

*Description:* The following documents provide you with a packet of all core LabWrite materials you can print or use in PDF format. Note that the Resources page included here only contains a list of LabWrite Resources. If you want a particular resource, you'll have to go to the Resources homepage and print it.

## Descriptive Labs SelfGuide

Printable Version

### PreLab: questions to answer before doing the lab

*First, carefully read the description of the lab.*

In most lab classes, you will have a lab manual that contains background for the lab and directions for doing the lab procedure. There may also be handouts or other materials you have access to. Read it all. And don't just skim it. In fact, you may need to read it more than once to get a good grasp of it.

*Next, answer the following questions about the lab:*

#### 1. What are you supposed to be learning about by doing the lab?

The goal of this lab is to help you learn about a scientific concept (principle, theory, law) or about a laboratory procedure. Based on your reading of the lab materials, identify the scientific concept and/or lab procedure you are supposed to be learning about. Then write down what you know about the concept or procedure of the lab based on information from the lab manual, textbook, class notes, handouts, etc.

If you are having trouble identifying what the lab is about--the scientific concept or laboratory procedure--check the title and introduction to the lab in the lab manual. It will be something like photosynthesis, quantization of energy, momentum conservation, distillation, hydrolysis, etc...

When you are writing down what you know about the concept/procedure, there is no need to try to make it pretty; just write it. Get as much down as you can. Because the point of the lab is to learn something about science, it's important to state what you already know about it.

#### 2. What are the objectives for this lab?

Describe the specific actions you are being asked to perform in the lab, such as observe, analyze, determine, etc.

Objectives are the activities you are being asked to do in order to complete the lab. Often the objectives are listed in the lab manual. You can list the objectives or write them in a paragraph. If they are not listed in the lab manual, read the lab procedure and figure out from the procedure what the objectives of the lab are. Because objectives are activities, be sure to list them as such: to observe, to analyze, to determine something.

#### 3. What is the overall purpose of the lab?

Briefly describe how what you are being asked to do in the lab (the objectives) will help you learn about the scientific concept(s) or laboratory procedure(s). In other words, show the link between your response to question 2 (what you will do in the lab) to your response to question 1 (what you are supposed to be learning by doing the lab).

This is where you make the all-important link between what you are doing and what you are learning. For example, if the scientific concept is cellular structure, how will observing plant and animal cells under the microscope help you understand cellular structure? This is the kind of question you need to ask yourself. If you are having some difficulty determining the purpose, read over what you have written about the scientific concept/procedure and objectives. Describe how you think completing the lab objectives will help you learn about the concept or procedure?

#### 4. What are some questions you have about the lab?

Look for aspects of the lab--related to the scientific concept, procedure, or anything else--that you don't understand or would like to know more about. Turn these into a list of questions. These questions provide a focus of inquiry for the lab.

As you read the background material for the lab, it is very likely that there will be some things about the lab that are uncertain to. Perhaps, you don't fully understand part or all of the scientific concept for the lab. Or perhaps you don't understand some details about how to perform the lab procedure. It may be that you are curious about how you can apply the lab protocol to another situation.

These questions may focus more generally on both the content material and the procedures of the lab. Such questions will guide your understanding of the laboratory concepts and will help you build a good Discussion for your lab report. For example, if conducting a dissection lab, you may want to know about the function of specific anatomical structures, you may want to know about differences between the organism you're studying and other related or unrelated organisms, you may want to know about diseases, you may want to know about different dissection tools or techniques, etc. Keep in mind that you will probably add questions to this list during.



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**NC STATE UNIVERSITY**

## **PreLab: questions to answer before doing the lab**

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Lab Section: \_\_\_\_\_

Lab Title: \_\_\_\_\_

### ***First, carefully read the description of the lab.***

In most lab classes, you will have a lab manual that contains background for the lab and directions for doing the lab procedure. There may also be handouts or other materials you have access to. Read it all. And don't just skim it. In fact, you may need to read it more than once to get a good grasp of it.

*Note:* This is the handout version, which only contains the Descriptive PreLab questions. For more help or additional information, you'll need to go to the on-line version of Descriptive PreLab at <http://labwrite.ncsu.edu> where you can view additional materials on-line or obtain a full printable version from the Descriptive Labs homepage.

### ***Next, answer the following questions about the lab:***

1. What are you supposed to be learning about by doing the lab?

The goal of this lab is to help you learn about a scientific concept (principle, theory, law) or about a laboratory procedure. Based on your reading of the lab materials, identify the scientific concept and/or lab procedure you are supposed to be learning about. Then write down what you know about the concept or procedure of the lab based on information from the lab manual, textbook, class notes, handouts, etc.

## **2. What are the objectives for this lab?**

Describe the specific actions you are being asked to perform in the lab, such as observe, analyze, determine, etc.

## **3. What is the overall purpose of the lab?**

Briefly describe how what you are being asked to do in the lab (the objectives) will help you learn about the scientific concept(s) or laboratory procedure(s). In other words, show the link between your response to question 2 (what you will do in the lab) to your response to question 1 (what you are supposed to be learning by doing the lab).

## **4. What are some questions you have about the lab?**

Look for aspects of the lab--related to the scientific concept, procedure, or anything else—that you don't understand or would like to know more about. Turn these into a list of questions. These questions provide a focus of inquiry for the lab.

# Descriptive Labs SelfGuide

Printable Version

## InLab: the lab procedure

### 1. Setting up the lab:

Before you start the lab, review the objectives and the procedures you will follow. Take detailed notes as you gather your materials, set up your lab, and calibrate instruments. These notes will help you document your experimental protocol, which you can use later when writing the Methods section of your lab report.

