

## Objective

Students will learn how to create data tables and graphs from experimental data.

## Data Tables

Data tables are just that: tables of your results. Tables should be organized before you start your experiment so that you can concentrate on your method instead of scrambling to organize your information while you work. Trust me on this: you will discover that your experiments go more smoothly if you come to class with your data tables set up, so that all you have to do is write the numbers in the right place. Some rules for data tables included in your lab reports:

1. Tables need a title! The title should identify what information is in the table.
2. All columns should be labeled and include the units of measurement at the top.
3. Use only numbers in the cells. If you include the units as well, computers won't read them as numbers, and they won't be able to plot them on a graph for you.
4. Use the same number of decimal places in every measurement in a column.
5. Center your numbers both vertically and horizontally to make the table easier to read.

Here is a nice sample data table, created from data my grade 9 class gathered during an experiment on biological membranes:

Table 1: Salt Concentration and Light Transmittance					
Salt Concentration (%)	Transmittance (%T)				
	Trial #1	Trial #2	Trial #3	Trial #4	Trial #5
0	77.23	74.50	64.88	75.27	54.66
3	85.23	92.82	78.91	60.71	57.96
6	88.39	100.05	73.66	66.51	64.54
9	80.71	100.05	68.29	64.91	52.96
12	82.66	117.18	71.01	56.91	46.95
15	72.55	115.40	65.72	66.03	55.38

## Graphs

Graphs are visual representations of the data (numbers) in your data table. Some people can easily identify trends from a group of numbers, but most of us find it easier to spot patterns when the numbers are plotted on an appropriate graph. Here are my rules for scientific graphs:

1. Graphs need a title, which shows what information is in the table.
2. Label each axis, and include both numbers and units of measurement.
3. Plot the independent variable across the x-axis. (IV = X)
4. Plot the dependent variable along the y-axis. (DV = Y)
5. A minimum of 3 data points are required to identify a trend. The more data you gather, the more reliable your results will be.
6. A line of best fit (trendline) is NOT connect-the-dots! Use the trendline function in your spreadsheet software to show overall patterns in your data series.

## How to create graphs for science

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These are the guidelines for a finished graph, but how do you create it in the first place? The best thing to do is to use spreadsheet software such as Microsoft Excel, Mac Pages, or OpenOffice Calc. Personally, I think Excel is the easiest one to use, but you should use whichever one you're most comfortable with. I've summarized the basic steps for the 2011 version of MS Excel for Mac in the steps below.

### MS Excel (2011 version for Mac)

1. Open a new worksheet and select cell A1.
2. Type the **title of your data table** in A1. You may want to merge several cells together and center the title, as shown in *Figure 1* below.

*Figure 1: Data Table Title*

	A	B	C	D	E	F
1	<b>Table 1: Salt Concentration and Light Transmittance</b>					

3. Type the name of the **independent variable and the unit of measurement** in cell A2
4. Type the measurements (your **results**) in the cells below A2, as shown in *Figure 2* below. Remember to only write the numbers - not the units - so that the software 'reads' your information correctly.

*Figure 2: Independent Variable*

	A
1	<b>Ta</b>
2	<b>Salt Concentration (%)</b>
3	0
4	3
5	6
6	9
7	12
8	15

5. Type the name of the **dependent variable and the units of measurement** in cell B2.
6. Type the measurements (your **results**) in the cells below B2, as shown in the right-hand column of *Figure 3* below.

*Figure 3: Dependent Variable*

	A	B
1	<b>Table 1: Salt C</b>	
2	<b>Salt Concentration (%)</b>	<b>Transmittance (%T) Trial #1</b>
3	0	77.23
4	3	85.23
5	6	88.39
6	9	80.71
7	12	82.66
8	15	72.55

7. If you repeated **more than one trial** of your experiment, add those measurements in the next columns, one column for each trial. This is shown in *Figure 4*. You now have a completed data table, ready for conversion to a graph!

