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LABORATORY SKILLS 8

Using Graphing Skills

Pre-Lab Discussion

Recorded data can be plotted on a graph. A graph is a pictorial representation of information recorded in a data table. It is used to show a relationship between two or more different factors. Two common types of graphs are line graphs and bar graphs.

In this investigation, you will interpret and construct a bar graph and a line graph.

Problem

How do you correctly interpret and construct a line graph and a bar graph?

Materials

No special materials needed

Procedure

Part A. Interpreting Graphs

1. The type of graph that best shows the relationship between two variables is the line graph. A line graph has one or more lines connecting a series of points. See Figure 1. Along the horizontal axis, or x–axis, you will find the most consistent variable in the experiment. Along the vertical axis, or y-axis, you will find the other variable.

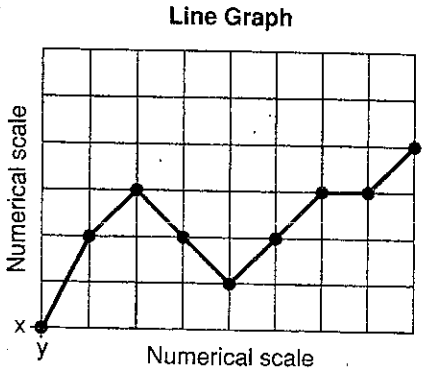

Figure 1

2. Use the line graph in Figure 2 to answer questions 1 through 6 in Observations.

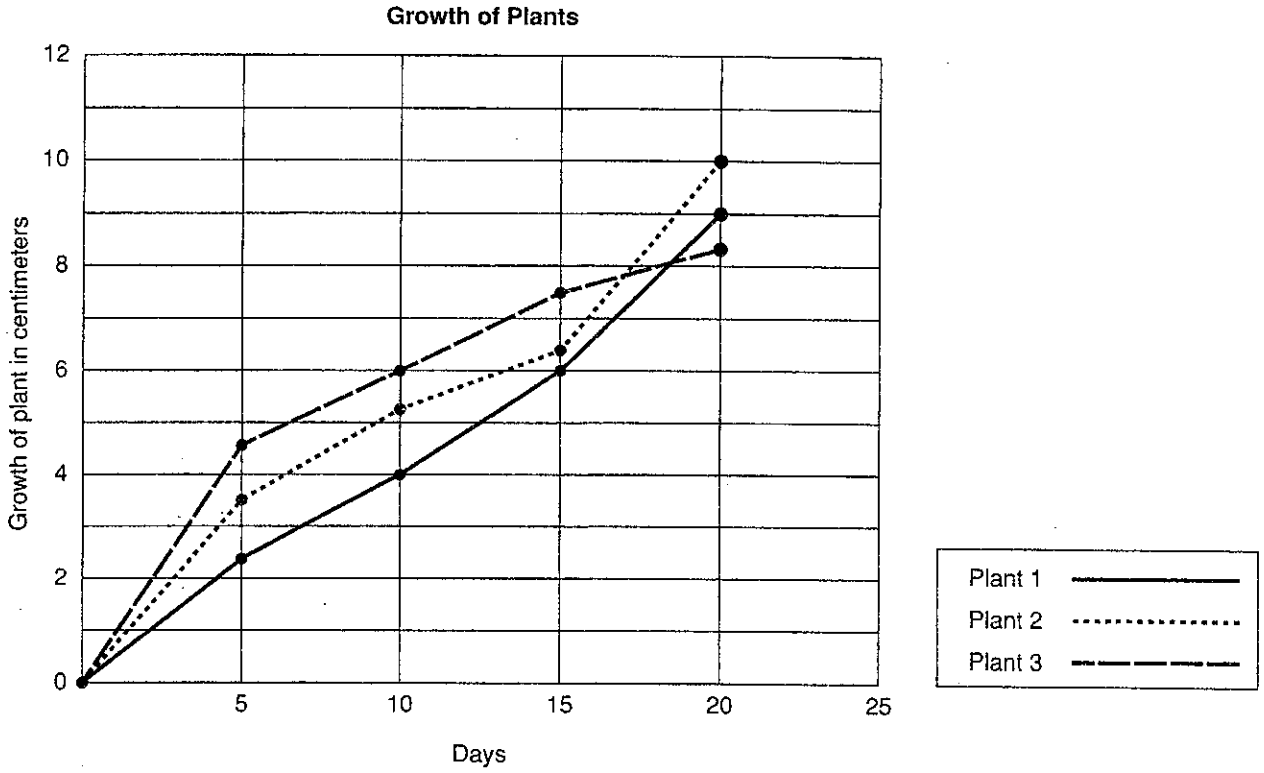

Figure 2

3. A bar graph is another way of showing relationships between variables. A bar graph also contains an x-axis and a y-axis. But instead of points, a bar graph uses a series of columns to display data. See Figure 3. On some bar graphs, the x-axis has labels rather than a numerical scale. This type of bar graph is used only to show comparisons.

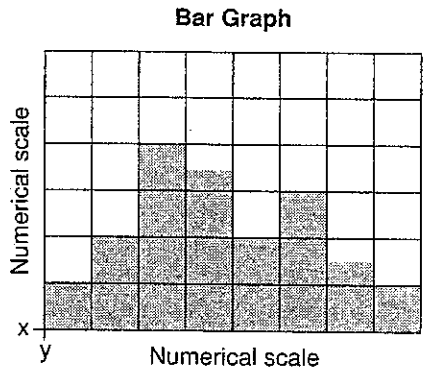

Figure 3

Observations

Part A. Interpreting Graphs

Use the line graph in Figure 2 to answer questions 1 through 6.

1. Which plant grew the tallest? _____
2. How many plants grew to be at least 6 cm tall? _____
3. Which plant grew the fastest in the first five days? _____
4. Which line represents plant 2? _____
5. After 10 days, how much had plant 3 grown? _____
6. How long did it take for plant 1 to grow 6 cm? _____

Use the bar graph in Figure 4 to answer questions 7 through 11.

7. At birth, what is the average number of red blood cells per mm^3 of blood?

   _____

8. What appears to happen to the number of red blood cells between birth and 2 months?

   _____

9. What happens to the number of red blood cells between the ages of 6 and 8 years?

   _____

10. Between what ages is a human likely to have 4.6 million red blood cells?

    _____

11. After 14 years of age, do males or females have a higher red blood cell count?

    _____

Part B. Constructing Graphs

Data Table 1 Breathing Rate of the Freshwater Sunfish

Temperature (°C)	Breathing Rate (per minute)
10	15
15	25
18	30
20	38
23	60
25	57
27	25

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4. Use the bar graph in Figure 4 to answer questions 7 through 11 in Observations.

