Organizing and Analyzing Experimental Data

Constructing a Data Table

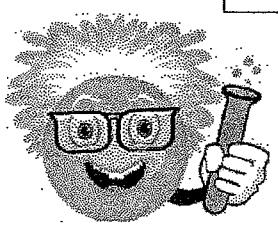
A data table is a good way to organize measurements you collect during an experiment. Although there are no set rules to constructing a data table, they are easy to make if you follow a few **conventions** (usual way of doing things)

1. The ***independent variable*** (the factor that is changed in the experiment) is usually the ***left column*** of the table.
2. Make a row for each level of the independent variable (ex: different temperatures)
3. The ***dependent variable*** (the factor being measured) is generally the ***right column*** of the table.
4. ***Every column should be titled.*** The column titles should include the name and units of measure of each variable.
5. Always give a data table a ***title.*** The title usually should clearly communicate the purpose of the experiment and include the variables being investigated.
6. Generally, **data is arranged from the smallest to the largest or the largest to the smallest.**

Example: A student wanted to know if temperature affects the germination of tomato seeds. She wraps 20 tomato seeds in a moist paper towel, places it into a plastic sandwich bag, and seals the bag. She repeats this procedure 4 more times. She places bag 1 in the freezer (0°C), bag 2 in the refrigerator (5°C), bag 3 in the basement (10°C), bag 4 in her closet (20°C), and bag 5 in the attic (30°C). After 8 days, she counted and recorded the number of seeds that germinated in each of the 5 bags. She repeated the experiment 2 more times during the next 2 weeks. She then summarized her data in the table below:

The Effect of Temperature on the Germination of Tomato Seeds

Temperature (°C)	Average Number of Seeds Germinated
0	0
5	2
10	4
20	12
30	18



Now it's your turn!

You are interested in testing the effect of light on plant growth. You go to a nursery and purchase 24 marigold plants that look healthy, planted in similar pots with similar soil, and are the same age. There are two marigold plants in each pot. You expose 4 pots to sunlight, 4 pots to artificial light, and 4 pots to darkness. The height of each plant was measured at the start and end of the experiment and the results are averaged. You found that the average growth of marigolds exposed to sunlight is 12 cm. The average growth of plants exposed to artificial light was 8 centimeters. All the marigolds died that were placed in the dark (average growth was 0 cm).

Based on the following scenario, please answer the following questions:

1. Complete the following data chart. Remember to title the chart, name the columns and rows, and fill in the data.

2. Identify the experimental groups and the control of this experiment.

3. Identify the independent and dependent variables.

4. What conclusion can you make from this data?

5. Why did you use only one species of plants in this experiment?

6. Do you think that your results would be more reliable if you used more marigold plants in each condition? Explain your answer.

7. Why do you think the average growth was calculated and reported instead of the individual growth of each plant?

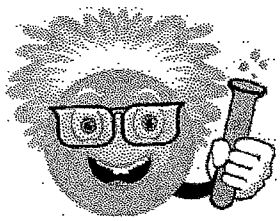
8. Why must you measure the plants at the start of the experiment?

Constructing a Line Graph

A line graph is a perfect to use when you want to illustrate the changes that take place between the independent and dependent variables. The data plotted on line graphs appear as points, which are connected, point to point, line a line. The chart below indicates, step by step, how to construct a line graph.