- List the materials you will be using. If using a specific instrument, you may want to make a sketch with appropriate labels for your lab notebook and for your lab report. If you have any questions about how to use any of the materials or equipment you will need for your lab, make sure to write them down. As you proceed with the lab, you will most likely find the answers. These notes will help you later when you write your lab report.
- When using laboratory equipment, there are many sources of error or uncertainty [pop-up] that may arise. Make sure to note these in your lab notebook. You will need to refer to them again when you write your lab report.
- In your lab notebook or manual, identify the types of data, you will be collecting during the lab, such as drawings, lists of physical properties, or descriptions of chemical reactions. Identifying types of data will make you ready to record your data properly in your lab notebook or manual.

Go to the on-line version of this document to see **example lab notebook pages**.

### 2. Preparing to collect data:

If you are collecting [quantitative data](#), identify the [variables](#) and [units of measurement](#) and create a **table** or set up a **spreadsheet** (for help with creating tables or setting up spreadsheets, go to the on-line version of this document or go to the LabWrite Resources homepage). If you are collecting [qualitative data](#), determine the kinds of data you will be collecting and then prepare appropriate materials for recording observations (drawings, [tables](#) for observations, photographs, etc.). Read the lab manual to see what kinds of data you are being asked to record and be sure that you are ready to record the data in the appropriate form when you begin the lab procedure.

Whatever the data may be, it is very important that you decide whether a [table or spreadsheet](#) is best for organizing your data so that you can refer to them later on when writing your lab report. (See below for definitions of underlined terms.)

#### ***Quantitative Data:***

Quantitative data are data for which the scale of measurement has magnitude and is either interval or ordinal. Quantitative values are continuous, so each possible value may be greater or less than any other value. Ordinal data has an order but the distance between values does not have precise numerical meaning. For example, rank in a graduating class or ranking of runners in a race. Interval data uses a scale that has a specific numeric distance between values: it has a unit of measurement. For example, the time which the runners ran the race is interval data.

### ***Qualitative Data:***

Qualitative data are data for which the scale of measurement is a set of unordered categories called a nominal scale. For example, types of trees, types of compounds, etc. Qualitative variables are considered discrete variables, because they vary in some quality but not magnitude--one category is not greater than the other.

Qualitative data are based on observations that do not lend themselves to numerical measures. They often call on scientists to make judgments about data. Qualitative data can be a record of differences in qualities, such as color change of a solution or the vitality of a plant over time. These kinds of data may be recorded in a table. Or qualitative data can be pictorial, such as a cell seen through a microscope or the petal structure of a flower. These kinds of data may be recorded in drawings or photographs.

### ***Variables:***

A variable is what is measured or manipulated in an experiment. Variables provide the means by which scientists structure their observations. Identifying the variables in an experiment provides a solid understanding of the experiment and what the key findings in the experiment are going to be.

To identify the variables, read the lab procedure described in the lab manual. Determine what you will be measuring and what you will be manipulating for each measurement. The first of these are the dependent variables and the other is the independent variable (see definitions and examples below). Write down the dependent and independent variables.

A dependent variable is what you measure in the experiment and what is affected during the experiment. The dependent variable responds to the independent variable. It is called dependent because it "depends" on the independent variable. In a scientific experiment, you cannot have a dependent variable without an independent variable.

An independent variable is the variable you have control over, what you can choose and manipulate. It is usually what you think will affect the dependent variable. In some cases, you may not be able to manipulate the independent variable. It may be something that is already there and is fixed, something you would like to evaluate with respect to how it affects something else, the dependent variable.

It is possible to have experiments in which you have multiple variables. There may be more than one dependent variable and/or independent variable. Usually, you choose one independent variable at a time and observe its effect on one or more dependent variables.

### ***Unit of Measurement:***

A standard of basic quantity or increment by which something is divided, counted, or described, such as ml, kg, mm, m/s, °F, etc.

### ***Creating a Table or a Spreadsheet:***

A table provides a very convenient tool for organizing the data you collect in your lab. You can quickly draw a table on a sheet of paper, you can make one with a word processing program, or you can generate one with spreadsheet software. Using a hand-drawn table in the lab also allows you the flexibility of entering the data into a spreadsheet at a later time. The chief advantage to entering data in a spreadsheet is that you can easily convert it not only into a table but also into all

sorts of graphs.

Use this guide to figure out whether or not you should use a table or a spreadsheet for recording your data in the lab:

If you do not have access to a computer with spreadsheet software in your lab, then you should create a table. You can use the data in the table to generate a spreadsheet later, if necessary.

If you know you will need to create graphs for your data and have access to spreadsheet software in the lab, then use the spreadsheet.

If you are not sure what form, table or graph, you will be using to report your findings and it is convenient to use a spreadsheet, then use a spreadsheet.

If creating a spreadsheet in the lab will take too much lab time, then use a table and create the spreadsheet later.

### 3. Collecting and recording lab data :

Carefully follow the experimental protocol. As you conduct your experiment and record your data, take notes on what you are doing and on any changes in the procedure. Taking good notes will help you recall the lab later on when you are writing your lab report. It's also important to note any problems with the procedure or deviations from the established protocol. Even if you are following the protocol in a lab manual, sometimes you will set up and run things differently. It could be that the materials specified in the lab manual were not available precisely as indicated, or perhaps your lab instructor decided to change the protocol somewhat.

As you record your data, you should be asking yourself various questions: What are the [relationships among the variables](#)? Do the data behave in the way that you had anticipated? If not, why not? If the data make no sense, you may need to consider [sources of uncertainty](#) once again. Sources of uncertainty may affect the [accuracy and precision](#) of your experimental data (See below for definitions of underlined terms.)