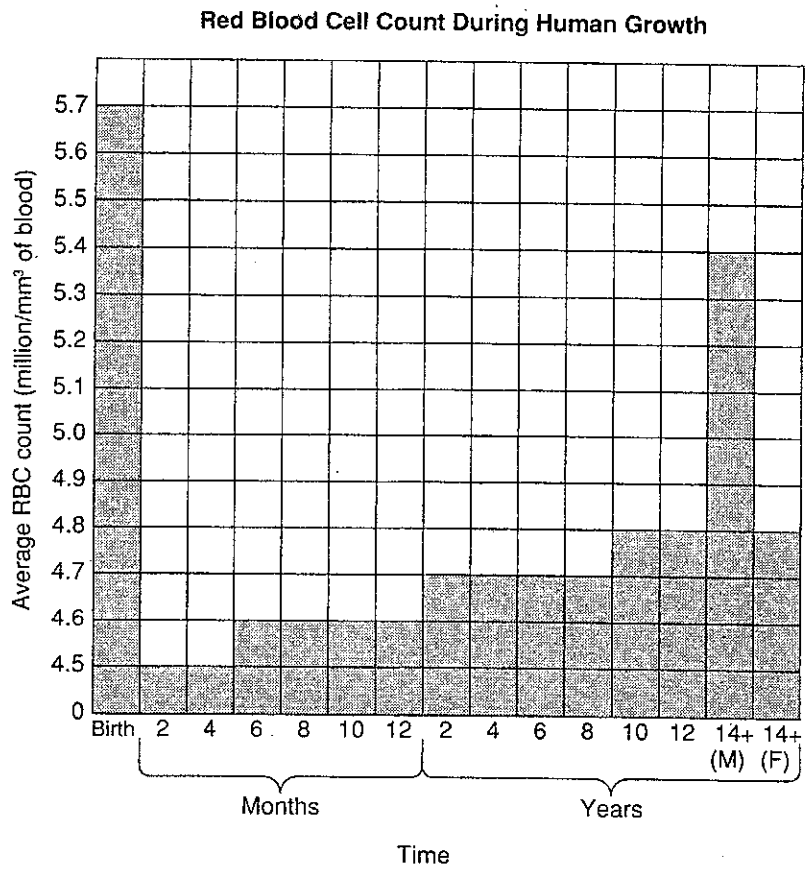

Figure 4

Part B. Constructing Graphs

1. When plotting data on a graph, you must decide which variable to place along the x-axis and which variable to place along the y-axis. Label the axes of your graph accordingly. Then you must decide on the scale of each axis; that is, how much each unit along the axis represents. Scales should be chosen to make the graph as large as possible within the limits of the paper and still include the largest item of data. If the scale unit is too large, your graph will be cramped into a small area and will be hard to read and interpret. If the scale unit is too small, the graph will run off the paper. Scale units should also be selected for ease of locating points on the graph. Multiples of 1, 2, 5, or 10 are easiest to work with.
2. Use the information recorded in Data Table 1 to construct a line graph on the grid provided in number 12 of Observations. You should label each axis, mark an appropriate scale on each axis, plot the data, connect the points, and give your graph a title.
3. Use the information recorded in Data Table 2 to construct a bar graph on the grid provided in number 13 of Observations. You should label each axis, mark an appropriate scale on each axis, plot the data, darken the columns of the graph, and give your graph a title.