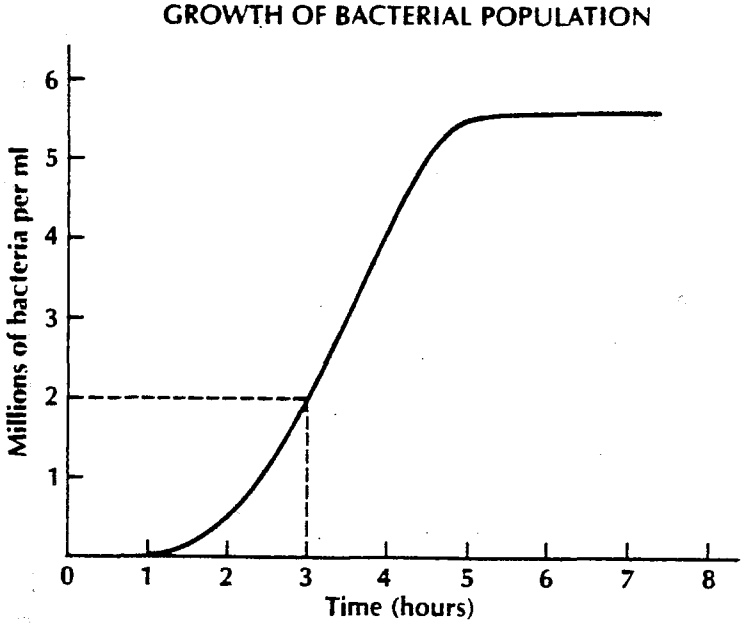
How To Construct a Line Graph On Paper*		
Step	**What To Do**	**How To Do It**
1	**Identify the variables and label the axes.**	a. **Independent Variable** (left side of data table) ♦ Goes on the **X axis** (horizontal) b. Dependent Variable (right side of the data table) ♦ Goes on the **Y axis** (vertical)
2	**Determine the variable range.**	a. Subtract the lowest data value from the highest data value. b. Do this for each variable separately.
3	**Determine the ale divisions for each axis.**	a. Determine a scale for the X and Y axes that best fits the range of each variable. ♦ Each square must have the same value b. Spread the graph to use MOST of the available space.
4	**Number and label each axis.**	a. This tells what data the lines on your graph represents.
5	**Plot the data points.**	a. Plot each data value on the graph with a dot.
6	**Draw the line.**	a. Connect each dot to the next from left to right forming a straight line.
7	**Title the graph.**	a. Your title should clearly communicate the purpose of the experiment and include the independent and dependent variables. b. If your graph has more than one set of data, provide a "key" to identify the different lines.
8	**Make a key.**	a. If your graph has more that one set of plotted data, (two lines) then provide a key to identify the different lines. b. Lines can be made in different colors or data points can be surrounded by circles for one line and by triangles for the other line.

Adapted from http://staff.tuhsd.k12.az.us/gfoster/standard/bgraph.htm



Now it's your turn! First, let's see how well you do in interpreting a line graph.

The following line graph shows how the size of bacteria changed over an eight-hour period.



After you familiarize yourself with the graph, answer the following questions:

1. What does the scale on the horizontal axis of the graph measure?

2. What quantity does one unit on the horizontal graph measure?

3. What does the scale on the vertical axis measure?

4. What quantity does one unit on the vertical scale equal?

5. What specific information can you learn from the graph?

6. How large was the bacteria population at the end of the fifth hour?

7. At what point were there 3 million bacteria per milliliter?

Let's see how you do at graphing...

A student counted the total number of leaves in a group of duckweed plants during a 5-day period. The data collected are shown in the table below.

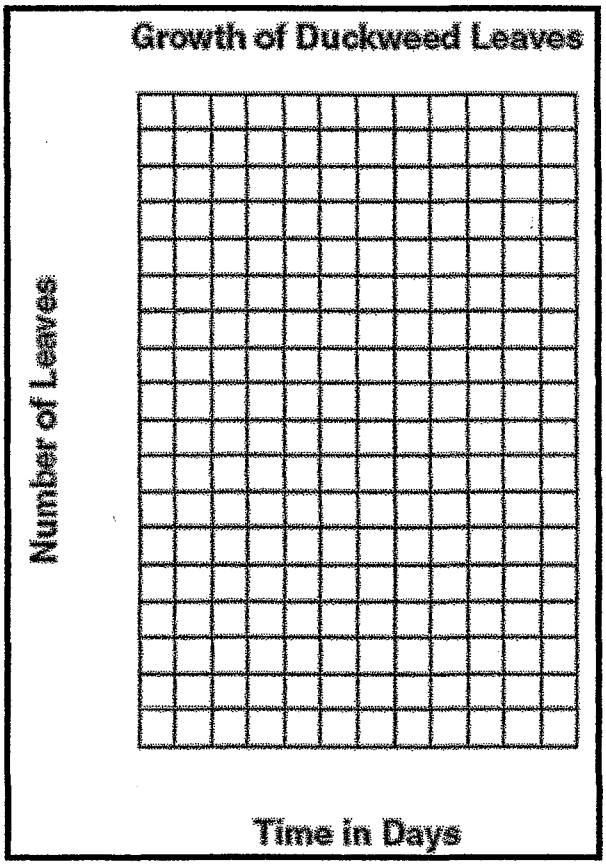
Number of Duckweed Leaves Collected in Five Days

