LAB 7

HUMAN RESPIRATORY LAB – Danville only

Assignments:

Due before lab:
Complete the charts on pgs. 70 and 71 and read directions for using hand-held dry spirometer.

Be prepared for a quiz:
Do the Respiratory exercises from Interactive Physiology (pg.72-74)

Due at the end of lab:
Do the Protocols I & II in your lab manual using the respiratory spirometer (10 points).

Do the Protocols III - V involving control or respiration (Holding your breath, hyperventilating and breathing into a bag) in groups of 3 or 4 at your lab table. (15 points).

Due next lab:
Quiz on Terms of Renal Lab (page 84) AND Interactive Physiology exercises (pages 89-91).
Know substances in the urine, the protocol for Lab 8 and how to calculate the chloride concentration in urine.

Objectives:
Know the respiratory volumes and capacities

Measure TV, VC, IRV, ERV using the BIOPAC System (Protocol I)

Calculate TV, VC, IRC, ERV and minute ventilation rate (Protocols I & II)

Understand and explain the control of respiration

Make predications concerning breathing rates before and after hyperventilation, breathing into a paper bag, and holding your breath and be able to give physiological explanations for your results.(Protocols III-V)
**LUNGS VOLUMES:** Fill in the average values and description of the following lung volumes using your textbook.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Average Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tidal Volume (TV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expiratory Reserve Volume (ERV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inspiratory Reserve Volume (IRV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vital Capacity (VC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residual Volume (RV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Lung Capacity (TLC)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Label the chart below using the following terms. Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), Vital Capacity (VC), Residual Volume (RV)

VC = IRV + ERV + TV

Question:

Use the values below to answer the question.

A patient's lung volumes are the following:

VC = 4800 ml
TV = 600 ml
ERV = 1300 ml

Calculate the patient's IRV
View the Control of Respiration on Interactive Physiology CD, answer the following questions and be prepared for a quiz.

Respiratory System – Pulmonary Ventilation

1. The relationship between pressure and volume is known as _________ Law.

   \[ \uparrow \text{volume} \rightarrow \_ \text{ pressure} \]
   \[ \downarrow \text{volume} \rightarrow \_ \text{ pressure} \]

2. Mark “I” for the muscles that control inspiration and “E” for the muscles which control forceful expiration.

   ___ Diaphragm
   ___ External oblique and rectus abdominus
   ___ Internal intercostals
   ___ External intercostals

3. Intrapulmonary pressure ___s \((\uparrow \text{or} \downarrow)\) during inspiration.

4. What pressure is always negative and helps to keep the lungs inflated? ________________

   pressure

   It is most negative during ________________.

5. If transpulmonary pressure equals zero, what will happen to the lungs?

   This is known as a ________________.

6. When the bronchiole constricts, what will happen to resistance? ___ airflow? ____
7. Name two other important factors which play roles in ventilation:
   
   a. _______________________
   b. _______________________

   For 8-10 fill in constrict or dilate then up and down arrows:

8. Histamine will ___________ bronchioles → ___ resistance → ___ airflow

9. Epinephrine will ___________ bronchioles → ___ resistance → ___ airflow

10. Acetylcholine will __________ bronchioles → ___ resistance → ___ airflow

11. Fibrosis will ___ compliance making it __________ to inflate the lungs.

12. A decrease in surfactant will result in a ___ in compliance.
1. The atmosphere is a mixture of gases, write down the percentages for:
   \[ \text{O}_2 \quad \quad \text{N}_2 \quad \quad \]
   \[ \text{CO}_2 \quad \quad \text{H}_2\text{O} \quad \quad \]

Calculate the partial pressures of the following gases at both atmospheric pressures:
2. \[ 760 \text{ mmHg} \]
3. \[ 747 \text{ mmHg} \]

\[ \text{O}_2 \quad \quad \quad \quad \text{O}_2 \quad \quad \]
\[ \text{CO}_2 \quad \quad \quad \quad \text{CO}_2 \quad \quad \]
\[ \text{N}_2 \quad \quad \quad \quad \text{N}_2 \quad \quad \]
\[ \text{H}_2\text{O} \quad \quad \quad \quad \text{H}_2\text{O} \quad \quad \]

