Experiment B-3
Respiration

Biology

Objectives

- To study the diffusion process of oxygen and carbon dioxide between the alveoli and pulmonary capillaries.
- To determine the percentage of oxygen in exhaled air while resting and after physical activity.

Modules and Sensors

- PC + NeuLog application
- USB-200 module
- NUL-205 oxygen logger sensor

Materials

▪ Balloon
▪ DO filling solution (included with the oxygen sensor)

Introduction

In physiology, respiration is a process in which an organism exchanges oxygen and carbon dioxide with its environment. In order for respiration to occur, oxygen and carbon dioxide must diffuse down their concentration gradients (or pressure gradients) between the external and internal environment of the organism.

In the human respiratory system, whose principles apply to most vertebrates, gases diffuse between the alveoli and pulmonary capillaries.
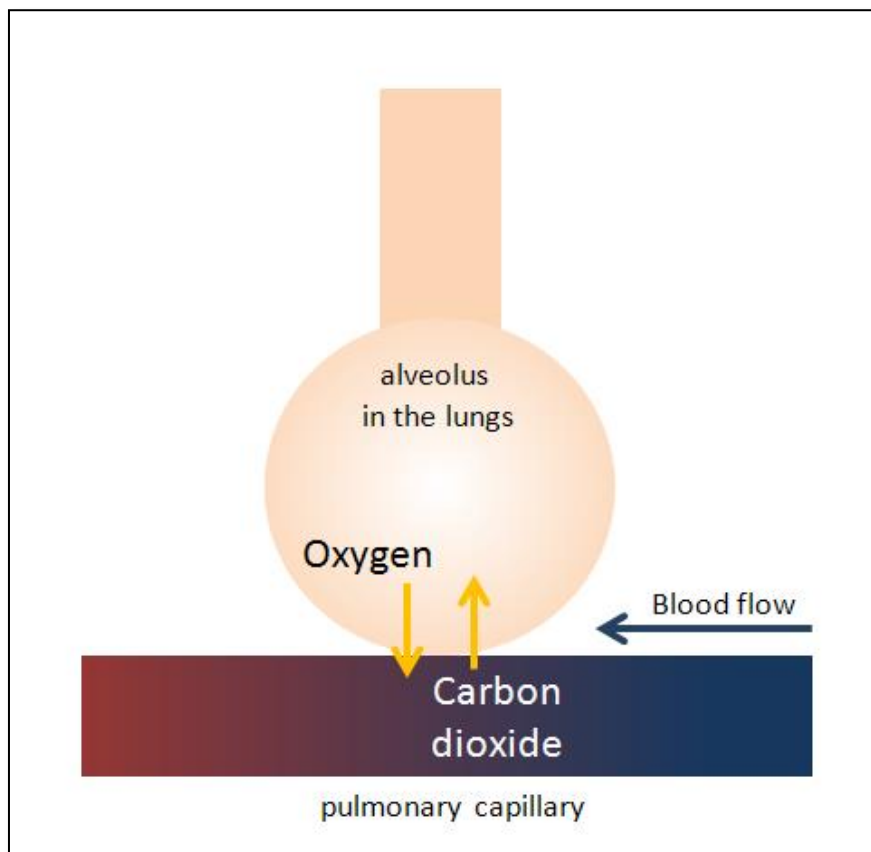
The inhaled air that reaches the alveoli in the lungs contains much more oxygen than the blood in the pulmonary capillaries; that is why oxygen diffuses into the blood plasma in the capillaries and then into red blood cells. In the red blood cells oxygen is bound to heme groups of hemoglobin.

When there is more carbon dioxide in the tissues than in the capillaries, carbon dioxide is diffused into the capillaries. The carbon

dioxide is then diffused into the alveoli down a concentration gradient.

Room air is composed of 20.93% O_2, 0.03% CO_2, 79.04% N_2 and other trace elements such as argon and krypton. Through this activity, we will investigate the percentage of oxygen in the gas exhaled during respiration (oxygen that did not diffuse into the capillaries).