Time in Days	Number of Leaves
0	15
1	20
2	25
3	40
4	60
5	80

Your task is to construct a graph on the grid provided below by doing the following:

1. Mark an appropriate scale on each axis.
2. Plot the data from the table above. Surround each point with a small circle and connect the points

3. After you graph the data, answer the questions that follow:
4.



Now, answer the following questions:

1. The time it takes for the number of leaves to increase from 15 to 30 is approximately
   (1) 2.0 days
   (2) 2.3 days
   (3) 2.9 days
   (4) 3.2 days

2. Why must the intervals (each square in the graph) be equal to each other?

Some More Practice with Line Graphs!

An insect known as a sawfly is found in evergreen forests in North America. Sawfly cocoons are the main source of food for shrews (small mammals) and some bird species. Scientists studied 1-acre plots in various parts of a state to determine the average number of sawfly cocoons, shrews, and robins. The data collected are shown in the table below.

Data Table

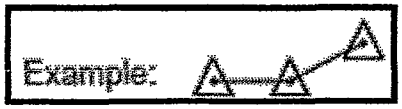
Average Number of Sawfly Cocoons per Acre (in thousands)	Average Number of Shrews per Acre	Average Number of Robins per Acre
100	5.0	0
300	7.5	0.5
600	19.0	0.8
900	23.5	1.0
1200	23.5	1.3

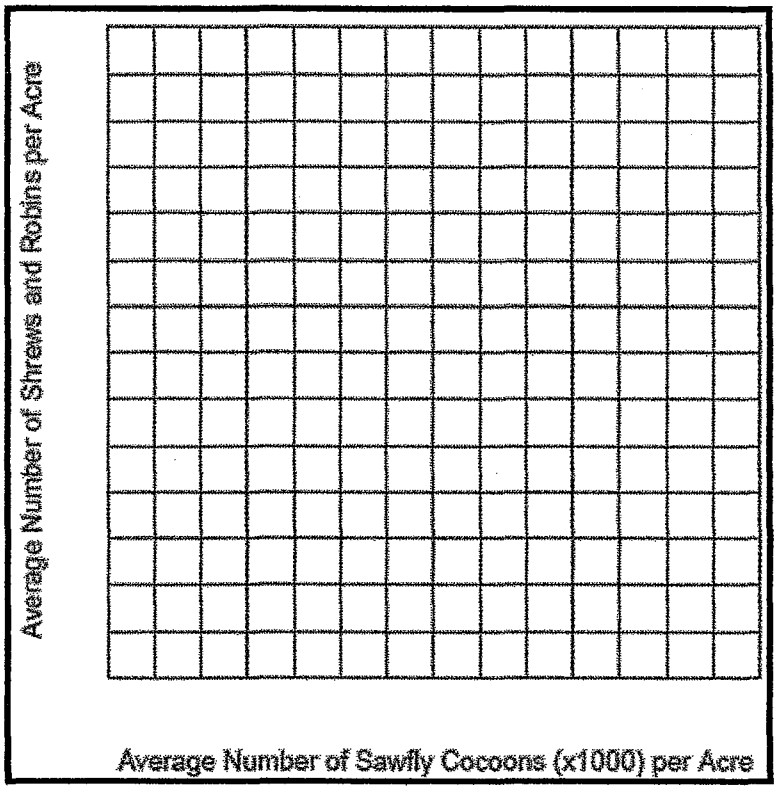
1. Mark an appropriate scale for the average number of sawfly cocoons per acre on the grid below. (X axis)

2. Mark an appropriate scale for the average number of shrews and robins per acre on the grid below (Y axis)

3. Plot the data for the shrews on the grid below. Surround each point with a small circle and connect the points.

5. Plot the data for the robins. Surround each point with a small triangle and connect the points.





Based on the graph above, answer the following questions:

5. What is the average number of shrews per acre when the average number of sawfly cocoons is 500,000?

6. State what would most likely happen to the number of sawfly cocoons per acre if the shrews and robins were removed from the area?