*Figure 4: Dependent Variable - Subsequent Trials*

	A	B	C	D	E	F
1	<b>Table 1: Salt Concentration and Light Transmittance</b>					
2	Salt Concentration (%)	Transmittance (%T) Trial #1	Transmittance (%T) Trial #2	Transmittance (%T) Trial #3	Transmittance (%T) Trial #4	Transmittance (%T) Trial #5
3	0	77.23	74.50	64.88	75.27	54.66
4	3	85.23	92.82	78.91	60.71	57.96
5	6	88.39	100.05	73.66	66.51	64.54
6	9	80.71	100.05	68.29	64.91	52.96
7	12	82.66	117.18	71.01	56.91	46.95
8	15	72.55	115.40	65.72	66.03	55.38

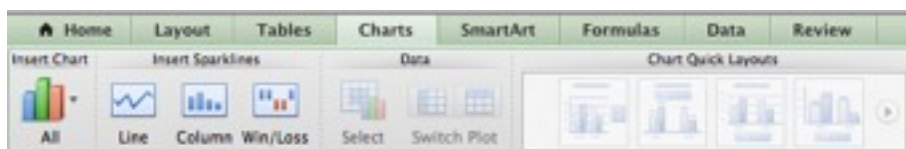
8. Select/highlight all the cells in the column heading row and all the data you want to appear in your graph. In *Figure 5*, we are selecting only the first trial in order to keep it simple, like this:

*Figure 5: Highlighting Selected Data in the Data Table*

	A	B
1	<b>Table 1: Salt C</b>	
2	Salt Concentration (%)	Transmittance (%T) Trial #1
3	0	77.23
4	3	85.23
5	6	88.39
6	9	80.71
7	12	82.66
8	15	72.55

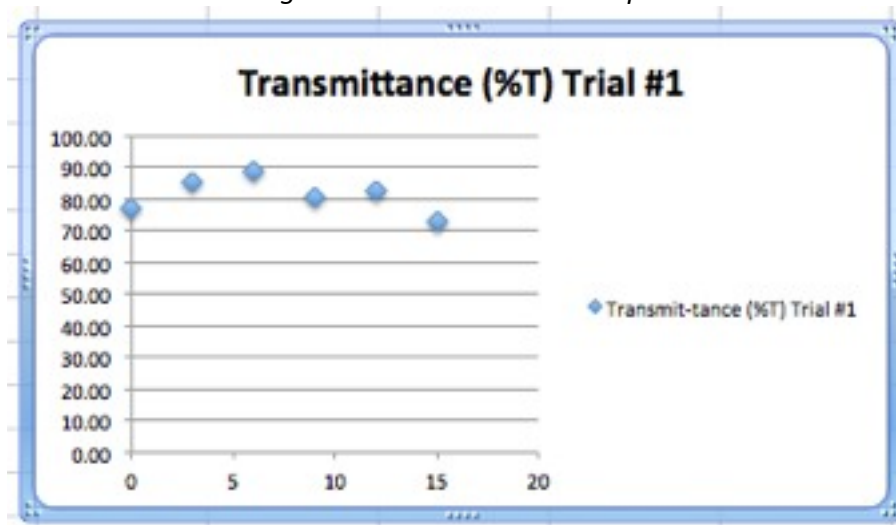
9. Click on the “Charts” tab in the ribbon, shown in *Figure 6*, and select “**Insert Chart**”.

*Figure 6: MS Excel Charts Ribbon*



10. From the drop-down menu, choose “**Marked Scatter**,” which should produce a ready-made but incomplete chart similar to the one in *Figure 7*.

Figure 7: Basic One-Trial Graph



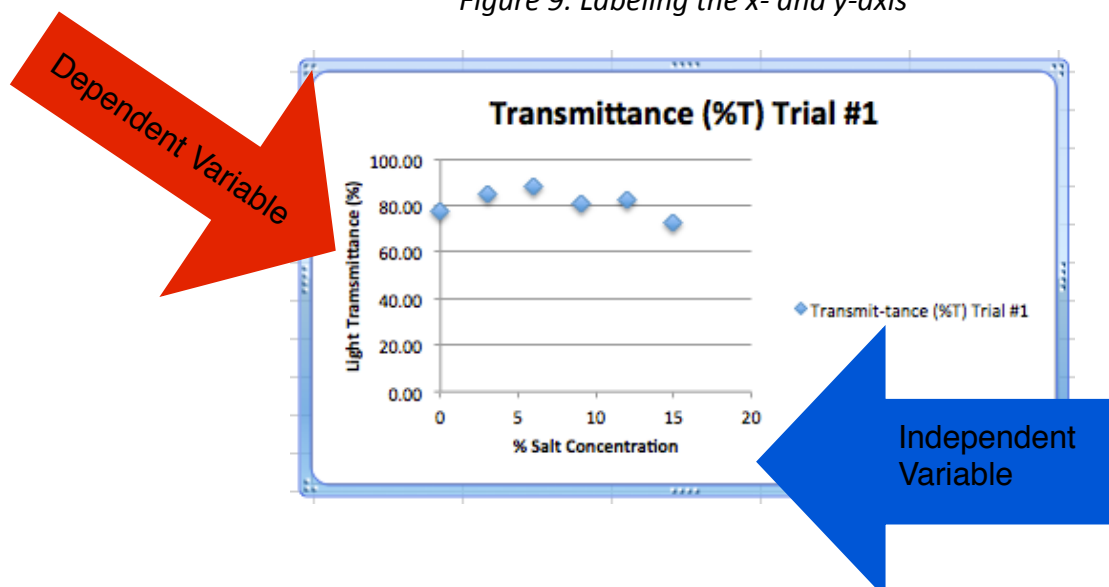
11. The above graph is pretty good, but it’s still missing some key elements: **Neither the x-axis nor the y-axis is labeled**. This is an easy problem to fix! Simply choose the “Chart Layout” tab from the ribbon and select the “Axis Titles” button, which produces another drop-down menu.

