MODULE 5:
Spirometry and Lung Volumes

This lab will include some activities and require some research that will help you understand and appreciate the mechanics of ventilation as well as the measurement of lung and breath volumes. There will be an online worksheet that you will enter your answers on. You will be allowed to "Save for Later" and "Submit" the worksheet as many times as you want. However, there are a couple of things to keep in mind.

1. You will not be allowed to Submit your worksheet after the deadline. If you do not submit before the deadline, you may be able to work out a way to submit it as a late assignment but there will be point deductions.

2. If you Submit the lab assignment, and then decide to retake it before the deadline, all of your answers will be gone and you will have to retype all answers before submitting again.

The lab worksheet has been reproduced for you on the following pages, so that you can work on things offline. If you have printed the lab manual, you might write notes in the textbox fields, or you might use a .pdf document annotator on your computing device. Whatever you decide to do is fine, but ultimately, only answers entered on the I-learn worksheet can be submitted for grading.

Follow the instructions below very carefully. Many of the items in this assignment require reading or videos or something else to do. Be sure to write your answers completely before submitting the assignment. There is an option in the bottom right to save your answers and come back later, but once you submit this assignment, it will be graded.

Lung Volumes

The process of moving air in and out of the lungs is called ventilation. Air movement is driven by changes in pressure between the lungs and the atmosphere. The ideal gas law describes the relationship between volume and pressure: P = nRT/V (P = pressrue; T = absolute temperature; V = volume; n = number of moles of the gas, and R = the universal gas constant). This law demonstrates that the pressure of a gas is inversely related to the volume. That is, in a closed container if you increase volume, pressure decreases and if you decrease volume pressure increases. Think of what happens to the pressure in a syringe if you put your finger over the opening and then move the plunger back to increase volume or push it forward to decrease volume. In the respiratory system, movements of the respiratory muscles change the volume of the thoracic cavity thus decreasing and increasing pressure and causing air to move between the atmosphere and the lungs. Measurement of the volume of air that moves in and out of the lungs under various conditions can provide information about the functioning and the health of the respiratory system. Spirometry is a technique used to measure various lung volumes and capacities and can also measure ventilation as a function of time.

The following definitions should help you through this lab.

Tidal volume (TV) - Volume of air moved into or out of the lungs during breathing.
Inspiratory Reserve volume (IRV) – Maximal volume that can be inspired from end-inspiratory level.
Expiratory reserve volume (ERV) – Maximal volume that can be exhaled from end-expiratory position.
Vital capacity (VC) - Maximal volume expired after maximal inspiration. (IRV + TV + ERV)
Residual volume (RV) – Volume of air remaining in the lungs after a maximal exhalation.
Total lung capacity (TLC) – Volume in the lungs at maximal inflation. (IRV + TV + ERV + RV)
Forced Expiratory Volume (1 second) (FEV_1) – The volume of air exhaled under forced conditions in the first second.

CLICK HERE to watch a video that explains the volumes above.

CLICK HERE to read an article, then answer the following questions.

1. In your own words explain the difference between obstructive and restrictive lung disease.

2. How would you expect residual volume to change with obstructive lung disease?

- ○ Increase
- ○ Decrease
- ○ Stay pretty much the same

3. Your favorite uncle gives you a huge bear hug. He squeezes you hard and you can hardly breathe. While your uncle is hugging you like this, what type of lung condition is being most closely imitated?

- ○ Obstructive
- ○ Restrictive

4. You would expect a restrictive lung disease to have the greatest effect on which of the following lung volumes?

- ○ Tidal Volume
- ○ Inspiratory Reserve Volume
- ○ Expiratory Reserve Volume
- ○ Residual Volume

Measuring Lung Volumes

On Campus Lab Students	Online Students
If you are taking the lab on campus, then your teacher will provide you with instructions on how to measure your own lung volumes.	If you are taking the lab strictly online, then follow these steps. **CLICK HERE** to watch a video that goes through the steps of measuring lung volumes on a "Harvard Spirometer". **CLICK HERE** to download an assignment that will allow you to calculate lung volumes from obtained data.

