DATA ANALYSIS

In biological research, scientists are often interested in whether or not there are differences between experimental and control groups of organisms, cells, or other units of measure. For example, at Auburn University Dr. Wendy Hood and her students are interested in whether producing offspring impacts on cellular respiration. **Cellular respiration occurs in organelles within cells called mitochondria**. Mitochondria are responsible for producing ATP that the body uses for energy. In addition to ATP, the mitochondria also produce small amounts of damaging compounds are called free radicals. Free radicals are produced when electrons escape the electron transport chain and bind oxygen or nitrogen. Free radicals can damage intracellular membranes, proteins, and DNA. This damage has the potential to reduce the efficiency of cellular respiration. In one study, Dr. Hood and her students asked if female mice that reproduce many times have mitochondria with more damage from free radicals (called oxidative damage) than mice that never reproduced and if that damage was associated with differences in the performance of mitochondria during cellular respiration. In this study, the reproductive mice represent the experimental group and the non-reproductive mice represent the control.

To conduct this work, Dr. Hood and her students collected data from several mice that didn't reproduce and several mice that reproduced many times. It was important to collect information from several mice in each group because the performance of mitochondria differs among individuals. For example, you have likely noticed there is a lot of variation between people (and other animals) in how fast they run. Part of that variation is due to differences in the performance of their mitochondria during cellular respiration. Some individuals produce ATP more efficiently than others, and some individuals have mitochondria that accumulate more damage from free radicals. Dr. Hood and her students were interested in whether animals that reproduce many times could have more oxidative damage and lower mitochondrial cellular respiration, despite their natural individual differences in mitochondrial performance. They collected data from 12 mice that reproduced continuously until they were 1 year of age (middle age for a mouse) and 12 1-year old mice that never reproduced. **The number of animals per group is referred to as the sample size, which is represented by the variable 'n'**. After they had measured oxidative damage and cellular respiration in the mitochondria of the mice, they needed to compare that data between groups to see if cellular respiration and oxidative damage were different. To do this, they needed a meaningful way to represent the typical performance of the mice in each group and a way to quantify the amount of variation in each group. Scientists measure the typical performance of members of a group with a variable called the average or the mean. **The mean ($\bar{x}$) is the sum of the values for each individual in a group divided by the sample size (n)**. The equation for the mean is: $\bar{x} = (\sum x) \ / \ n$.

The standard deviation is a measure of how much individuals within each group differ. Standard deviation (*s*) is calculated by quantifying how far each sample is from the mean and adjusting for the number individuals measured. More specifically, $s = \sqrt{\frac{\sum(x - \bar{x})^2}{n-1}}$

To calculate the standard deviation, subtract the mean from the value for each sample. Then, take the square of that value. Once that value is calculated for each sample, add them all together and divide the resulting value by the sample size minus 1. Finally, take the square root of that value. (Scientists use a computer to do these calculations when they have a lot of data to analyze). In addition, scientists typically use a statistic test to determine if their groups differ. But, it's often easy to determine if groups differ without running a statistical test. **If we graph our means and represent the standard deviation with error bars** (see figure to the right), we can see how the groups compare. If the bars overlap, the groups aren't different; **if the values don't overlap, the groups are different**. Thus, in this study, Dr. Hood and her students found that cellular respiration did not appear to be impacted by reproduction, but oxidative damage was higher in animals that reproduced. This was an interesting result because many investigators believe greater oxidative damage should contribute to lower respiratory performance, but that wasn't the case in this study. Much of the current research in Dr. Hood's lab focuses on understanding why oxidative damage isn't always damaging.

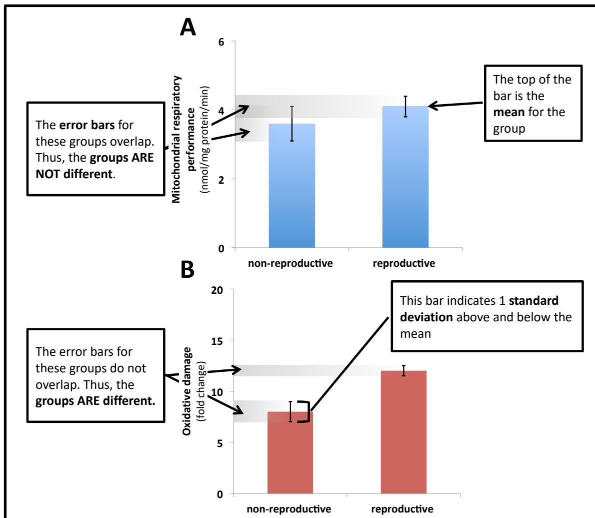

Figure 1. Mitochondrial respiratory performance (A) and oxidative damage (B) in 1 year old mice that never reproduced (non-reproductive) and mice that breed continuously from breeding age to year 1 (reproductive).

Review. *Answer the following questions and reference the line number in the text that the answer or equation came from.*

1. What is the definition of sample size? What was the sample size for Dr. Hood's study?
2. What is the mean and standard deviation for the following data set [1,3,4,1,5]?