One More Problem to Graph!

Look over the data in the table below:

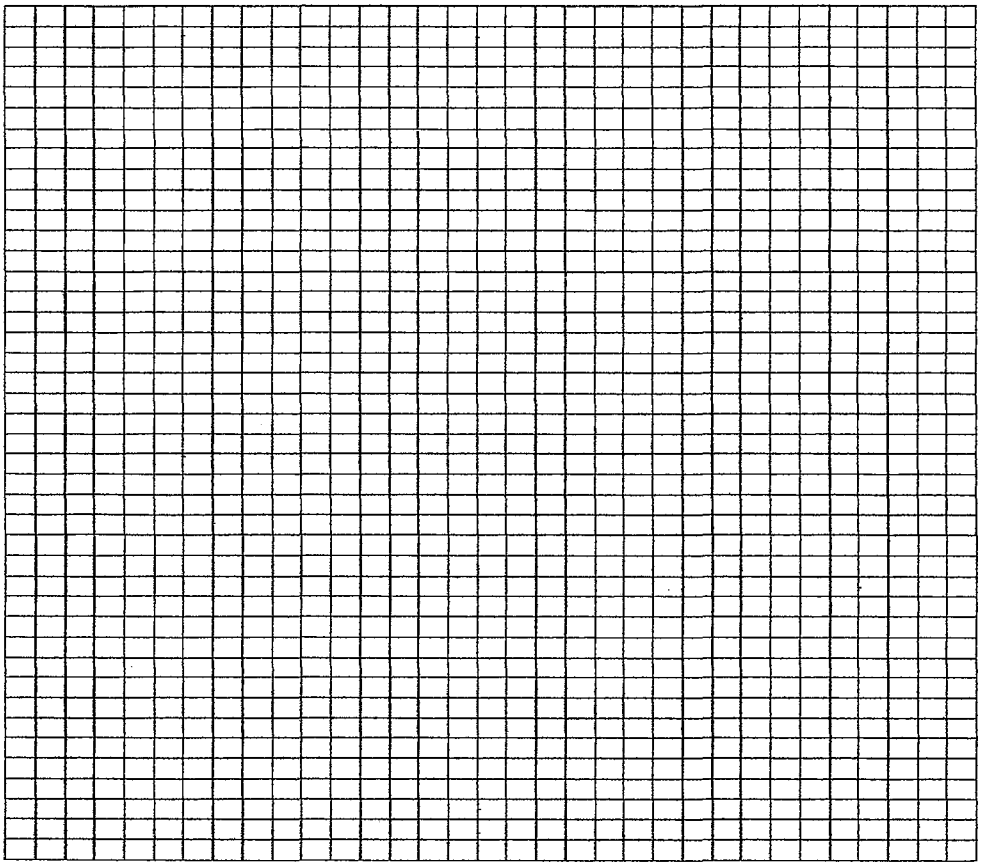
Population of Selected Threatened and Endangered Species

Species	1950	1960	1970
Whooping Crane	24	41	78
California Condor	56	43	46

Using the graph below:

1. Name the x and y axes.
2. Determine and mark an appropriate scale for each axis. Remember that the intervals between years must be the same.
3. Plot the data for the Whooping Crane – surround the data points with circles – connect the

data points.
4. Plot the data for the California Condor – surround the data points with triangles – connect the data points.
5. Title the graph.