Analysis and Conclusions

1. How is a graph similar to a data table? _____

2. How is a line graph different from a bar graph? _____

3. Does a steep curve on a line graph indicate a rapid or a slow rate of change?

Critical Thinking and Application

1. You are conducting an experiment to measure the gain in mass of a young mouse over a ten-week period. In constructing a graph to represent your data, which variable should you place along the x-axis and which variable should you place along the y-axis? Explain your answer.

2. What is an advantage of using multiple lines on a line graph? (See Figure 2.)

3. Why is it important to have all parts of a graph clearly labeled and drawn?

Going Further

A circle graph (sometimes called a "pie chart") is a convenient way to show the relative sizes of the parts that together form a whole body of data. Look through magazines and newspapers to find examples of circle graphs. Construct a chart listing the similarities and differences between circle graphs, line graphs, and bar graphs.

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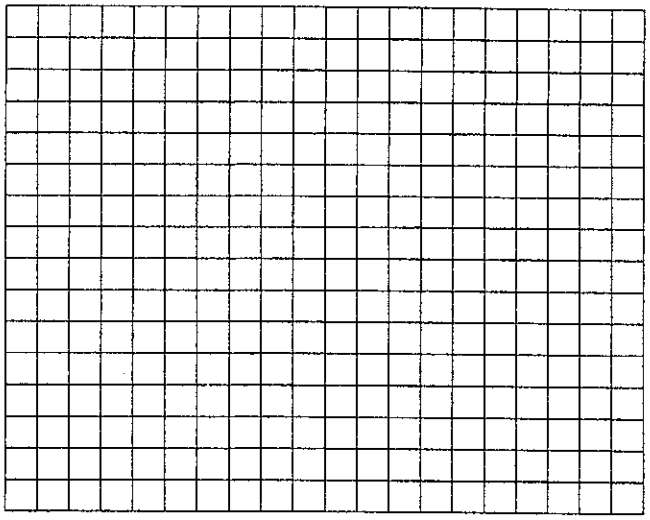
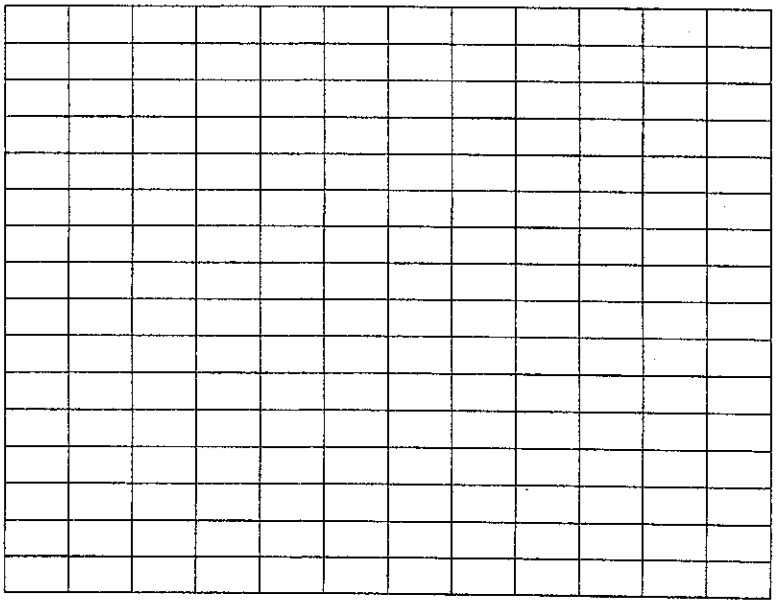
12. Use the grid below to construct a line graph for the information shown in Data Table 1.