Figure 8: MS Excel Chart Layout Ribbon



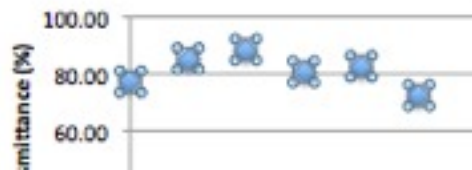
12. Once you’ve selected the “**Horizontal Axis**” option, simply type the name of your **independent variable** in the new field in the chart. Select “**Vertical Axis**” and type the **dependent variable** in the new chart field as well. You should see something similar to *Figure 9* below.

Figure 9: Labeling the x- and y-axis



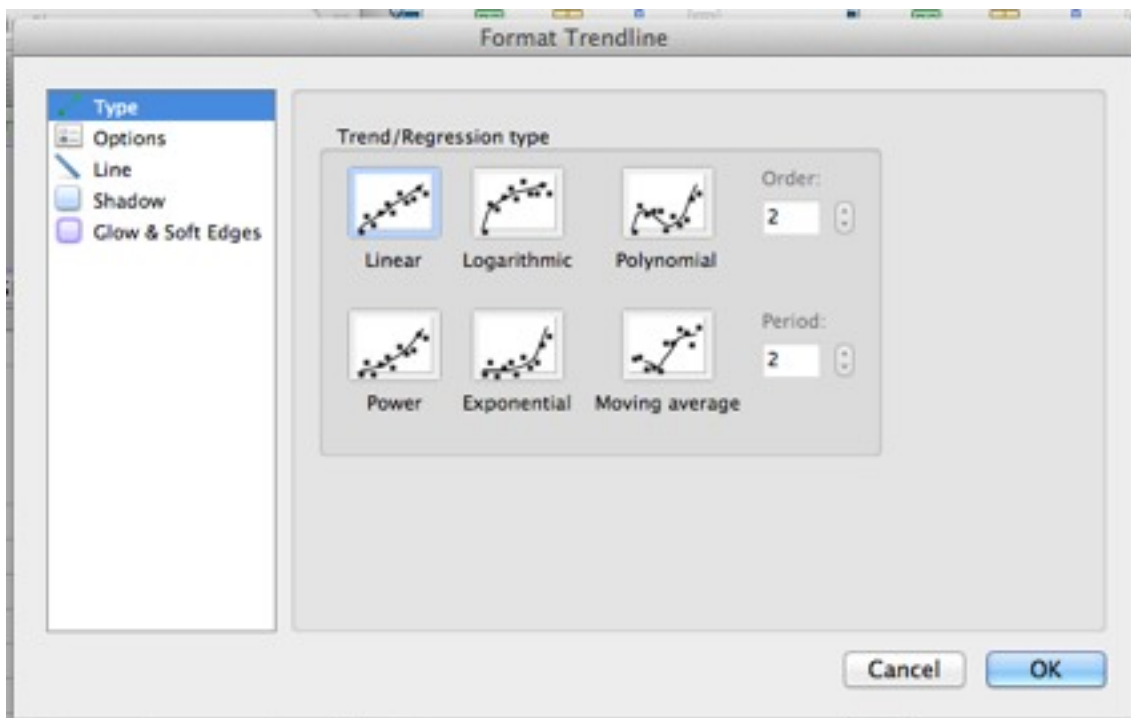
13. The last step to creating a truly scientific graph is to **add a trendline**, or **line-of-best-fit**. Excel will do this for you too! Click on one of your data points in the chart so that it looks like *Figure 10*.

