Comparing Means of Two Populations

Objectives of this lab are to:

1. Practice measuring using the metric system
2. Formulate a hypothesis and test it
3. Analyze data and make a conclusion
4. Learn how to determine whether measurements from two populations are significantly different
5. Understand that there is variation within biological populations, and learn one method used by biologists to measure such variation

Introduction:

Within a population of organisms, individuals vary. You will learn more about the cause of such variation when we study genetics. But for now we want to measure and statistically analyze variation within a population.

Biologists often need to compare two populations. For example, measurements from a control group and an experimental group are compared to see whether a particular parameter has had an effect on the experimental group. Comparing an individual from each group would be inadequate, since a single individual might not be representative of the population. Also, a single measurement from an individual gives no information about the variation within the population. So biologists often measure many individuals from the two populations and then compare the means.

Methods:

The populations we will measure today are the ones that are most readily available in the lab: male and female *Homo sapiens.*

The measuring tools available are metric rulers, meter sticks, and tape measures.

1. Measure your height, or have it measured, and enter the data in Table 1 and also on the blackboard, so that everybody in the classroom has access to it. Measurements must be repeatable, so we will discuss how to measure height in a consistent manner throughout the class and record that procedure below:

2. Within your group, decide on a body measurement you think might be different between men and women. (Note: The measurement must be measurable in both men and women, and it must be measurable without pain or embarrassment to the person measured.) Be creative. Think of something that might be different, but is not obvious. We'll call this the '**specific measurement'** for the rest of the lab. Describe precisely what you plan to measure and how you will do so: ________________________________

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3.a. Make a hypothesis about relative sizes of males and females and record it here. Remember, a hypothesis is a testable statement about the physical world. ________________________________

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3b. Make a prediction based on your hypothesis. That is, in this particular study of the **specific measurement**, what should the results of your study be if the hypothesis you made above is true? For example, should the means be the same in both sexes, or should one sex have a higher mean than the other? ____

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4. Make this **specific measurement** on everybody in the room. For ease of calculation and data transfer within the classroom, make all your measurements in millimeters. Enter the data in Table 1 next to that person's identification code.

5. Since human males are generally larger than human females, men may be larger in some measurement only because they tend to be bigger. If you had an equally tall group of women, there might be no difference. To correct for the effect of height, you will calculate a **relative measurement**. Divide your **specific measurement** by the height of the individual to determine the **relative measurement**. For example, if a person's nose length is 200 mm, and the same person's height is 1800 mm, then the relative nose length is 200mm/1800mm, or 0.11. This means that their nose length is 11% of their height. This measurement will have no units, and because of the way the spreadsheet is configured, should be recorded as a percentage.

Make a hypothesis about comparing sizes of **relative measurements** in males and females.
Hypothesis: ____

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6. Make a prediction based on your hypothesis. That is, in this particular study of the **relative measurement**, what should be the result if the hypothesis you made above is true. ____________________

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Table 1: Data for measurements in class