Data Table 2 Average Rainfall in Willamette Valley

Month	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall (mL)	15	21	28	24	16	8	2	1	2	3	5	10

13. Use the grid below to construct a bar graph for the information shown in Data Table 2.



EXERCISE 1

Given the following information, complete Data Table 1. Then interpret the data and answer the five questions that follow.

Information: The following hair colors were found among three classes of students:

Class 1:	Class 2:	Class 3:
brown—20	brown—18	brown—15
black—1	black—0	black—4
blond—4	blond—6	blond—5

Data Table 1

Hair Color	Class 1	Class 2	Class 3	Total
Brown				
Black				
Blond				

1. What type of information is being gathered? _____

_____

2. Which hair color occurs most often? _____

3. From the information in the Data Table, can you give the number of boys with black hair?

_____ What information can you give about the number of students with black hair?

_____

4. Which class has the most blond students? _____

5. How many students made up the entire student population? _____

Presenting Data

To seek answers to problems or questions they have about the world, scientists typically perform many experiments in the laboratory. In doing so, they observe physical characteristics and processes, select areas for study, and review the scientific literature to gain background information about the topic they are investigating. They then form hypotheses, test these hypotheses through controlled experiments, record and analyze data, and develop a conclusion about the correctness of the hypotheses. Finally, they report their findings in detail, giving enough information about their experimental procedure so that other scientists are able to replicate the experiments and verify the results.

The Laboratory Investigations in the *Biology Laboratory Manual* provide an opportunity for you to investigate scientific problems in the same manner as that of a typical scientist. As you perform these investigations, you will employ many of the techniques and steps of the scientific method a working scientist does. Some of the most important skills you will acquire are associated with the step of the scientific method known as recording and analyzing data. Three of these skills are creating and filling in data tables, making drawings, and finding averages. Another set of skills useful in presenting data is examined in the Laboratory Skills activity titled Using Graphing Skills.

It is important to record data precisely—even if the results of an investigation appear to be wrong. And it is extremely important to keep in mind that developing laboratory skills and data analysis skills is actually more valuable than simply arriving at the correct answers. If you analyze your data correctly—even if the data are not perfect—you will be learning to think as a scientist thinks. And that is the purpose of this laboratory manual and your experience in the biology laboratory.

DATA TABLES

When scientists conduct various experiments and do research, they collect vast amounts of information: for example, measurements, descriptions, and other observations. To communicate and interpret this information, they must record it in an organized fashion. Scientists use data tables for this purpose.

You will be responsible for completing data tables for many of the Laboratory Investigations. Each column in a data table has a heading. The column headings explain where particular data are to be placed. The completed data tables will help you interpret the information you collected and answer the questions found at the end of each Laboratory Investigation.

DRAWINGS

Laboratory drawings can be made using several methods, depending on a particular Laboratory Investigation. Some drawings are made in circles that represent the viewing field of a microscope or another type of magnifier. When completing these drawings, be sure to include the magnification at which you viewed the object. Other laboratory drawings are representative of entire organisms or parts of organisms. These drawings show the relative size, shape, and location of anatomical structures. When completing representative drawings, make the structures as clear and as accurate as possible.

