Data Analysis and Graphing in Microsoft Excel:

Microsoft Excel is a program for entering, storing, and analyzing data. It is available on most PC and Mac computers as part of the Microsoft Office package and is commonly used in many professions. Knowing how to use Excel is a valuable skill to list when applying for jobs.

Today we are going to learn how to enter and visualize data in Excel. We will enter data in a basic table set up to suit our experiment. Then we will use Excel's graphing features to display the data in a way that is easy to analyze and discuss.

The example experiment measured how corn and been seedlings grow when watered with tap water or water of different pHs. There were ten replicates for each watering treatment. Weight of the seedlings was measured in grams. The data is entered in the Excel spreadsheet your teacher gave you.

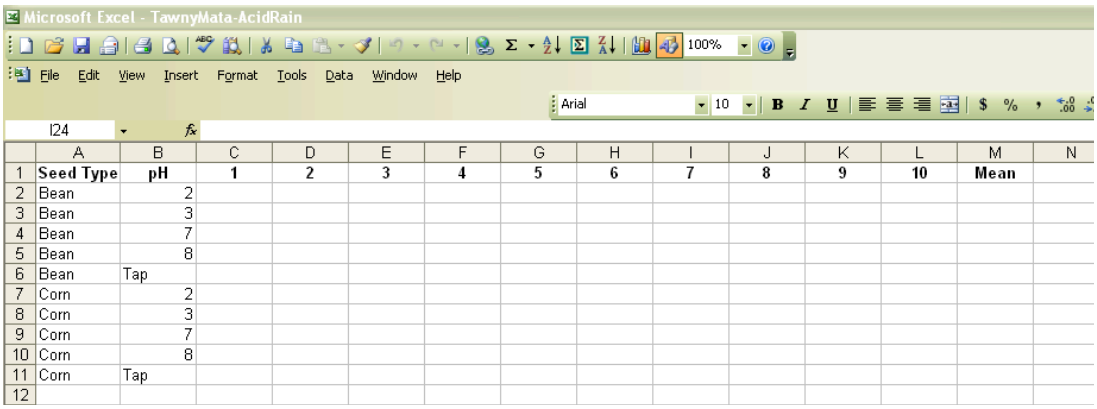
Phase 1: Raw Data Entry

1. Open Excel. A blank document will appear. Go to "File" and then to "Save As." In the "File Name" box type "[YourName]-AcidRain." Under "Save In" at the top of the screen, select "Desktop." Click "Save" in the lower right hand corner.
2. Excel is already set up as a table. All you have to do is label the rows and columns. The first thing we need to do for each pH level and seed type is figure out the **mean growth**. The mean is an average for a set of numbers. It tells you what value your data clusters around. In our case, it is going to tell us the average size of corn and bean seeds for each pH environment and allow us to compare seed growth across different pH environments.

   The mean is equal to the sum of all of the data points divided by the number of data points:

   $$\text{Mean} = \frac{(Seed1 + Seed2 + Seed3 ... + Seed10)}{Number of Seeds}$$

3. Set up your data table with a column labeled "Seed Type" (Cell A1) and an adjacent column labeled "pH" (Cell B1). In the columns next to pH, type the numbers 1-10 to correspond to the individual seeds you measured (Cell C1-K1). After the column titled 10, label another column "Mean" (Cell M1). Highlight everything you typed and make it **bold** so that you can tell they are column labels.
4. For the first row in your "Seed Type" column, type "Bean" (Cell A2). For the first row in you "pH" column type "2" (Cell B2). Fill out the rest of the "Seed Type" and "pH" columns with the different combinations of seed type and pH we used in our experiment. Now your spreadsheet should look like this:

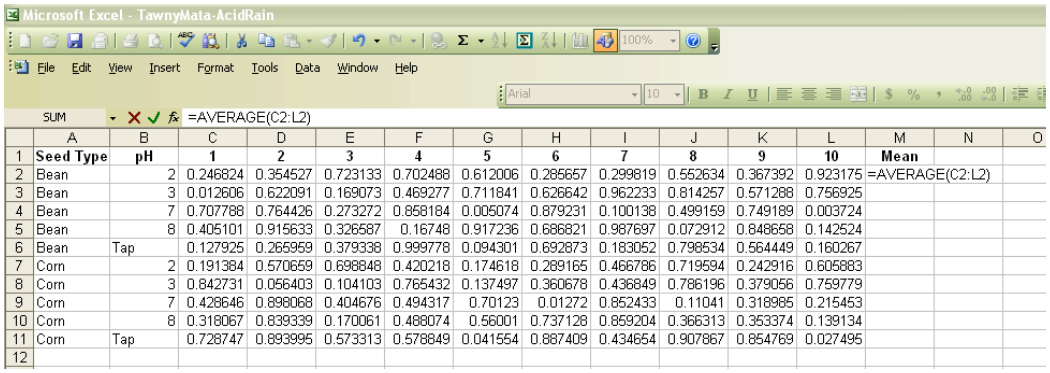


Microsoft Excel - TawnyMata-AcidRain

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Seed Type**	**pH**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**	
2	Bean	2												
3	Bean	3												
4	Bean	7												
5	Bean	8												
6	Bean	Tap												
7	Corn	2												
8	Corn	3												
9	Corn	7												
10	Corn	8												
11	Corn	Tap												
12														

5. Now enter the raw class data into each row. For each seed type and pH combination, you will have 10 cells to fill in that correspond to the 10 different seeds measured.
6. Now go to the column you labeled “Mean” (Cell M1). In the cell M2, type exactly this:

   =AVERAGE(C2:L2)



Microsoft Excel - TawnyMata-AcidRain

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**Seed Type**	**pH**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**		
2	Bean	2	0.246824	0.354527	0.723133	0.702488	0.612006	0.285657	0.299819	0.552634	0.367392	0.923175	=AVERAGE(C2:L2)		
3	Bean	3	0.012606	0.622091	0.169073	0.469277	0.711841	0.626642	0.962233	0.814257	0.571288	0.756925			
4	Bean	7	0.707788	0.764426	0.273272	0.858184	0.005074	0.879231	0.100138	0.499159	0.749189	0.003724			
5	Bean	8	0.405101	0.915633	0.326587	0.16748	0.917236	0.686821	0.987697	0.072912	0.848658	0.142524			
6	Bean	Tap	0.127925	0.265959	0.379338	0.999778	0.094301	0.692873	0.183052	0.798534	0.564449	0.160267			
7	Corn	2	0.191384	0.570659	0.698848	0.420218	0.174618	0.289165	0.466786	0.719594	0.242916	0.605883			
8	Corn	3	0.842731	0.056403	0.104103	0.765432	0.137497	0.360678	0.436849	0.786196	0.379056	0.759779			
9	Corn	7	0.428646	0.898068	0.404676	0.494317	0.70123	0.01272	0.852433	0.11041	0.318985	0.215453			
10	Corn	8	0.318067	0.839339	0.170061	0.488074	0.56001	0.737128	0.859204	0.366313	0.353374	0.139134			
11	Corn	Tap	0.728747	0.893995	0.573313	0.578849	0.041554	0.887409	0.434654	0.907867	0.854769	0.027495			
12															

This command is telling Excel that you want it to take the average of all of the numbers from cell C2 to cell L2. When you press enter, it will give you the average growth for all of the bean seeds grown at a pH of 2. Instead of typing in “C2:L2” you could have simply typed in “AVERAGE(” and highlighted the numbers you wanted to average, and then typed “)” to close the parentheses. Try that method for the bean seeds grown at a pH of 3. Press enter and there’s the mean.