4. What is the atmospheric pressure on the top of Mt. Whitney? ________

5. Calculate the partial pressure of \( \text{O}_2 \) on the top of Mt. Whitney.
   \[ \quad \text{ mmHg} \]

6. Why does more \( \text{CO}_2 \) than \( \text{O}_2 \) dissolve in liquid when both gases are at the same pressure?
   Name the law that explains this? \[ \quad \]

7. Efficient external respiration depends on three main factors, list them.
   a. \[ \quad \]
   b. \[ \quad \]
   c. \[ \quad \]
8. What 3 factors cause the partial pressures of gases in the alveoli to differ from pressures in the atmosphere?
   a. ______________________  c. ______________________
   b. ______________________

9. When airflow is restricted so that the partial pressure of O₂ is low and CO₂ is high, what happens to the arterioles and the bronchioles?
   Arterioles - ______________________
   Bronchioles - ______________________

10. Internal respiration depends on three factors, list them.
    a. ______________________  c. ______________________
    b. ______________________

11. The planet Pneumo has a total atmospheric pressure of 900 mmHg. Oxygen and carbon dioxide each constitutes 30% of the atmosphere. What is the partial pressure of oxygen on the planet Pneumo? Which gas would be found in the highest concentration in your blood?
Respiratory System – Control of Respiration

1. Identify where the inspiratory and expiratory centers are located in the medulla.
   a. Inspiratory __________________________
   b. Expiratory __________________________

2. What modifies these medullary centers?
   a. __________________________
   b. __________________________

3. What is the most important stimulus controlling ventilation? __________

4. What ion directly stimulates the central chemoreceptors? __________

5. Arterial PO$_2$ must drop below what to stimulate the peripheral chemoreceptors?
   __________

6. If a person hyperventilates what will happen to the following in the blood?
   PCO$_2$ __________
   pH __________

7. If a person hypoventilates what will happen to the following in the blood?
   PO$_2$ _______
   PCO$_2$ _______
8. Explain what will be stimulated and the result of lung hyperinflation on inspiration.

What is this reflex called?

Receptors stimulated: ___________________________

Effect of stimulation: ___________________________

Reflex: ______________________________________

9. Dust, smoke and noxious fumes will stimulate receptors in airways. Name the receptors and explain the protective reflexes.

a. Receptors ______________

b. Protective reflexes __________

10. Name 4 of the 6 factors which probably increase ventilation during exercise.

a. _______________________ c. ___________________

b. _______________________ d. __________________
Directions for BIO 139 Respiratory Lab using a Hand-held Dry Spirometer

1. Breathe normally for one minute. After a normal inspiration, exhale a normal breath into the spirometer. Read the meter on the spirometer. This will be your Tidal Volume (TV).

2. Breathe normally for one minute. After a normal expiration, forcefully exhale as much air as you can into the spirometer. Read the meter on the spirometer. This will be your Expiratory Reserve Volume (ERV).

3. Breathe normally for one minute, and then inspire as much air as possible into the spirometer, exhale as much air as you can. Read the meter on the spirometer. This will be your Vital Capacity (VC).

4. Record your values on the following page.
Protocol I (5 points)

From the previous page, record the respiratory values you measured with the hand-held dry spirometer.

TV = 

ERV = 

VC = 

Calculate IRV: (VC = IRV + ERV + TV)

IRV = 

Compare these values to normal values given in your textbook. Are they higher, lower, or about the same? Record your response next to your values.
Protocol II (5 points)

Determine your respiratory rate or **frequency**. Count the number of breaths you take in one minute.

\[
\text{Frequency} = \underline{\hspace{2cm}} \text{breaths/min}
\]

TV (from previous page) = \underline{\hspace{2cm}} ml

Now calculate **Minute Ventilation** \((V_e = TV \times \text{frequency})\)

**Prediction – Exercise**

Write down what you think will happen to frequency, tidal volume and the minute ventilation in response to **exercise**. Will it increase, decrease or stay the same. Fill in the chart below.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Tidal Volume</th>
<th>Minute Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Now, measure the frequency and tidal volume during exercise. Do a control period followed by 1-2 minutes of exercise.**

- Breathe normally and count your breaths for one minute. Determine TV using the spirometer. Record your control values.
- During exercise, count your breaths for one minute. Immediately following exercise, determine your TV using the spirometer. Record your exercise values.