#### ***Relationships Among the Variables:***

Since dependent variables "depend" on independent variables, there has to be a relationship between the two. The relationships between the dependent and independent variables are what is described in the hypothesis. So it's important to determine what those relationships are in order to see whether or not the hypothesis has been supported.

#### ***Sources of Uncertainty:***

In science, a source of uncertainty is anything that occurs in the laboratory that could lead to uncertainty in your results. Sources of uncertainty can occur at any point in the lab, from setting up the lab to analyzing data, and they can vary from lab to lab. This is why it is so important to keep detailed notes of everything you do in the lab procedure and any problems you encounter. Try to be especially aware of any problems in setting up the lab, calibrating instruments, and taking measurements as well as problems with the materials you are using.

For advanced labs, you may want to classify the kinds of uncertainty you have identified. Sources of uncertainty can be classified as random-those that cannot be predicted-or as systematic-those that are related to personal uncertainty, procedural uncertainty, or instrumental uncertainty.

#### ***Accuracy and Precision:***



Accuracy refers to the closeness of a measured value to a standard or known value. For example, if in lab you obtain a weight measurement of 3.2 kg for a given substance, but the actual or known weight is 10 kg, then your measurement is not accurate. In this case, your measurement is not close to the known value.

Precision refers to the closeness of two or more measurements to each other. Using the example above, if you weigh a given substance five times, and get 3.2 kg each time, then your measurement is very precise. Precision is independent of accuracy. You can be very precise but inaccurate, as described above. You can also be accurate but imprecise.

For example, if on average, your measurements for a given substance are close to the known value, but the measurements are far from each other, then you have accuracy without precision.

A good analogy for understanding accuracy and precision is to imagine a basketball player shooting baskets. If the player shoots with accuracy, his aim will always take the ball close to or into the basket. If the player shoots with precision, his aim will always take the ball to the same location which may or may not be close to the basket. A good player will be both accurate and precise by shooting the ball the same way each time and each time making it in the basket.

#### 4. Visualizing the data:

If your data are quantitative, it may be useful to turn the table or spreadsheet you created into a graph. If you are going to keep your data in a table, revise the table so that it can be presented correctly in the report. Representing your data in the proper visual format will allow you to identify trends and relationships among variables more easily. For assistance with graphs or tables, follow these steps:

- Establish what types of data you have, [quantitative or qualitative](#) (refer to the Resources page in the web version of this document; once there, choose "Data Types").
- Determine if the data should be represented as a [table or a graph](#) (refer to the Resources page in the web version of this document; once there, choose "Tables vs. Graphs").
- If you decide to use a graph to represent your data, determine which [type of graph](#) is one that best represents your data (refer to the Resources page in the web version of this document; once there, choose "Graph Types").
- If a table is the best format for representing your data, then modify the table you used to collect your data so that it is labeled and organized properly (for help in making tables, refer to the Resources page in the web version of this document; once there, choose "Designing Tables").
- If you need help creating a spreadsheet to make a table or graph, refer to the Resources page in the web version of this document. Once there, choose "Excel Tutorial".
- Remember that the purpose of your table or graph is to summarize your findings for yourself and for others and to reveal trends in your data.

#### 5. Making sense of your data:

Review all your drawings, tables, graphs, and other data you collected during your lab and summarize in a sentence or two the overall finding for the lab. Then write a few sentences about how these findings help to answer the questions you raised in the PreLab, question 4. If you haven't completed the PreLab, you may want to go there now.

Summarizing your data in a sentence or two helps you to understand the lab. It is also useful for when you write the Results section of your lab report. Considering the questions from the PreLab will be useful for writing your Discussion.

If your lab instructor says it is OK, ask other students in the lab about their observations. Comparing your observations to those of other students can be valuable as a way of furthering your learning about the subject at hand. It is also a very common practice among scientists, which usually leads to more ideas and more laboratory investigation. It's OK if your findings are different. Your job is to try to figure out why, to identify the sources of the difference. You can use this information when explaining your findings in the Discussion section of your lab report.



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**NC STATE UNIVERSITY**

## ***InLab: the lab procedure***

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Lab Section: \_\_\_\_\_

Lab Title: \_\_\_\_\_

*Note:* This is the handout version, which only contains the Descriptive InLab steps. For more help or additional information, you'll need to go to the on-line version of Descriptive InLab at <http://labwrite.ncsu.edu> where you can view additional materials on-line or obtain a full printable version from the Descriptive Labs homepage.

### **1. Setting up the lab:**

Before you start the lab, review the objectives and the procedures you will follow. Take detailed notes as you gather your materials, set up your lab, and calibrate instruments. These notes will help you document your experimental protocol, which you can use later when writing the Methods section of your lab report.

### **2. Preparing to collect data:**

If you are collecting quantitative data, identify the variables and units of measurement and create a table or set up a spreadsheet. If you are collecting qualitative data, determine the kinds of data you will be collecting and then prepare appropriate materials for recording observations (drawings, tables for observations, photographs, etc.). Read the lab manual to see what kinds of data you are being asked to record and be sure that you are ready to record the data in the appropriate form when you begin the lab procedure.

### ***3. Collecting and recording lab data:***

Carefully follow the experimental protocol. As you conduct your experiment and record your data, take notes on what you are doing and on any changes in the procedure. As you record your data, you should be asking yourself various questions: What are the relationships among the variables? Do the data behave in the way that you had anticipated? If not, why not? If the data make no sense, you may need to consider sources of uncertainty once again. Sources of uncertainty may affect the accuracy and precision of your experimental data.