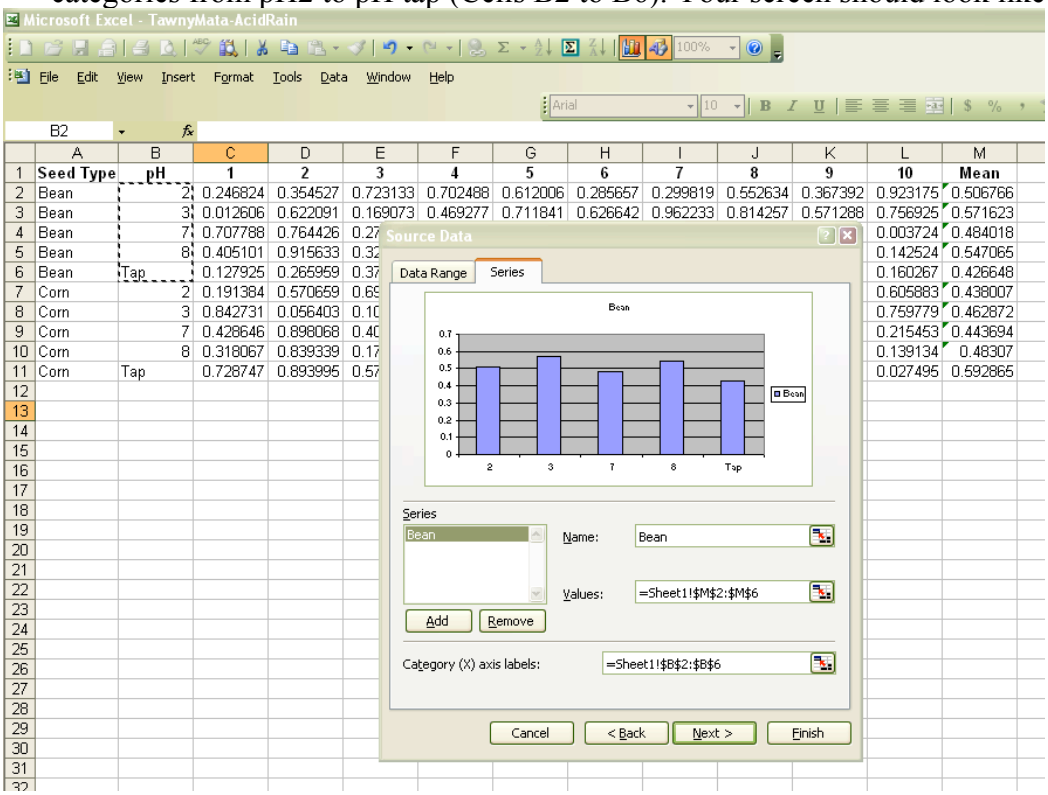
Typing out all of these formulas is kind of a drag, so luckily Excel is smart. Click on the cell with the average for bean seeds grown at a pH of 3. Click on the small square in the lower right hand corner of the cell, hold the mouse button down, and drag the little box all of the way down that column to your last row of data, which should be for corn grown in tap water (Cell M11). When you release your mouse button, the average for each row will be calculated. Based on the formula you typed in M3, Excel has correctly guessed that you want that formula applied to

each row of data. Click on a few of the cells in the "Mean" column to check if the formula excel guessed is correct.

Now that we have our means, let's graph them.