Procedure

Experiment setup

1.   Set up the experiment as shown in the picture below.

2.   Remove the rubber protection from the oxygen sensor's cap.

3.   Unscrew the cap, fill half of it with the included liquid and screw it back.

NeuLog

Sensor setup

4. Connect the USB-200 module to the PC.

5. Check that the oxygen sensor is connected to the USB-200 module.

Important:

You must wait about 5 minutes after connecting the sensor to the USB-200 module before beginning offsetting and measurements. For a more accurate measurement you can look at the module window and wait for the reading to stabilize (it could take longer than 5 minutes).
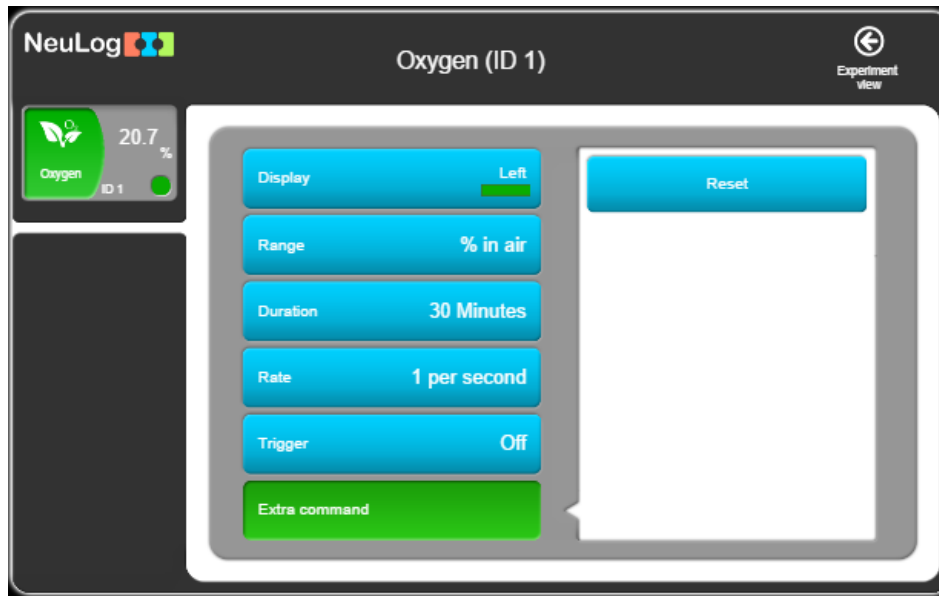

Note:

The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

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6. Run the NeuLog application and check that the oxygen sensor is identified.

Settings

7.   Click on the pressure **sensor's module** box.

8.   Select the "% in air" button to set the sensor's mode.

9.   Click on the ⊙ icon to go back to the graph.

10.   Click on the **Run Experiment** icon ⊞ and set the:

      Experiment duration to 10 seconds
   Sampling rate to 10 per second

Testing and measurements

11.   Press on the sensor's offset button continuously (3 seconds), or alternatively, click on the **Extra command** button in the **Module setup** menu and then on the **Reset** button. This will offset the sensor to a value of 20.9%.