Calculate minute ventilation for both control and exercise. Are they as you predicted?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Tidal Volume</th>
<th>Minute Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PROTOCOL III (5pts)

Holding your breath.

1. Breathe normally for 2 minutes, then inhale deeply. Now measure how long you can hold your breath. Record in the table below.

2. Breathe normally for 2 minutes and exhale deeply. Now measure how long you can hold your breath. Record below.

A. Measurement:

<table>
<thead>
<tr>
<th></th>
<th>How long you can hold your breath</th>
</tr>
</thead>
<tbody>
<tr>
<td>After forced inspiration</td>
<td></td>
</tr>
<tr>
<td>After forced expiration</td>
<td></td>
</tr>
</tbody>
</table>

B. DATA SHEET:

1. If you inhale deeply before holding your breath, do you have the urge to inspire or expire when you resume respiration? _____________

2. If you exhale deeply before holding your breath, do you have the urge to inspire or exhale when you resume respiration? _____________

3. Explain your results in #1. Consider what effect lung volume may have on the desire to inspire or expire. (Discuss this in terms of the Hering Breuer reflex)
**PROTOCOL IV** (5pts)

Hyperventilation is an increase in ventilation with no change in metabolic rate.

1. First, breathe normally for 1 minute and **record breathing rate**.

2. Then hyperventilate by breathing deeply and forcefully at the rate of about 1 breath/4 sec for about 30 seconds. Record breathing rate **after** hyperventilation has been completed.

3. Rest for 3 minutes. Then, hold your breath for as long as you can and record below.

4. Hyperventilate for 1 minute, then hold your breath for as long as you can and record.

A. **Measurement**

<table>
<thead>
<tr>
<th></th>
<th>Breathing rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breathing rate before hyperventilation (breaths/min)</td>
<td></td>
</tr>
<tr>
<td>Breathing rate <strong>after</strong> hyperventilation (breaths/min)</td>
<td></td>
</tr>
<tr>
<td>How long can you hold your breath after normal quiet breathing?</td>
<td></td>
</tr>
<tr>
<td>How long you can hold your breath after hyperventilating?</td>
<td></td>
</tr>
</tbody>
</table>

1. **After** hyperventilating, is your **respiratory rate** faster or slower than during normal quiet breathing? ______________

2. Why? Discuss chemoreceptors and respiratory drive
3. After hyperventilating, can you **hold your breath** for a longer or shorter period of time compared to after normal quiet breathing? ______________


5. Why do you become dizzy after hyperventilating?
PROTOCOL V (5pts)

Breathing into a paper bag.

1. Breathe normally for 3 minutes and record your breathing rate.

2. Then breathe into a paper bag for 3 minutes. After completing this, measure your breathing rate for 1 minute.

3. Next, hyperventilate for 1 minute. Then breathe into a paper bag for 3 minutes. After completing this, measure your breathing rate for 1 minute.

A. Measurement

What do you think will happen to your subject’s ventilation following a period of rebreathing the same gas?

<table>
<thead>
<tr>
<th>Breathing rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Normal quiet breathing rate</td>
</tr>
<tr>
<td>2. rebreathing bag air after normal respiration</td>
</tr>
<tr>
<td>3. rebreathing bag air after hyperventilation</td>
</tr>
</tbody>
</table>

1. ***After* breathing into a paper bag for 3 minutes, does respiration become faster or slower than during normal quiet breathing? 

2. Why? – Discuss in terms of chemoreceptors and respiratory drive.

3. Hyperventilate before breathing into a paper bag. Is your respiration slower or faster than after rebreathing in bag after normal respiration? 

4. Explain your results. – Discuss in terms of chemoreceptors and respiratory drive