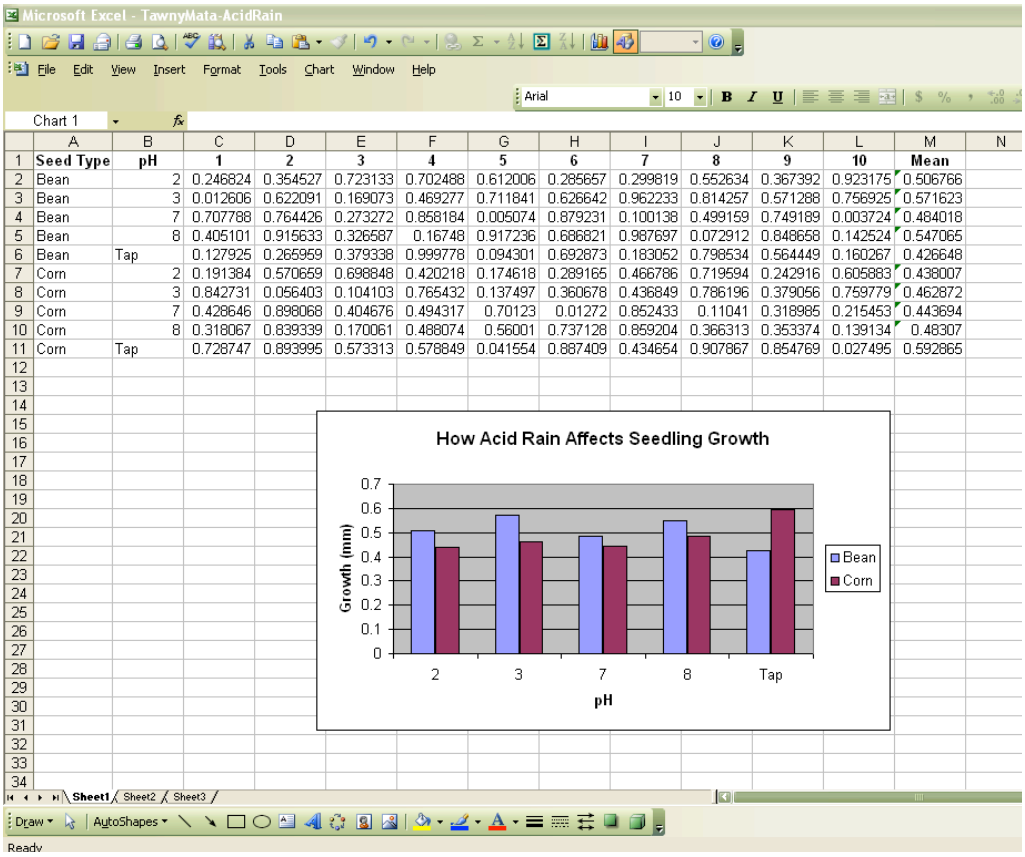
Phase 2: Graphing in Excel

1. In the upper right-hand corner of your menu bar, locate the little icon that looks like a chart. Click on it.
2. In the window of chart types, select "Column" and then click "Next."
3. At the top of the window, click the tab labeled "Series."
4. Now click "Add."
5. In the "Name" box type "Bean."
6. In the "Values" box, delete anything already typed in there but leave the cursor in the box. Without closing that window, go to your main spreadsheet and highlight all of the means for the bean seedlings grown at each pH (Cells M2 to M6). The window for the graphing feature will temporarily minimize, but as soon as you release your mouse, it will come back. Now the "Values" box will say "=Sheet1!$M$2:$M$6."
7. In the "Category (X) Axis Labels", click the mouse and then without closing the window go over to your main spreadsheet and highlight all of the different pH categories from pH2 to pH tap (Cells B2 to B6). Your screen should look like so:



8. Now click "Add" again. Now in the "Name" box type "Corn."

9. In the "Values" box, delete whatever is already in there, leave the cursor in the box, and switch over to your spreadsheet to highlight all of the means for your corn data. You will now see "Sheet1!$M$7:$M$11."
10. When you look at the "Category (X) axis labels" box, you will notice it is already filled in. Click "Next."
11. In the next window, give your graph a title and label your axes appropriately. You should label the x-axis with the variable you were manipulating, which in our case was pH. You should label the y-axis with the variable you were measuring, which in our case was growth. On the growth axis, make sure to also include the units of measurement.
12. Click "Next" and then "Finish." Now you should have a completed graph and it will look like this:



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Phase 3: What did you find?

Looking at your graph:

1) How does pH affect seedling growth?
2) Does pH affect bean and corn seedlings differently?
3) What do your results suggest about the affects acid rain can have on the environment?