5. What is your Tital Volume measurement *(Online students should enter their calculations from the downloaded assignment)*.

6. What is your Inspiratory Reserve Volume measurement *(Online students should enter their calculations from the downloaded assignment).*

7. What is your Expiratory Reserve Volume measurement *(Online students should enter their calculations from the downloaded assignment)*.

8. What is your Vital Capacity *(Online students should enter their calculations from the downloaded assignment)?*

9. Among adults, the average pulmonary vital capacity decrease with age. Women tend to have smaller volumes than men of the same age and height. As height increases, vital capacity tends to increase. We can take these size and age related variables into account and use a formula to estimate predicted vital capacity:

Male: VC = 0.052H - 0.022A - 3.60

Female: VC = 0.041H - 0.018A - 2.69

VC = vital capacity in liters

H = height in centimeters

A = age in years

Use this formula from your lab manual and calculate your estimated Vital Capacity. Students attending lab on campus can measure their own vital capacity. Vital capacity is considered normal if it is within 80% of the predicted VC.
* *(Those doing the lab strictly online should use the data from the downloaded assignment).*

What is your vital capacity?

Measuring FEV_1

On Campus Lab Students	Online Students
If you are taking the lab on campus, then your teacher will provide you with instructions on how to measure your own FEV_1. You will also need to figure out your FEV_1 / VC ratio.	If you are taking the lab strictly online, then follow these steps. **CLICK HERE** to watch a video that goes through the steps of measuring an FEV_1 on a "Harvard Spirometer". **CLICK HERE** to download an assignment that will allow you to calculate an FEV_1 and a FEV_1 / VC ratio from obtained data.

Answer the following questions:

10. What was your FEV_1 *(online students should enter the calculated FEV_1 from the downloaded assignment)*?

11. What was your FEV_1 / VC ratio *(online students should enter their answer from the downloaded assignment)?*

12. Bobbie has severe scoliosis. He has such curvature in his spine that his ribs are folding down and in and his left lung is nearly collapsed. Bobbie will likely have surgery in the future to correct this problem, but for now, he is trying to keep his respiratory muscles as strong as possible. Bobbie has a normal FEV1 / VC ratio. Explain how this is possible.

13. Which of the following muscle groups would benefit Bobbie the most for his breathing problems?

- ○ External Intercostals
- ○ Internal Intercostals
- ○ External Abdominal Obliques
- ○ Internal Abdominal Obliques

14. The most common cause of death in premature infants is respiratory distress syndrome. What causes this condition in the babies and how can it be treated?

15. If it were possible to do an FEV1 / VC ratio test on an infant struggling with respiratory distress syndrome, what would you expect?

- ○ Likely around 80% or higher
- ○ Likely under 50%

16. Explain your answer for the last question.

Ventilation

Ventilation refers to the movement of air in and out of the lungs. In humans as in all mammals, ventilation occurs by the creation of pressure gradients. Pressure gradients are created by changing thoracic cavity volume. The volume of the thoracic cavity is manipulated by respiratory muscles as well as the elasticity and compliance of lung tissue.

Humans are referred to as negative pressure inspirators because a negative pressure is generated in the lungs in order to "suck" air in. However, there are some occasions when humans get air into the lungs by positive pressure. For example, pressurized air tanks can "push" air into a person lungs underwater and this helps overcome the difficulty of expanding the chest cavity under high water

pressure that can exist if you are very deep. Also, people who have paralyzed muscles can sometimes be put on "ventilators". The ventilators used now days create a "positive" pressure that pushes air into a patients lung.

CLICK HERE to watch a video about ventilation and Boyles Law.

CLICK HERE to watch a video that talks more about ventilation and other ways that humans can incorporate positive pressure inspiration.

17. You should now understand how a human uses negative pressure to bring air into the lung. Given this understanding explain two things. First, what would air to relative to the lung if a hole were made on the surface of a persons lung (i.e. a rib fractured and punctured a lung). Second, would air move the same way for a Frog's punctured lung? Explain.

18. Is it possible to increase your vital capacity? Defend / support your answer.