### ***4. Visualizing the data:***

If your data are quantitative, it may be useful to turn the table or spreadsheet you created into a graph. If you are going to keep your data in a table, revise the table so that it can be presented correctly in the report. Representing your data in the proper visual format will allow you to identify trends and relationships among variables more easily.

**5. *Making sense of your data:***

Review all your drawings, tables, graphs, and other data you collected during your lab and summarize in a sentence or two the overall finding for the lab. Then write a few sentences about how these findings help to answer the questions you raised in the PreLab, question 4. If you haven't completed the PreLab, you may want to go there now. If your lab instructor says it is OK, corroborate your findings with your peers.



## PostLab: writing your lab report

The following pages include the PostLab guide for writing your lab report. A good strategy is to open a word processing file and write the report following the directions step by step. Follow the LabWrite process, beginning with writing Methods and finishing with writing the title. Then when you've finished, you can rearrange the sections of your report in the proper order for turning it in.

## Descriptive Labs SelfGuide

### SECTION ONE : Methods

#### Describing the lab procedure

Using your lab manual, handouts, and notes taken during the lab as a guide, describe in paragraph form how you did the lab. The point is to demonstrate that you have a solid grasp of the lab procedures, such as conducting a dissection or using specific laboratory equipment to determine an unknown. Provide enough detail of the materials you used and the methods you followed so that someone else could repeat the procedure. Make sure to note any differences between the procedures presented in the lab manual and what you actually did. This will be very important when you are writing the discussion portion of your report. Remember that the Methods should only describe what you did in the lab and not what you found.

#### More Help:

- Begin by reviewing the directions in the lab manual and any notes you took as you did the lab. If it is a complex procedure, make a rough outline of what you did.
- Write the procedure in paragraph form. For relatively simple labs, one paragraph will do; more complex labs will take multiple paragraphs. Keep the paragraphs relatively short because it's hard for readers to process detailed information like this without sufficient breaks.
- Describe what you actually did in your own experiment, even though it may be somewhat different from the ideal procedure in the manual. The Methods section should be an accurate reflection of what you did.
- Avoid putting any results of the lab in the Methods. Just describe what you did, not what you found.
- Use the proper past tense and passive voice. Methods are usually written in past tense because you are describing what you have already done. They are also typically written in passive voice ("Two ml. *were pipetted* into a test tube"). However, your lab instructor may permit you to use active voice, which uses first person, "I" or "we" ("We *pipetted* 2 ml. of the solution into the test tube").

#### More Helpful Hints:

- To make your description of the experimental procedure clear, use appropriate transitional or "sign post" words that indicate a sequence and help the reader follow the sequence: step 1, step 2, step 3; first, then, finally; first, second, third; after, next, later, following; etc.

- Include the methods you used for both gathering data and analyzing the data.

***For more advanced labs:***

- If your lab is complicated, perhaps consisting of more than one experimental procedure, then consider dividing your Methods into sections with subheadings.
- If you used what is considered a standard procedure (one that competent scientists in the field are likely to be familiar with) then there is no need to describe it in detail. Simply state that you used that procedure, being sure to give its common name. (If you are not sure about what standard procedures are in your field, ask your lab instructor.)
- When describing an apparatus or instrument, it's better to include a sketch of it rather than to try to describe it fully in words. This is especially useful in cases where the apparatus is complex or designed by you. All you need is a couple of sentences that give a general sense of the apparatus, and then refer the reader to the figure that contains the sketch, the same way you would refer the reader to tables or graphs.

## SECTION TWO : Results

### Making sense of your findings for yourself and others

**Step 1:** If you haven't already done so, create appropriate tables, graphs, and other figures to enable you to visualize your lab data. Use a spreadsheet program or table function in a word processing program. If your lab data consists of only drawings, or observations, you may want to organize these in tabular format as well. If not, go to step 2. Remember that representing your data in a visual format will allow you to identify trends, relationships, and other patterns in your data more easily.

**More Help:**

For help with creating visuals for lab report, follow these steps:

- Establish what types of data you have, [quantitative or qualitative](#).
- Determine if the data should be represented as a [table or a graph](#).
- If you decide to use a graph to represent your data, determine which [type of graph](#) is one that best represents your data.
- If a table is the best format for your data, then modify the table you used to collect your data so that it is labeled and organized properly. For more help with tables, go to [Designing Tables](#).
- If you need help creating a spreadsheet to make a table or graph, go to "[Excel Tutorial](#)."



**Step 2:** Once you have generated visual representations of your data, determine the best order for presenting the visuals. If the the proper order for visuals is already determined by the lab manual, go to step 3.

#### **More Help:**

The visuals tell the main story of your data. In relatively simple labs, determining the order of the visuals may not be an issue because you may have only one or two data sets to report. But in more complex labs, ordering your data is an issue. Here are some suggestions for ordering multiple data sets so that they make sense to the reader:

- chronological order: if the lab consists of more than one procedure, you can present the results in the order in which you did the procedures, especially if that order provides a useful way of leading the reader through the results.
- order of importance: arrange the visuals by putting the one that is the most important first and then the others in descending order of importance.
- order of generality: sometimes it is better to start with the most general representation of the data and then place the more specific ones after that, especially if the specific ones serve to support the broad representation or add more details to it.

**Step 3:** Review all the data from your experiment. In a sentence or two, summarize the main finding of this lab. This is the opening sentence(s) of the Results section.