*Figure 10: Selecting a Data Series*



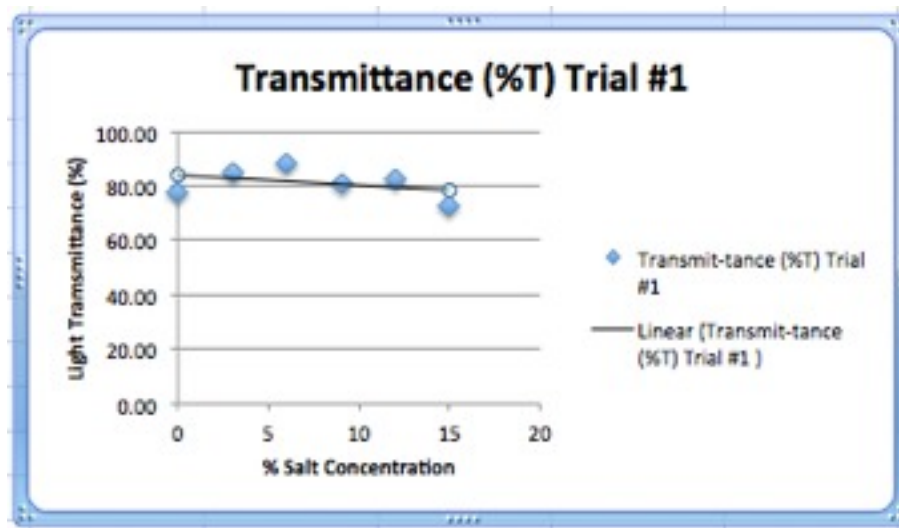
14. Click on “Chart” at the menu at the top of the screen, and select “Add Trendline...” from the drop-down menu. This will open a pop-up window creatively titled, “Format Trendline,” as illustrated in *Figure 11*.

*Figure 11: Formatting a Trendline*



15. The **linear trendline** is the default selection, and that’s the one you want. Click “OK.” Now your chart looks like this:

Figure 12: Basic Graph with Trendline



16. You can **resize the graph** by dragging any of the corners where you want them. Click outside the chart area, and *voila!* Your scientific graph is complete!

**Graphing more than one trial in an experiment**

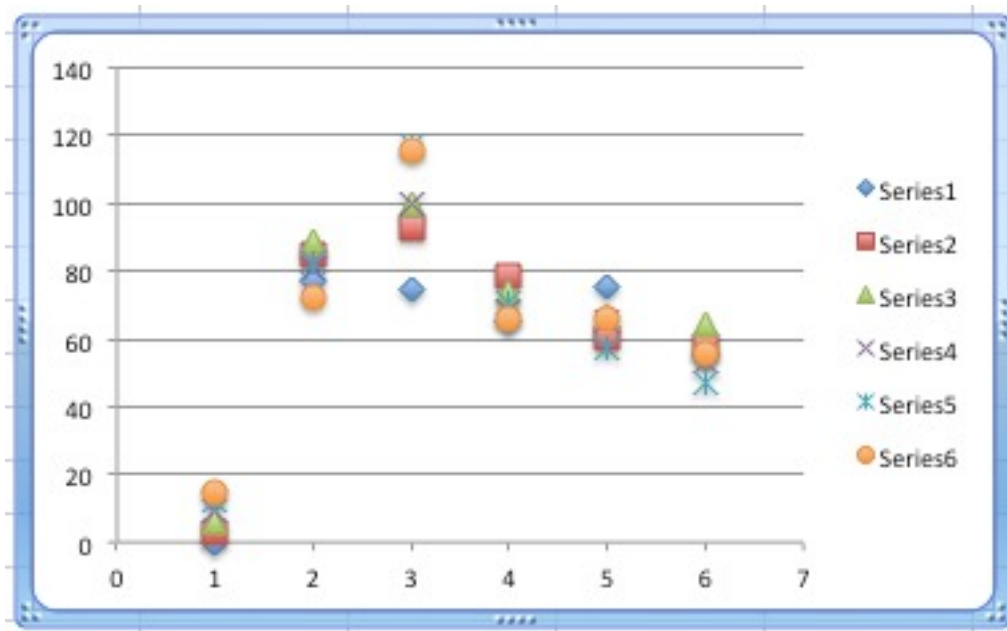
17. The process is identical to creating a chart for a single set of data, except that you should **highlight all your results**, as shown in Figure 13 below.

