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Lab 14- Respiratory physiology
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**Purpose:** The purpose of this experiment was the measurement of ventilation rates by recording the changing impedance of an expanding and contracting thorax. We used a spirometer.

**Procedure:**

14A) The measurement of human lung volumes (SVC)

1. The Morgan ComPAS computer program has already calculated and factored in the BTPS (Body Temperature Pressure Saturation) correction factor for the spirometer temperature.

   Ex.: spirometer temperature = 25°C BTPS correction factor = 1.075
   454 ml x 1.075 = 488.05 ml (rounded off to 488 ml)

2. Fully insert the Pneumotrac filter/mouthpiece you purchased at the bookstore. If you have difficulty keeping air from leaking through your nose, you may need to wear a nose clip, as air leakage will result in inaccurate results.
3. Be sure the correct student information is loaded up before you start the SVC (slow vital capacity) test.
4. After starting the SVC test, follow the verbal instructions of your instructor: begin with your mouth off the mouthpiece so the pneumotach can equilibrate; then get a good seal with your lips and begin normal quiet (tidal) breathing.
5. Watch the screen to be sure you are showing stable tidal breathing; the moving line should be around a half liter and NOT drifting up or down.
6. After stable tidal breathing, you will be instructed to take the deepest breath in as you can, then blow it all out, and finally return to normal tidal breathing. Your instructor will print out your SVC Volume Time Curve. This will be a part of your 14-A results.
7. Label your spirometer tracing and calculate the amount for each lung volume and capacity. Descriptions for lung volumes and capacities are on the next page. Average values based on a 5'10", 70-kg. (~170 lbs.) male are provided, as well as some percent values needed to calculate volumes and capacities for other individuals. Tidal Volume (TV) – Air moved in and out of lungs during quiet breathing. Average = 500 ml
   -Expiratory Reserve Volume (ERV) – Air expelled during a forced expiration less the tidal volume. Average = 1200 ml or 25% of VC.
   -Expiratory Capacity (EC) – Air expelled during forced expiration plus the tidal volume. (EC = ERV + TV) Average = 1700 ml.
   -Inspiratory Reserve Volume (IRV) – Air drawn into the lungs during a forced inspiration less the tidal volume. Average = 3100 ml.

-Inspiratory Capacity (IC) – Air drawn into the lungs during a forced inspiration plus the tidal volume. (IC = IRV + TV) Average = 3600 ml or 75% of VC.
-Vital Capacity (VC) – Air expelled from the lungs during a forced expiration after the deepest inhalation. (VC = IRV + TV + ERV) Average = 4800 ml.
<u>Values not measured by the spirometer:</u>
-Minute Reserve Volume (MRV) – Air volume that passes in and out of the lungs during quiet breathing per minute. (MRV = TV x Number of breaths per minute)
-Residual Volume (RV) – Air that always remains within the lungs. Average = 1200 ml.
-Total Lung Capacity (TLC) – Total air that the lungs contain. (TLC = VC + RV) Average = 6000 ml.

8. To calculate the six lung volumes and capacities we are measuring in 14-A: convert the millimeter measurement into milliliters by measuring the height of the volume in mm in the SVC graph (see Fig. 14-1 on p. 92) and multiplying that length in mm by 64.17 ml/mm (our SVC conversion factor). Then round off ml to whole numbers. Use the gridlines to double check that your figures are in the ballpark (e.g., if you calculated the vital capacity in Fig. 14-1 to be 3800 ml, you must be off because you can tell from just looking at the gridlines that it is much closer to 5000 ml than 3800 ml).
9. After completing 14-C, you will have a predicted VC from a nomogram; compare your actual VC from the SVC test (14-A) with that predicted VC from the 14-C nomogram.

14B) The Forced Vital Capacity (FVC) or Forced Expiratory Volume (FEVT)

1. The Morgan ComPAS computer program has already calculated and factored in the BTPS (Body Temperature Pressure Saturation) correction factor.
2. Fully insert the Pneumotrac filter/mouthpiece you purchased at the bookstore. If you have difficulty keeping air from leaking through your nose, you may need to wear a nose clip, as air leakage will result in inaccurate results.
3. Be sure the correct student information is loaded up before you start the FVC test.
4. After starting the FVC test, follow the verbal instructions of your instructor: begin with your mouth off the mouthpiece so the pneumotach can equilibrate; after getting a good seal with your mouth, start with tidal breathing; when you are ready, take in the deepest breath possible, then forcefully blow it out as fast as you can and keep squeezing until instructed to stop. The instructor will print out your "FVC Volume Time Curve" (part of your 14-B results)
5. To calculate the vital capacity for the FVC test (also called the forced expiratory volume), measure the height of the highest peak of the curve in mm and multiply that length in mm by 66.67 ml/mm (our FVC conversion factor). Then round off ml to whole numbers. (NOTE: this is similar to the 14-A SVC calculations, but with a different conversion factor.) Just like in 14-A, use the gridlines to double check that your figures are in the ballpark (e.g., if you calculated the vital

capacity in Fig. 14-2 on p. 94 to be 3635 ml, you must be off because you can tell from just looking at the gridlines that it is much closer to 4500 ml than 3635 ml)