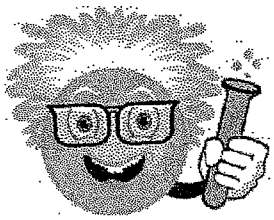
Constructing a Bar Graph

Bar graphs are used to help visually represent data so that comparisons and trends will be easier to see. Categories that are being studied or compared are placed on the x-axis. Measurements for or amounts are placed on the y-axis. An individual bar represents the measurement for each category being studied. The height of the bar indicates the amount of that measurement. A few basic rules to constructing a bar graph are listed below and will assist you in making your own bar graphs.

1. Draw the x and y-axes on graph paper.
2. Label the axes.
   - Remember that the categories being compared on placed on the x-axis; the measurements for these categories are placed on the y-axis.
3. Determine a scale for the y-axis.
   - The scale should reflect the range of the measurement.
   - Intervals (boxes on the graph paper) should be equal.
   - Mark the scale intervals on the y-axis.
4. Make the bars for the categories being compared on the x-axis.

- Use an equal number of boxes for the width of each bar.
- Leave at least 1 box (space) between bars.

5. Using the data, draw each bar.
   - The height of the bar should exactly reflect the measurement or amount found in each category.



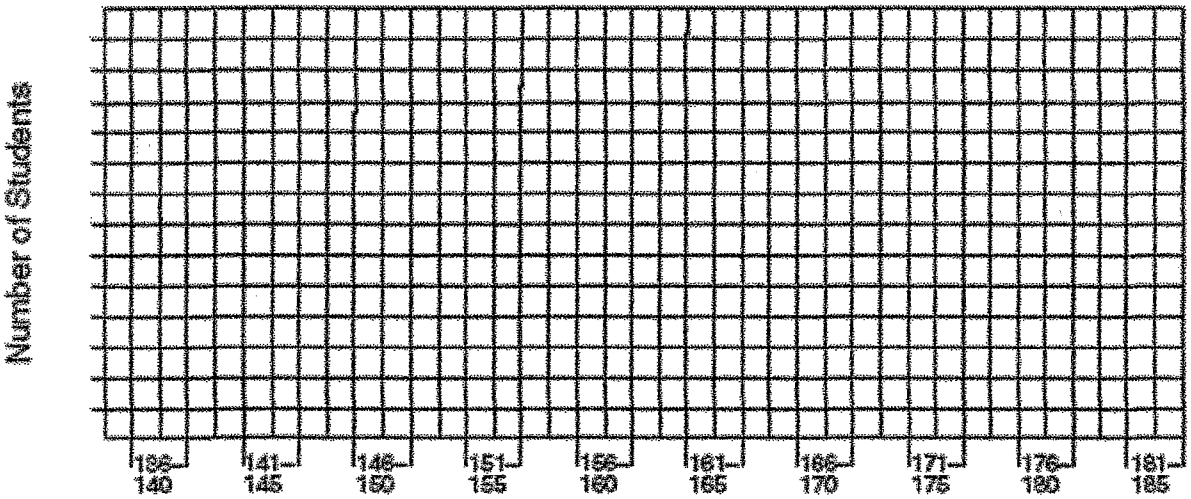
Now it's your turn! Try constructing a bar graph using the following information and data.

A science class was studying various human physical characteristics in an Investigation for a report on human genetics. As part of the investigation, the students measured the arm span of the class members. The data table below summarizes the class results.