Figure 13: Selecting Multiple Trials for a Graph

Table 1: Salt Concentration and Light Transmittance						
	Salt Concentration (%)	Transmittance (%T) Trial #1	Transmittance (%T) Trial #2	Transmittance (%T) Trial #3	Transmittance (%T) Trial #4	Transmittance (%T) Trial #5
1	0	77.23	74.50	64.88	75.27	54.66
2	3	85.23	92.82	78.91	60.71	57.96
3	6	88.39	100.05	73.66	66.51	64.54
4	9	80.71	100.05	68.29	64.91	52.96
5	12	82.66	117.18	71.01	56.91	46.95
6	15	72.55	115.40	65.72	66.03	55.38

18. Once you've selected the "Marked Scatter" choice from the "Charts" ribbon, Excel will automatically generate a chart similar to the one below. **Each trial's data are represented by a different color.**

Figure 14: Basic Multi-Trial Scatter Plot



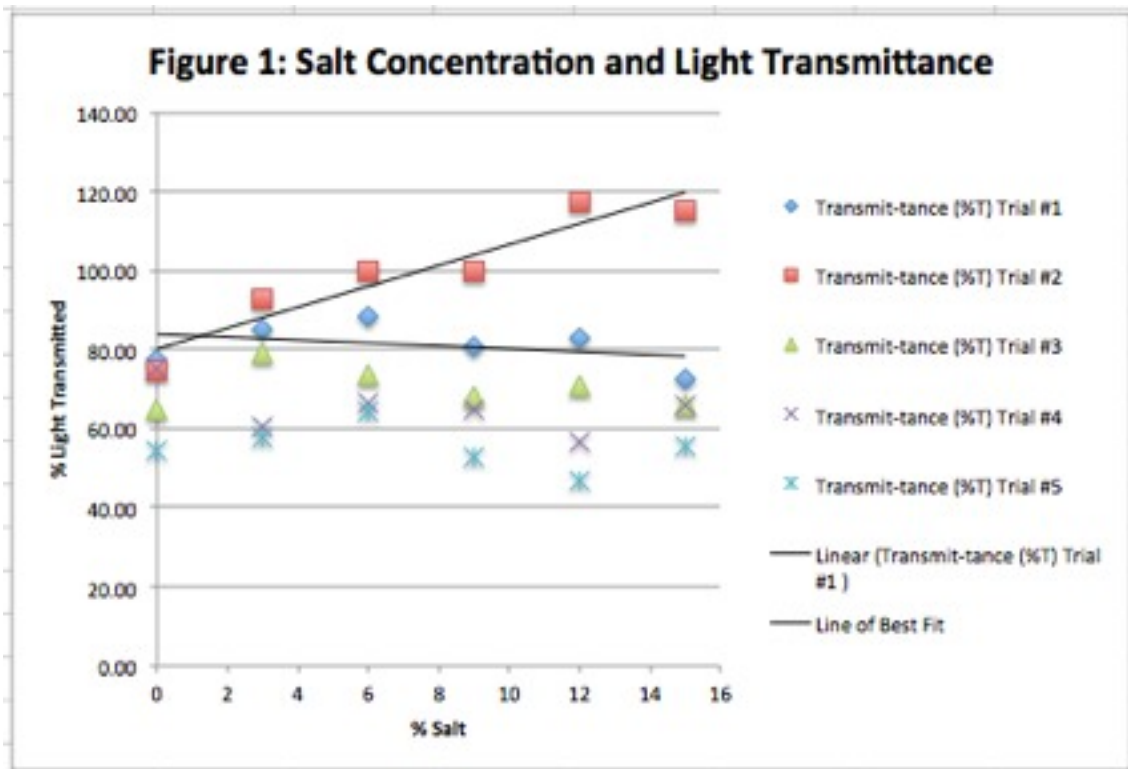
19. While your data are still highlighted in the cells, click "**Switch Plot**" in the "Chart" tab of the ribbon, as illustrated below.

Figure 15: The 'Switch Plot' Button



20. Your chart should change to look more like this one. Then you can **add the titles** and **label the x- and y-axis** just like you did in the single-trial graph above. **Trendlines** must be added for each separate data series.

Figure 16: Final Multi-Trial Graph



21. Now choose "File" >> "Save As..." and select "PDF" from the drop-down menu. Your data table and your graph are converted to a PDF and ready to be uploaded to Turnitin.com!