Most laboratory drawings are labeled. Use the following guidelines to help make your laboratory drawings clear and legible.

- Use a ruler to draw label lines.
- Label lines should point to the center of the structure being labeled.
- Do not write on the label lines.
- Print all labels horizontally.
- Label the right-hand side of the drawing, if possible.
- Do not cross label lines.

EXERCISE 3

The following laboratory drawing was completed without using the guidelines for laboratory drawings. Circle those parts of the drawing that do not follow the guidelines. Then, on the lines provided, explain how these parts of the drawing should be done properly.

Magnification _____

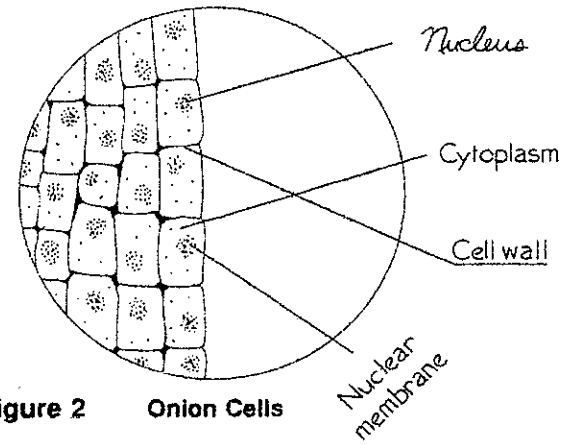


Figure 2 **Onion Cells**

_____

_____

_____

_____

_____

_____

_____

AVERAGES

Occasionally you will be required to find the average of data gathered from an investigation. To find an average, add the items in the group together and then divide the total by the number of items. For example, if there were five students of different ages—12, 13, 14, 17, and 19—how would you find the average age of the group? Add the five ages together and divide the total by 5, which is the number of items (students) in the group. What is the average age of this group of students? Your answer should be 15 years old.

EXERCISE 4

In a garden the heights of six sunflowers are 135 cm, 162.5 cm, 180 cm, 235 cm, 185 cm, and 167.5 cm. What is the average height of the sunflowers?

_____

EXERCISE 2

Given the following information, organize the data into a table. Use the blank table provided in Figure 1 to draw in the necessary columns and rows. Then interpret the data and answer the questions that follow.

Information: On an expedition around the world, several scientists collected the venom of various snakes. One of the tests that the scientists conducted determined the toxicity of the venom of each snake. Other data obtained by the scientists included the mortality percentage, or relative death rate, from the bites of various snakes.

The snakes observed were the (1) southern United States copperhead, (2) western diamondback rattlesnake, (3) eastern coral snake, (4) king cobra, (5) Indian krait, (6) European viper, (7) bushmaster, (8) fer-de-lance, (9) black-necked cobra, and (10) puff adder.

The mortality percentage of people bitten by the snakes varied from 100% to less than 1%. The scientists noted the mortality percentage for each of the snakes was (1) less than 1%, (2) 5–15%, (3) 5–20%, (4) greater than 40%, (5) 77%, (6) 1–5%, (7) usually 100%, (8) 10–20%, (9) 11–40%, and (10) 11–40%.