#### **More Help:**

Summarizing your overall results in a sentence or two allows you to make sense of the findings of the lab for yourself and for your reader. A one- or two-sentence summary allows the lab instructor to judge how well you understand the lab as a whole.

- Review the findings in your visuals (tables, graphs, drawings, and other figures). If you have trouble shaping a one or two sentence summary, look for a unifying feature among the data sets. This is likely to be the dependent variable. The sentence will be a general statement that summarizes your findings about that variable or related variables.
- You can start the sentence in several ways: "The results of the lab show that ..."; "The data from the experiments demonstrate that..."; "The independent variable X increased as Y and Z were...."; "The observations show that...."

**Step 4:** In separate paragraphs, summarize the [general finding](#) in each of your visuals-- tables, graphs, drawings, or other figures. First, describe any relationship or interaction which exists among variables for each visual. Then include any specific details from the visual(s) that are important for understanding the results. Refer to your tables, graphs, drawings, or other figures as figure or table 1, 2, 3, etc.

#### **More Help:**

The main job of the Results section is to report data from the lab. The Results typically consists of both visual representations of data (tables and graphs and other figures) and written descriptions of the data.

- Describe each visual in a separate paragraph. Each paragraph has two parts:
  1. The first sentence gives the [general finding](#) for the visual, what it indicates overall, and
  2. The following sentence(s) provides key details from the visual that are important to understanding the experiment (don't include all the details).
- You can determine the general finding for each visual in one of two different ways:

1. as a summary of all the information in the visual OR
  2. as a statement that focuses on the most important point that is made in the visual (important, that is, in terms of the hypothesis).
- Refer to your visual(s) in the written part of your Results in one of two ways:
    1. Refer to your visual(s) at the beginning of your findings, for example, "Table 1 shows that the reaction times decreased as the strength of the solution increased." "Figure 3 demonstrates the percent yield of acetylsalicylic acid, commonly known as aspirin, from salicylic acid and acetic anhydride." (It is also possible to use verbs such as *lists*, *displays*, *describes*, etc.)
    2. Refer to your visual(s) in parentheses at the end of the of your findings. For example, "The reaction times decreased as the strength of the solution increased (Table 1)." "The mortality rate among riparian mammals adhered to approximately seven-year cycles (see Figure 3)." (Ask your teacher which format to use for parenthetical documentation.)

**Step 5:** Complete the Results by placing all the elements you've written in the proper order: (1) the sentence summarizing the overall data for the lab; (2) the paragraphs of word descriptions for each visual arranged in the order the visuals are presented. Remember that the Results only reports and describes what you observed and collected during your lab. The Results does not explain, discuss, or draw conclusions.

**The Results looks like this:**

- Summary of overall findings of lab
- Paragraph related to visual 1
  1. Sentence of overall finding from visual 1
  2. Sentence(s) with key details from the visual 1
- Paragraph related to visual 2
  1. Sentence of overall finding from visual 2
  2. Sentence(s) with key details from the visual 2
- Paragraph related to visual 3
  1. Sentence of overall finding from visual 3
  2. Sentence(s) with key details from visual 3, etc.

## SECTION THREE : Introduction

### Establishing a context for the lab

**Step 1:** Begin the opening paragraph of the Introduction by stating the scientific concept (principle, theory, law) or laboratory procedure of the lab. Then finish the paragraph by writing down all the details about the concept or procedure relevant to the lab that you can find in the lab manual, textbook, class notes, handouts, etc. If you completed the PreLab, this step corresponds to question 1. Note any citations you use here for including in the References section of your report.

#### More Help:

- If you are having trouble writing a good opening sentence for the lab report, you can say something like: "This laboratory experiment focuses on X..."; "This laboratory experiment is about X..." ; "This lab is designed to help students learn about, observe, or investigate, X..." Or if you are working with a scientific concept or procedure, you can begin by defining it: "X is a theory that..."; or "X is a procedure that is used for..."
- Once you have your opening sentence, you are ready to complete the opening paragraph by telling what you know about the scientific concept or lab procedure. The point is to show your lab instructor that you have a good grasp of the scientific concept. Make sure to include the following:
  - Information about the scientific concept or laboratory procedure that is directly related to the lab (not everything there is to know about the concept or procedure)
  - Additional relevant information about the concept or procedure you may have learned since doing the PreLab or since doing the lab.
- If you have a lot to say about the scientific concept or lab procedure, use more than one paragraph.
- This part of the Introduction is typically written in present tense.
- For help with citing references, go to [Citations and References](#).

#### *For more advanced labs:*

If you are writing a lab report that is more like a full scientific paper, you may need to do more research using the internet and library. With your teacher's guidance, you should search the recent scientific literature to find other research in this area of study. Summarize that research in a paragraph or so, stating what the general findings have been and using those findings to describe the current knowledge in the area (such a "review of the literature" is typical of scientific journal articles). This summary should come after your initial sentence about the scientific concept. For help with citing references, go to [Citations and References](#).

**Step 2:** Write in sentence form the objectives for this lab--specific things you are being asked to do in the lab, such as measure, analyze, observe, test something, etc. Then, continue the paragraph by describing the purpose of the lab--how the achievement of these objectives are designed to help you learn about the scientific concept or procedure of the lab. If you completed the PreLab, this step corresponds to questions 2 and 3.