6. Go to the "1 second" vertical line in your FVC graph and measure the height where the curved line crosses the 1 second vertical line in the same way as you did for the FVC in step 5. This is your $FEV_1$ volume.
7. Divide the volume you calculated for $FEV_1$ by the volume you calculated for the vital capacity in step 6, and then multiply by 100 to determine the percentage of the vital capacity exhaled at one second.
8. Go to the "3 second" vertical line in your FVC graph and measure the height where the curved line crosses the 3 second vertical line in the same way as you did in steps 5 and 6. This is your $FEV_3$ volume.
9. Divide the volume you calculated for $FEV_3$ by the volume you calculated for the vital capacity in step 6, and then multiply by 100 to determine the percentage of the vital capacity exhaled at three seconds.
10. Compare these values to the predicted values and explain possible causes for any differences.

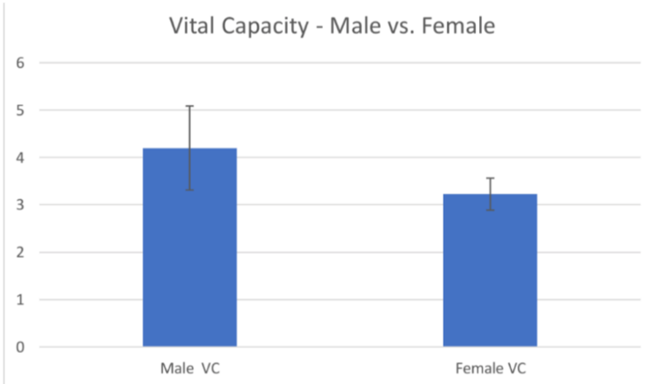
## 14C) Portable spirometry

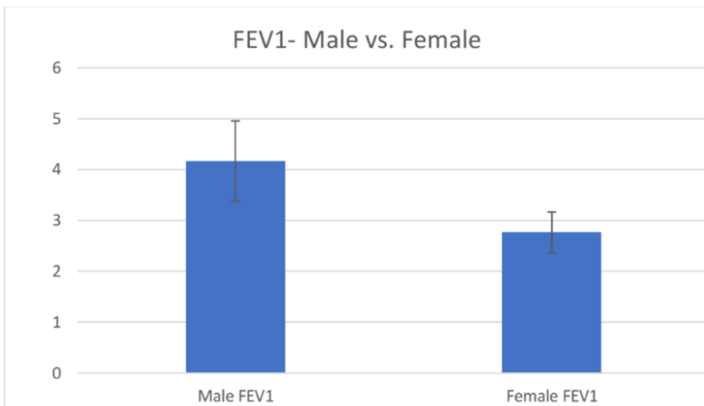
1. Open the grey plastic box on your lab desk that says "BASELINE Lung Capacity Spirometer" on the lid. Inside the lid of the box is a white paper that has specific instructions, please read the whole inside page with "how to use."
2. Insert the clear plastic mouthpiece on the "Windmill-Type" spirometer and make sure the measurement indicator is at the zero position before beginning.
3. Make sure you only exhale into the spirometer, DO NOT inhale from it.
4. After exhaling, record the measurement from the spirometer. Be sure to place your used plastic mouthpiece in the correct tub after use (the tub is labeled).
5. Calculate your predicted vital capacity from the nomograms available in lab. Using a straightedge, make a line matching your height and age to the vital capacity prediction. Note that the VC is in liters whereas other measurements have been taken in milliliters.
6. Compare the values obtained from the portable spirometer, the predicted values from the nomograms, and the value obtained from the Koko spirometer, if available. How can you account for any differences?

## 14D) Incentive inspiratory devices

1. Obtain an incentive device and attach your disposable cardboard mouthpiece and white (or blue) filter to the breathing tube. The filter is quite a bit bigger than the breathing tube, so use your hand to try to get the best seal possible, it is not crucial to have a complete seal.
2. Breathe in as deeply as possible and record the measurement given on the device. Depending upon the model, you may have to move colored balls up plastic columns or move a bellows within a column.
3. Record your values. Discard the disposable cardboard mouthpiece and place the filter in the correct tub after use (the tub is labeled).

**Results:**




**Discussion:** For this lab we had to make a graph, which I find to be the hardest part in doing labs. Collecting the data isn't as bad, but when it comes to actually making the graph itself is what always slows me down. My group and I ended up using google collab since it's easier to make the graphs you just need the codes and your data. This was a fun experiment to do since we got to do male vs females.

**Conclusion:** In conclusion, lab 14 the movement of air in and out of the lungs is essential to maintain the important process of cellular respiration, the oxidation of nutrient molecules. We focused on measuring the ventilation rates and the contraction of the thorax.