12.   Insert the sensor in the deflated balloon.

13.   Click on the **Record** icon ⏺ to start the measurement.

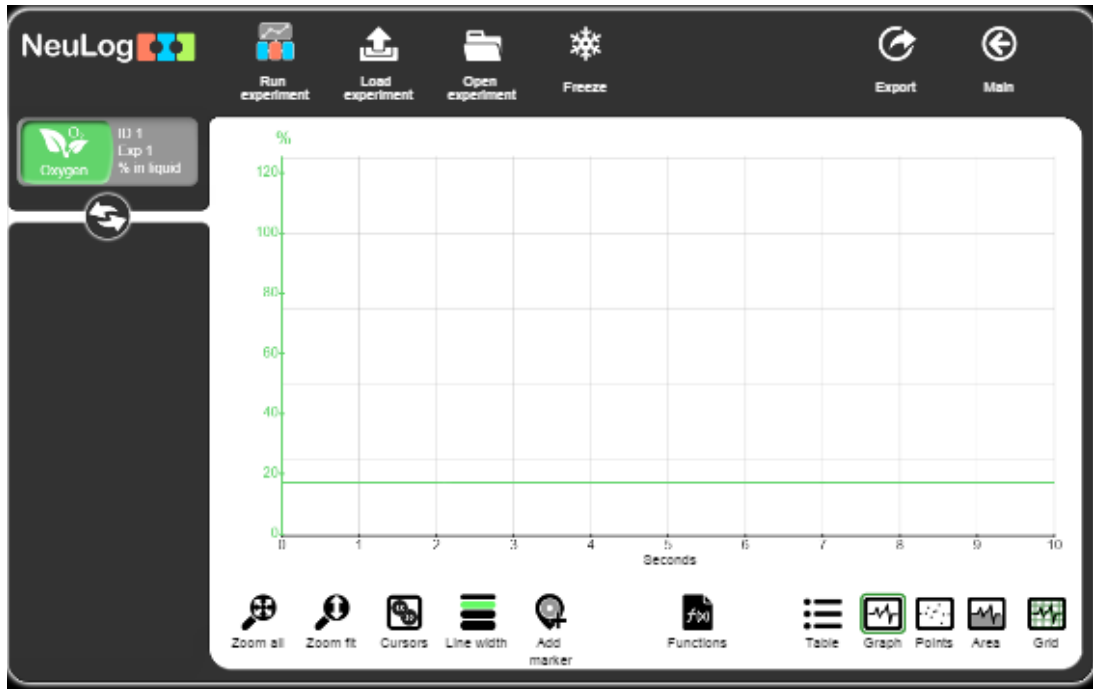14. Your graph should be similar to the following:
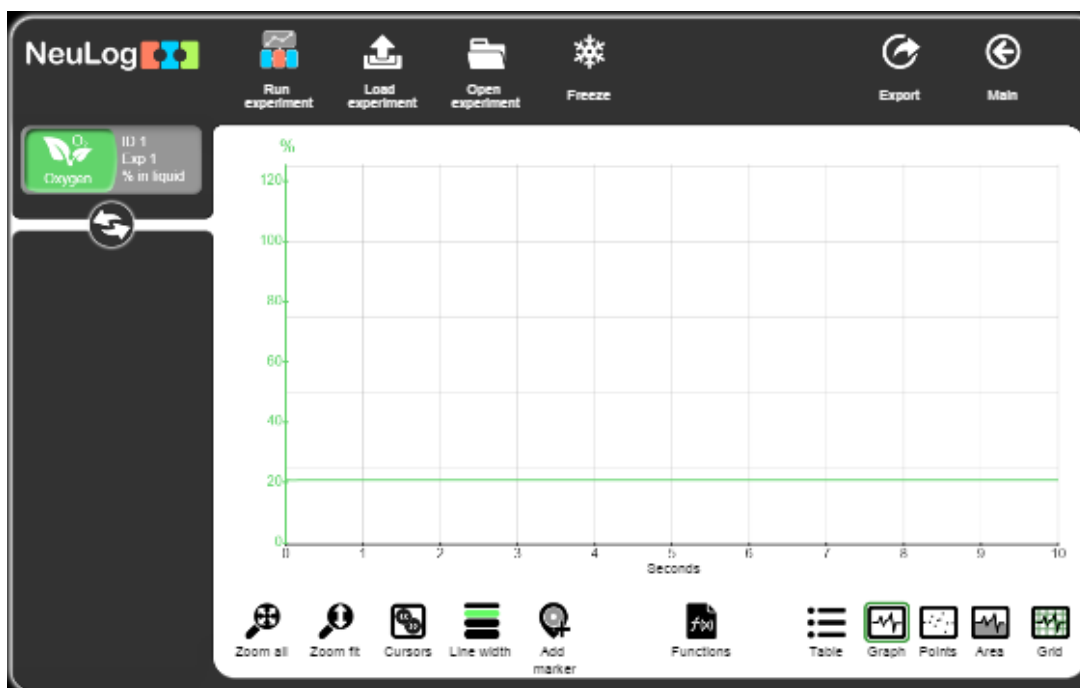
15. Click on the **Export** Icon and then on the **Save value table (.CSV)** button to save your graph.

16. Click on the icon to go back to the graph.

17. The measurement of oxygen percentage in the balloon is as the oxygen in outside air (around 20.9%).

18. Inflate the balloon and, while keeping the air inside, insert the sensor (too much pressure in the balloon could influence the reading).

19. Click on the **Record** icon again to start a new measurement of the oxygen percentage inside the inflated balloon.

20.   Your graph should be similar to the following:

21.   Click on the **Export** Icon ⟳ and then on the **Save value table (.CSV)** button to save your graph.

22.   Click on the ⟲ icon to go back to the graph.

23.   The measured oxygen percentage in the inflated balloon was 17.1% in the sample measurement. This matches the known value of oxygen percentage in exhaled air (~17%). Because the measurement was at rest a relatively small amount of oxygen was used. The expected carbon dioxide percentage would be around 3.3%.

Challenge research

24. Do some exercise and then repeat the experiment. Do you think that the oxygen percentage will be higher or lower than before?

Summary questions

1. Compare the results of the measurements before the physical activity and after the physical activity. Explain the difference between them.

2. What do you expect to be the change in the exhaled carbon dioxide after exercise? Will it increase or decrease?

3. What is the difference between physiological respiration and cellular respiration?