**More Help:**

- Objectives are typically actions you are being asked to perform for the lab. Often the objectives are listed in the lab manual. Writing the objectives of the lab in your own words demonstrates your understanding of what you were supposed to accomplish in the lab. With most labs, you should be able to do this in 1 or 2 sentences. You can begin by saying something like: "The main objectives of this lab were to..."; "In this lab we were asked to..." This will be the beginning of the paragraph. If your response to PreLab question 2 was a list of objectives, revise it by summarizing the primary objectives in your own words.
- Continue the paragraph by addressing the purpose of the lab. This is where you make the all-important link between what you do in the lab (the objectives) and the purpose for doing the lab: to learn something about the scientific concept or procedure of the lab. Read over the objectives again. In what way do you think that doing the experiment, accomplishing the objectives, helped you learn about the scientific concept? You can start by saying something like this: "The objectives of this lab enabled me to learn about X by..."; "Performing these objectives helped me to understand X by...." If you completed the PreLab, revise question 3, showing that you comprehend the purpose of the lab.
- This part of the Introduction is usually all in past tense.

**Step 3:** Describe the questions you had before doing the lab, things you didn't understand or would like to know more about. These are questions about the scientific concept, lab materials, procedures, or application of this lab to other scenarios. If other questions came up as you were completing the lab, include them here as well. State why these questions are important to understanding the lab. Make sure to describe your questions in the context of the scientific concept for the lab. If you completed the PreLab, this step corresponds to question 4.

**More Help:**

- Since the purpose of the lab and the report is to help you learn something about science, the final paragraph of the Introduction should create a learning context for the rest of the lab report. Writing a paragraph that describes issues that you didn't understand or wanted to know more about before or during the lab establishes a basis for learning. It shows what you may be able to learn by doing the lab. You will return to these issues in the Discussion.
- If you did not do the PreLab, one strategy for finding these issues at this point is to go back to the lab manual and read the section about this lab. Look for things that you were unclear about before you did the lab. Perhaps, you didn't fully understand aspects of the scientific concept for the lab. Or perhaps there were some details about how to perform the lab procedure that were not clear to you. It may be that you were curious about how you could apply the lab protocol to another situation. You can include issues that you still don't understand.
- To write the paragraph, describe what you don't know or are just curious about. You can do this in sentence form or list them in bullets.
- To show how the issues you raise are important to the lab, show how they relate to the main scientific concept or procedure of the lab.

## SECTION FOUR : Discussion

### Interpreting the results of the lab

**Step 1:** For the opening paragraph of the Discussion, explain what the findings mean in terms of the scientific concept or laboratory procedure of the lab. In other words, discuss the connection between the evidence you collected and what you were supposed to be learning about by doing the lab. If necessary, refer to graphs, drawings, tables, lists, or other visuals from the Results to support your explanation.

#### More Help:

- Go back to the first part of your Introduction where you establish the main focus of the lab--the scientific concept or procedure of the lab--and use what you have written to address the following questions in your opening paragraph of the Discussion:
  - What is the connection between your findings and the scientific concept or procedure of the lab?
  - What implications do the findings suggest about the concept or procedure?
  - How do the findings relate to your description of what you already knew about the concept or procedure in the first paragraph of the Introduction?
- If appropriate, refer to specific drawings, tables, or other visuals from the Results to support your explanation.

**Step 2:** Go back to the questions you raised in your Introduction, and in a paragraph or so, discuss any answers you arrived at as a result of doing the lab or as a result of additional research you may have done. Where appropriate, refer to specific data in your findings or to specific points in the protocol to support the answers to these questions. Finally, discuss the importance of these questions to the scientific concept or lab procedure you explored in this lab. Note any citations you use here for including in the References section of your report.

#### More Help:

- Return to the Introduction and to the original PreLab question (if you did one) where you raised the questions to guide your learning. Identify any of those questions that doing the lab or doing additional research provided answers for, even partial answers. These are the ones you can discuss in this section of the report.
- In the Discussion, consider each question separately, unless some questions are better grouped together. Restate the question or issue and then present what you think is an answer to it. Then explain how you came to the answer. This is where you should refer to specific findings or other observations from the laboratory procedure.
- If you are not sure of an answer, put in any qualifiers you think are appropriate. You can say that you think the answer is tentative.
- For help with citing references, go to [Citations and References](#).

**Step 3:** In the final part of your Discussion, write about other items as appropriate, such as (1) questions from the Introduction that remain unanswered; (2) [sources of uncertainty](#) in your lab methods that may have led you to unclear answers; (3) how your findings compare to the findings of other students in the lab and an explanation for any differences; (4) what further investigations you would do in order to gather more information; (5) suggestions for improving the lab.

**More Help:**

- The final part of your Discussion allows you to bring up other issues that may be appropriate for this lab. The list here is intended to be suggestive. They point to the kinds of things you could address here.
- Previously, you had identified questions from the Introduction that you could answer based on the lab research. Go back to the ones that you don't have a satisfactory answer for. Restate those questions and talk about why they remain unanswered and speculate, if you can, on what it would take to answer them.
- If you have reason to be uncertain about some of your data (for example, it doesn't match what you think you should have found or if you had problems in your lab procedure) go back to the notes you took as you were setting up the lab and collecting and recording data. These notes might enable you to identify [sources of uncertainty](#).
- In scientific articles, the Discussion is where scientists typically compare their results to those from other scientific experiments. If your teacher says it is permissible, you can do something similar by comparing your results to those of other students in the lab. In your paragraph, comment on any similarities or differences you find and offer possible explanations for the differences.
- Professors who write lab manuals are typically interested in how they can improve the experiments in the manuals. You can also demonstrate your ability to provide a productive critique of the lab by offering suggestions for improvement.
- In the Discussion section, use the past tense when referring to what has been done in the experiment, but use present tense when talking about most everything else, such as scientific concepts, explanations, and references to articles. For help with citing references, go to [Citations and References](#).

