Control of Human Respiration

Your respiratory system allows you to obtain oxygen, eliminate carbon dioxide, and regulate the blood's pH level. The process of taking in air is known as *inspiration*, while the process of blowing out air is called *expiration*. A respiratory cycle consists of one inspiration and one expiration. The rate at which your body performs a respiratory cycle is dependent upon the levels of oxygen and carbon dioxide in your blood.

You will monitor the respiratory patterns of one member of your group under different conditions. A respiration belt will be strapped around the test subject and connected to a computer-interfaced Gas Pressure Sensor. Each respiratory cycle will be recorded by the computer, allowing you to calculate a respiratory rate for comparison at different conditions.

OBJECTIVES

In this experiment, you will

- Use a computer to monitor the respiratory rate of an individual.
- Evaluate the effect of holding of breath on the respiratory cycle.
- Evaluate the effect of rebreathing of air on the respiratory cycle.

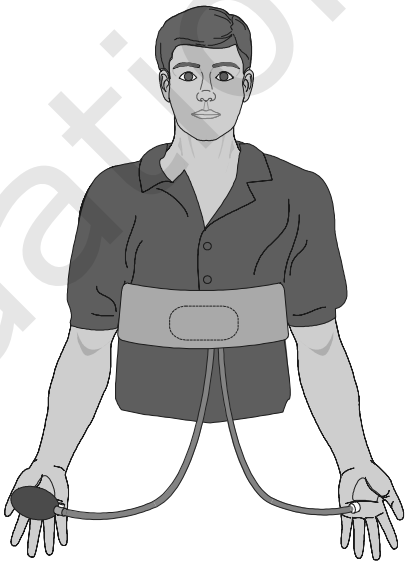

Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Vernier Gas Pressure Sensor
Vernier Respiration Monitor Belt
plastic produce bag 30 × 40 cm (12" × 16")
small paper grocery bag

PROCEDURE

1. Connect the Gas Pressure Sensor to the computer interface.
2. Prepare the computer for data collection by opening the file "26a Human Respiration" from the *Biology with Vernier* folder of Logger*Pro*.
3. Select one member of the group as the test subject. Wrap the Respiration Monitor Belt snugly around the test subject's chest. Press the Velcro strips together at the back. Position the belt on the test subject so that the belt's air bladder is resting over the base of the rib cage and in alignment with the elbows as shown in Figure 3.

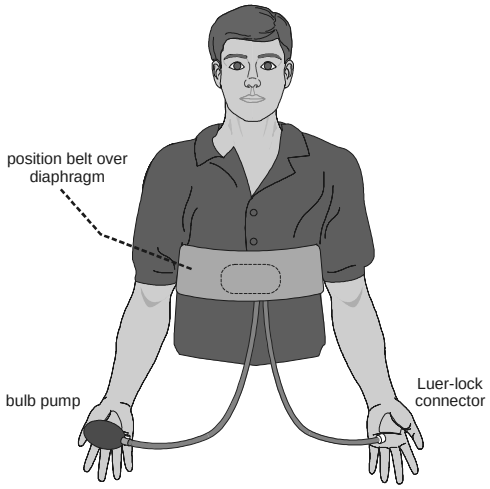

Figure 3

4. Attach the Respiration Monitor Belt to the Gas Pressure Sensor. There are two rubber tubes connected to the bladder. One tube has a white Luer-lock connector at the end and the other tube has a bulb pump attached. Connect the Luer-lock connector to the stem on the Gas Pressure Sensor with a gentle half turn.
5. Have the test subject sit upright in a chair. Close the shut-off screw of the bulb pump by turning it clockwise as far as it will go. Pump air into the bladder by squeezing on the bulb pump. Fill the bladder as full as possible without being uncomfortable for the test subject.
6. The pressure reading displayed in the meter should increase about 6 kPa above the initial pressure reading (e.g., at sea level, the pressure would increase from about 100 to 106 kPa). At this pressure, the belt and bladder should press firmly against the test subject's diaphragm. Pressures will vary, depending upon how tightly the belt was initially wrapped around the test subject.
7. As the test subject breathes in and out normally, the displayed pressure alternately increases and decreases over a range of about 2 – 3 kPa. If the range is less than 1 kPa, it may be necessary to pump more air into the bladder. Note: If you still do not have an adequate range, you may need to tighten the belt.

Part I Holding of Breath

8. Instruct the test subject to breathe normally. Start collecting data by clicking Collect. When data has been collected for 60 seconds, have the test subject hold his or her breath for 30 to 45 seconds. The test subject should breathe normally for the remainder of the data collection once breath has been released.

9. Examine the respiration rates recorded in the bottom graph by clicking the Examine button, . As you move the mouse pointer from point to point on the graph the data values are displayed in the examine window. Determine the respiration rate before and after the test subject's breath was held and record the values in Table 1.

Part II Rebreathing of Air

10. Prepare the computer for data collection by opening the file "26b Human Respiration" from the *Biology with Vernier* folder of Logger*Pro*.

11. Place a small paper bag into a plastic produce bag. Have the test subject cover his or her mouth with the bags, tight enough to create an air-tight seal. The test subject should breathe normally into the bags throughout the course of the data collection process.

12. Click Collect to begin data collection. Again, the test subject should be sitting and facing away from the computer screen. Collect respiration data for the full 300 seconds while breathing into the sack. **Important:** Anyone prone to dizziness or nausea should not be tested in this section of the experiment. If the test subject experiences dizziness, nausea, or a headache during data collection, testing should be stopped immediately.

13. Once you have finished collecting data in Step 12, calculate the maximum height of the respiration waveforms for the intervals of 0 to 30 seconds, 120 to 150 seconds, and 240 to 270 seconds:

    a. Move the mouse pointer to the beginning of the section you are examining. Hold down the mouse button. Drag the pointer to the end of the section and release the mouse button.
    b. Click the Statistics button, , to determine the statistics for the selected data.
    c. Subtract the minimum pressure value from the maximum value (in kPa).
    d. Record this value for each section as the wave amplitude in Table 2.

DATA

Table 1	
Holding of Breath	
Before holding breath	After holding breath
_____ breaths / minute	_____ breaths / minute

Table 2		
Rebreathing of Air: Amplitudes of Respiration Waves		
0 to 30 seconds	120 to 150 seconds	240 to 270 seconds
_____ kPa	_____ kPa	_____ kPa

QUESTIONS

1. Did the respiratory rate of the test subject change after holding his or her breath? If so, describe how it changed.

2. What is different about the size (amplitude) or shape (frequency) of the respiratory waveforms following the release of the test subject's breath? Explain.

3. What would be the significance of an increase in the amplitude and frequency of the waveform while the test subject was breathing into the bag?

4. How did the respiratory waveforms change while the test subject was breathing into the bag? How would you interpret this result?

5. Explain how you think carbon dioxide affects your breathing.

Vernier Lab Safety Instructions Disclaimer

THIS IS AN EVALUATION COPY OF THE VERNIER STUDENT LAB.

This copy does not include:

- **Safety information**
- **Essential instructor background information**
- **Directions for preparing solutions**
- **Important tips for successfully doing these labs**

The complete *Biology with Vernier* lab manual includes 31 labs and essential teacher information. The full lab book is available for purchase at:
http://www.vernier.com/cmat/bwv.html

Vernier Software & Technology
13979 S.W. Millikan Way • Beaverton, OR 97005-2886
Toll Free (888) 837-6437 • (503) 277-2299 • FAX (503) 277-2440
info@vernier.com • www.vernier.com