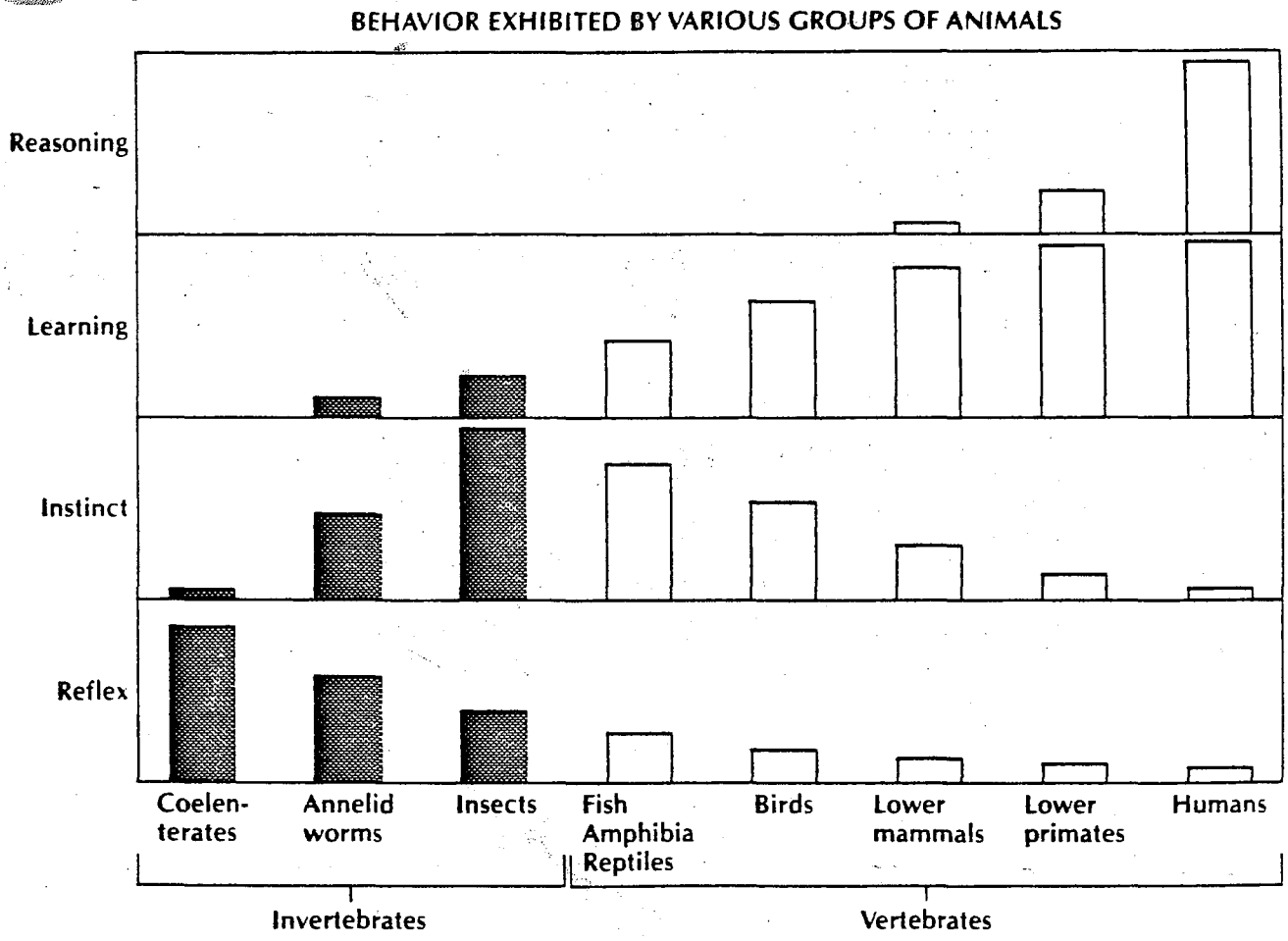
Arm Span of the Students	
Student Arm Span (cm)	**Number of Students**
136–140	1
141–145	2
146–150	0
151–155	4
156–160	5
161–165	8
166–170	5
171–175	5
176–180	3
181–185	1

1. Mark an appropriate scale on the axis labeled "Number of Students."
2. Construct vertical bars to represent the data. Shade in each bar.

Arm Span of Students



Let's see how you do with interpreting the following bar graph that compares the behaviors exhibited by eight different groups of animals.



1. List the kinds of behaviors that are compared on this graph.

2. Why are some of the bars shaded while others are not?

3. Since this graph does not have a numerical scale on the y-axis, how can you interpret the meaning of the bars?

4. Which group of animals exhibits the most instinctual behavior?

5. Which group of animals exhibits the least learning behavior?

6. Which group of animals exhibits the most reasoning behavior?

7. What pattern do you observe with respect to the categories of behavior listed on the y-axis?

8. What differences (more than 1) do you observe between the vertebrate and invertebrate animal group?

9. What pattern do you observe when moving from left to right across the graph?