## SECTION FIVE : Conclusion

### Interpreting the results of the lab

**Step 1:** Write a paragraph summarizing what you have learned about the scientific concept or procedure of the lab. Back up your statement with details from your lab experience.

**More Help:**

- Return to the scientific concept or lab procedure you established as your focus in the Introduction. But instead of describing what you know about it in the Conclusion, describe what you learned about it from doing the lab. For example:
  - How has your understanding of it improved or otherwise changed from doing the lab?
  - What specific aspects of the lab experience contributed to your learning?
  - What difficulties did you have with lab before doing it, and how were those difficulties alleviated by doing the lab?
  - How might what you have learned in the lab be applicable in the future?
- Be direct in your statement of what you have learned. Don't be afraid to start out saying, "In this lab, I learned that ...." This sort of clarity will be appreciated by the

reader. Elaborate on your statement with additional details about what you have learned.

**Step 2:** There may be more that you have learned about from the lab experience that is not directly related to the main focus of the lab, the scientific concept or lab procedure. If so, describe it in a paragraph or two.

**More Help:**

- Here are some examples of other things you may have learned by doing the lab:
  - Was there anything in the lab procedure that you found particularly interesting to learn how to do?
  - Did you apply a procedure for analyzing data that was useful to learn about?
  - Did you learn anything about using a spreadsheet or graphing or creating other visuals?
  - Did you learn anything about writing or about how science works from writing the report?

## SECTION SIX : Abstract

### Summarizing the lab report

Summarize each major section of the lab report--Introduction, Methods, Results, Discussion, and Conclusion--in 1 sentence each (two if a section is complex). Then string the summaries together in a paragraph in the order the sections come in the final report.

**More Help:**

- Here are some suggestions for what to include in each sentence of the Abstract:
  - **Introduction:** the main focus of the lab (scientific concept or lab procedure) and main objective(s) of the lab
  - **Methods:** a quick description of the how the lab was done
  - **Results:** statement of the overall findings
  - **Discussion:** statement explaining the findings of the lab and their relationship to the scientific concept or lab procedure
  - **Conclusion:** what you learned about the scientific concept or lab procedure
- Put all these sentences together into one paragraph with the heading Abstract.

## SECTION SEVEN : Title

### Capturing the essence of the report

A good title very efficiently tells the reader what the report is about. Write a title that captures what is important about the lab, including the scientific concept the lab.

#### More Help:

- If you are having trouble writing a title, try this approach.
  - List the keywords related to the report: the scientific concept of the lab, the kind of procedure you used, names of key materials, what you observed, etc.
  - Then write a title that describes the lab using the most important of these keywords.
- Here are some other tips on creating a good title:
  - A title should use the fewest possible words to adequately describe the content of the report.
  - A title should be as specific as possible. Specify the primary focus of the experiment and procedures used, including the scientific names of chemicals, animals, etc.
  - Do not write the title as a complete sentence, with a subject and a verb. Titles are labels, not sentences.
  - Do not use catchy titles. This is not an English paper or an editorial.
  - Find the right balance for the length of the title: not so short that it doesn't communicate what the report is about but not so long that it rambles on for more than a line.

## SECTION EIGHT : References

### Acknowledging sources of information

List all the sources you referred to in writing the report, such as the lab manual, a textbook, a course packet, or a scientific article. Be sure to use the proper form of documentation for the scientific field you are working in (see [Citations and References](#)).

#### More Help:

- Different scientific fields use somewhat different styles for documenting sources in the References. For example, in chemistry you would follow the American Chemical Society (ACS) style. In biology, it would be the Council of Biological Editors (CBE) style. Check to see which style is appropriate for your class.
- You can find information about various documentation styles at [Citations and References](#).



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## LabChecklist : SelfGuide

### Descriptive Labs

#### The Title of my Lab Report...

- describes the specific content of the lab concisely but with enough detail to get the main ideas across to the reader.

#### The Abstract of my Lab Report...

- summarizes the gist of each section of the report in a sentence (or two for an especially complex section).
- arranges the sentences in the order the sections are presented in the report, Introduction to Conclusion.
- stays within the maximum words allowed (usually 100-200 words, but if there is a different word limit for your class, be sure you are within it).

#### The Introduction in my Lab Report...

- starts out by stating (in a sentence or two) the scientific concept or lab procedure of the lab and then describes what I know about that scientific concept or lab procedure that is relevant to the lab (typically one or two paragraphs).
- sets down in sentence form the main lab objective(s) and then describes what these objectives will help me learn about the scientific concept of the lab (typically one paragraph).
- presents interesting or useful questions or issues relevant to the lab.

#### The Methods in my Lab Report...

- provides a concise, easy-to-follow description of how I completed the lab.
- describes any materials and specific procedure used so that the experiment could be repeated just as I did it.

#### The Results in my Lab Report...

- begins with a sentence or two describing the main finding(s) of the lab.
- contains visuals (drawings, tables, or other figures) that are appropriate to the lab and are arranged in an order that best tells the "story" of the data.
- clearly describes each visual and refers to the appropriate visuals in the paragraphs (Table 1, Figure 2, etc.).
- reports findings from the experiment only, successfully avoiding any explanations or conclusions about the data.

#### The Discussion in my Lab Report...

- explains how the findings link to the scientific concept or procedure of the lab.
- discusses questions or issues raised in the introduction.
- addresses other issues that may be appropriate, such as (1) questions from the Introduction that remain unanswered; (2) sources of uncertainty in my lab methods that may have led to unclear answers; (3) how my findings compare to the findings of other students in the lab and an explanation for any differences; (4) what further investigations I would do in order to gather more

information; (5) suggestions for improving the lab.