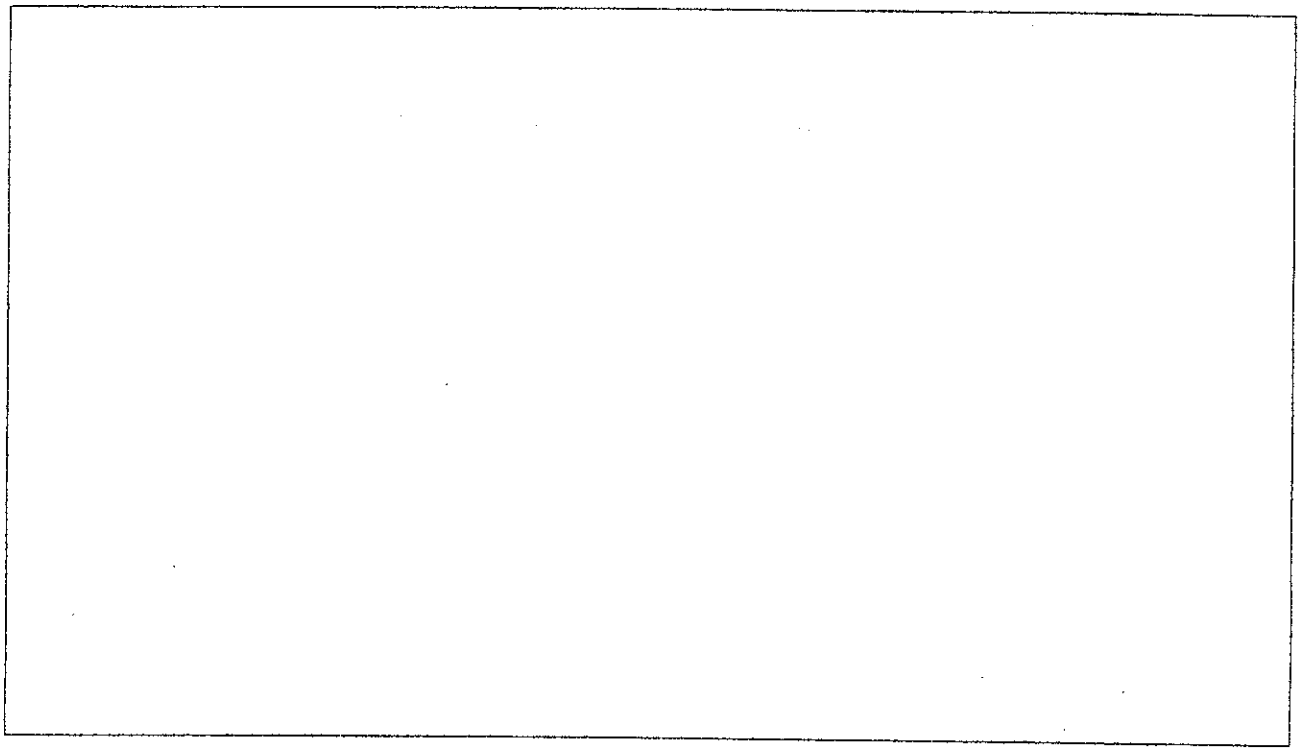


Figure 1

1. Which snake's venom has the highest mortality rate. _____
2. Which snake's venom has the lowest mortality rate? _____
3. From the information recorded, can you determine the snake whose venom works the most rapidly? The least rapidly? _____
4. Which two snakes' venom have the same mortality rate? _____
5. How many snakes were observed? _____

EXERCISE 5

Find the average for the following group of data. Then use the results to answer the questions that follow.

In an experiment on plant growth and overcrowding, plants of the following heights are in three equal-sized containers.

Flowerpot 1: 20 cm and 18 cm
Flowerpot 2: 12 cm, 10.8 cm, 11.2 cm, and 12.4 cm
Flowerpot 3: 7.5 cm, 8 cm, 6 cm, 6.2 cm, 5.8 cm, and 7.3 cm

1. What is the average height of the plants in each flowerpot? _____

2. In which flowerpot did the plants grow the tallest? Explain. _____

EXERCISE 6

Find the averages for the following group of data. Express your answers to the nearest tenth.

In a sample group of students, the number of breaths per minute was taken at rest and after exercise. The results were as follows:

At rest
Males: 10.1, 13, 12.5, 10.2, 13.1, 11.8
Females: 10.4, 13.0, 12.1, 11.9, 10.5, 12.8

After exercise
Males: 18.9, 23.7, 22.6, 21.3, 19.2, 20.6
Females: 25, 26.7, 29, 35.3, 33.1, 31.7

1. What is the average number of breaths per minute for males at rest? _____

   Females at rest? _____

2. What is the average number of breaths per minute for males after exercise? _____

   Females after exercise? _____

3. How many students make up the sample group? _____

4. What is the average number of breaths per minute for the entire group at rest? _____

   After exercise? _____

5. Do males or females take more breaths per minute at rest? _____

   After exercise? _____