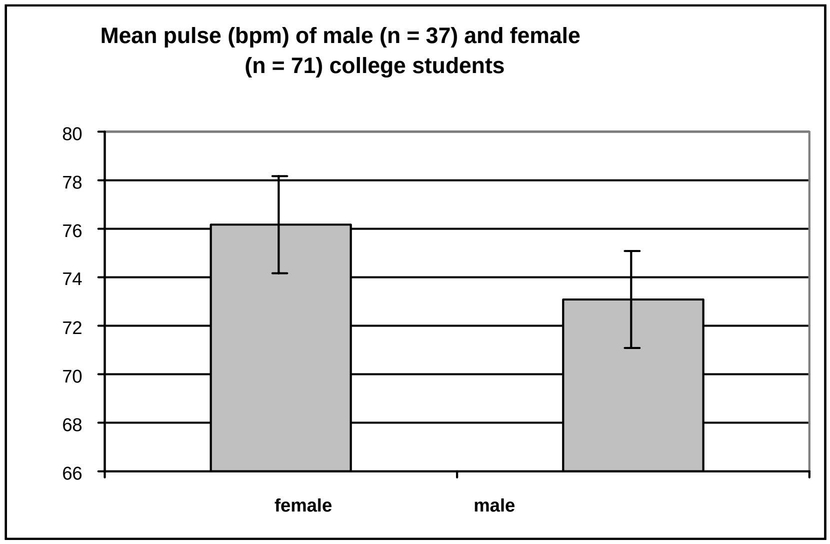
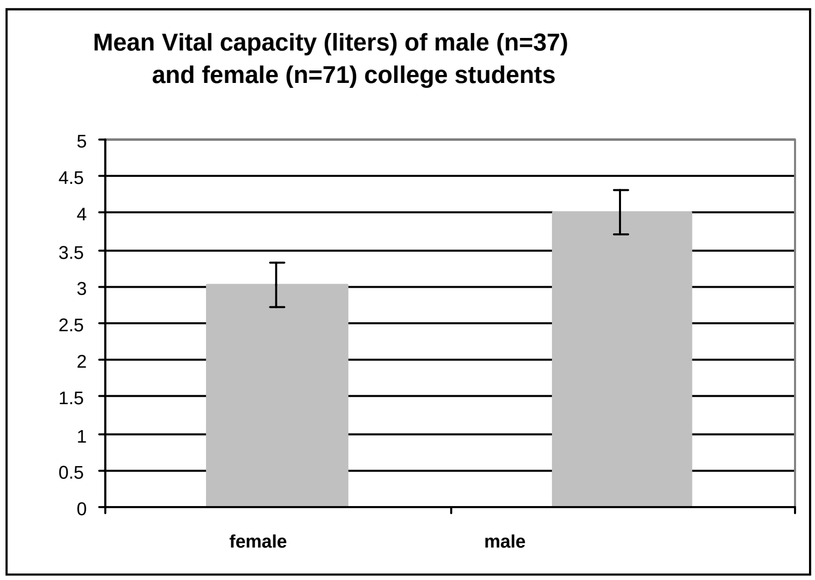
Males				Females			
Code	Specific Measurement mm	Height mm	Relative measurement %	Code	Specific Measurement mm	Height mm	Relative measurement %
M1				F1			
M2				F2			
M3				F3			
M4				F4			
M5				F5			
M6				F6			
M7				F7			
M8				F8			
M9				F9			
M10				F10			
M11				F11			
M12				F12			
M13				F13			
M14				F14			
M15				F15			
M16				F16			
M17				F17			
M18				F18			
M19				F19			
M20				F20			
Mean				Mean			
s.e.				s.e.			

Results:

Your instructor may show you how to enter this data on a computer in lab. You may continue your data analysis on any computer with internet access**.**

1. Means and standard errors can be calculated on a template available on the Biology Department's statistics web site (www.radford.edu/~biol-web/stats.html). Go to the section on Margin of Error. Study the example for entering data in the spreadsheet template. Open the template and enter your data as instructed.

2. Graph your data, i.e. the means and standard errors. You'll end up with three graphs in your group: one to compare your chosen measurement, another to compare heights, and a third to compare relative measurements.

Graph the standard error as brackets around the mean, (as shown in Fig. 1 and Fig. 2) extending one standard error above the mean and one standard error below the mean. The interval between these two numbers is the 'margin of error.' (More discussion of this is found in "How to use and interpret the margin of error statistic" at the Biology Department's statistics web site.) In Figure 1, the margins of error overlap, so the means **are not** significantly different. I.e., there is not a significant difference in the pulse rate of males and females in this study.	Figure 1: Mean pulse of males and females 
In Figure 2, the margins of error do not overlap, so the means **are** significantly different. I.e. there is a significant difference in the vital capacity of males and females. (Vital capacity is one measurement of lung volume.)	Figure 2: Mean Vital Capacity of males and females 

Conclusions:

1. Compare the bar graphs for the means of your **specific measurements.** Does the mean of males differ at all from that of females? (See 'Note' at top of page 5.)

Note: The means are probably different. However, you do not know if this is true for <u>all</u> men and women, or just for the sample you measured. The actual mean of the **population** (not the sample) might be anywhere within the margin of error. If the margin of error bars overlap (as they do in Figure 1), the hypothesis of different means is not supported; the two populations are not significantly different. If the margin of error bars do not overlap (as they do not in Figure 2), the hypothesis of different means is supported; we conclude the two populations are significantly different. (This is not the best way to look for differences in the means of two populations, but it is a simple test that we will use here and throughout the semester.)

2. Using the method of determining difference discussed above, are the means of the **specific measurements** of males and females significantly different? Explain how you know the difference is or is not significant.

3. Compare the heights of males and females using the same method. Are they significantly different? Explain how you know the difference is or is not significant.

4. Compare the relative measurements of males and females using the same method. Are they significantly different? Explain how you know the difference is or is not significant.

5. Keep in mind what you have learned about sampling and about variation. Why do scientists say that hypotheses can be supported, but are never proven?