**The Conclusion of my lab report...**

- directly states what I have learned about the scientific concept of the lab from doing the lab.
- gives enough details of what I have learned to be convincing.
- describes anything else I may have learned from doing the lab and writing the report.

**The References for my lab report...**

- includes all the sources I have used in writing my lab report, such as the lab manual, the textbook, and any reference books or articles I cited.
- uses the appropriate documentation style for citations and references (CBE, ACS, etc.).

**Overall issues: My lab report...**

- uses the correct format (titles, captions, etc.) for the tables, graphs, and drawings
- is written in a scientific style (tone should be objective; sentences should be clear and to the point).
- is clear of spelling errors (use the spell check on your computer).
- includes all the necessary headings (each section of the report should have a heading).



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# Descriptive Labs SelfGuide

Printable Version

**LabCheck: Evaluation Guide**

Writer: \_\_\_\_\_

	F	D	C	B	A
<b>Title</b>					
• describes lab content concisely, adequately, appropriately					
<b>Abstract</b>					
• conveys a sense of the full report concisely and effectively					
<b>Introduction</b>					
• successfully establishes the context (scientific concept, lab procedure) of the lab					
• effectively presents the objectives and purpose of the lab					
• presents interesting questions or issues related to the lab					
<b>Methods</b>					
• gives enough details to allow for replication of procedure					
<b>Results</b>					
• opens with a sentence or two describing the main finding(s) of the lab					
• presents visuals clearly and accurately					
• presents verbal findings clearly and with sufficient support					
• successfully integrates verbal and visual representations					
<b>Discussion</b>					
• opens with an explanation of how the findings link to the context of the lab					
• addresses questions and issues related to the lab and discusses answers to these questions					
• sufficiently addresses other issues pertinent to lab					
<b>Conclusion</b>					
• convincingly describes what has been learned by doing the lab					
<b>Presentation</b>					
• citations and references adhere to proper format					
• format of tables and figures is correct					
• report is written in scientific style: clear and to the point					
• grammar and spelling are correct					
<b>Overall Aims of the Report: The student...</b>					
• has successfully learned what the lab is designed to teach					
• accurately analyzes data for lab findings					

# LabWrite Resources

## Graphing Resources

### Excel Tutorial

A step-by-step tutorial on how to use Excel. It covers both basic techniques (entering raw data, formula entry, cell displays, basic graphing) and advanced techniques (such as importing raw data, creating various kinds of graphs, culling data, formatting graphs, and using descriptive statistics in graphs--error bars).

### Data Types

A flow chart to use for help when trying to categorize the types of data collected during the lab.

### Tables vs. Graphs

A guide with helpful hints on how to decide which format best represents the data collected in lab.

### Designing Tables

General information on creating tables to represent data collected in lab.

### Graph Types

A flow chart to use when trying to decide which type of graph best represents the type of data collected in lab.

### Bar Graphs

Use this guide for a description of the different types of bar graphs followed with examples that illustrate when to use each one.

### Histograms

Use this guide for a description of the different types of histograms followed with examples that illustrate when to use each one.

### Line Graphs

Use this guide for a description of the different types of line graphs followed with examples that

illustrate when to use each one.

## **Scatter Plots**

Use this guide for a description of the different types of scatter plots followed with examples that illustrate when to use each one.

## **Revising Your Visuals**

A useful guide that provides helpful hints on how to refine and modify key elements of visuals to prepare them for final presentation.

## **Error Bars**

Provides information on summarizing data with mean values and representing experimental uncertainty with error bars.

## **Representing Significant Digits**

This page will give you some guidance on how to report your experimental results with the appropriate number of significant digits.

# **Writing Resources**

## **Quick Guide to PostLab Stages**

An abbreviated version of the Post-Lab stages to be used as a quick reference guide by those already familiar with Post-Lab.

## **LabChecklists**

A checklist of the elements that need to be in an effective lab report is available for any type of lab you may have completed--standard, descriptive, or designed by you. The LabChecklist follows the guidelines presented in PostLab and is designed for use prior to turning in the lab report for a grade. Use this to double-check the lab report in order to improve the chances of getting a better grade.

## **Help Improving Your Lab Report Grade**

Helpful hints on how to improve each component of the lab report for any type of lab you may have completed--standard, descriptive, or designed by you. Use this in conjunction with the LabCheck Evaluation Guides available for each type of lab for help in interpreting and improving lab report grades. Before using this resource, make sure you are familiar with PostLab.

## **LabCheck Evaluation Guides**

A LabWrite Evaluation Guide is available for any type of lab you may have completed--standard, descriptive, or designed by you. The Evaluation Guide lists criteria that instructors will be using to grade your lab reports. Links to Help Improving Your Lab Report Grade are available within each section of the guide. Use this guide to become familiar with the LabWrite grading criteria before turning in your lab report and to help you interpret your lab report grade.

after you get it back.

## **Online Writing Handbook**

Web sites to help you with questions about grammar, style, punctuation, mechanics, using the internet, search engines, and much more.

## **Citations and References**

Documenting sources : advice on citing information from outside sources in the body of the report and listing those sources of information in the References section at the end of the report.

## **Additional Resources**

### **Writing a Research Proposal**

A step-by-step guide that takes you through the process of writing a research proposal.

### **Labwrite for Middle School**

Labwrite activities for students in the middle grades.

### **Sample Lab Reports**

Examples of lab reports that illustrate how the parts of the report are written and arranged. Use this to see what a completed lab report looks like.

### **Glossary**

An alphabetical list of words and phrases with their definitions as used throughout LabWrite.



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