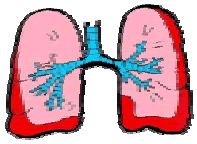


Breathing Lab

Station I: Breathing and Energy

Tasks:

1. Close your eyes. Try to breathe in and out naturally. Count your breathing rate for 30 seconds. Repeat this four times. Calculate your average rate of breathing at rest per minute.

   ..... ……. ……. ……. breaths per 30 seconds

   ……. average breathing rate at rest per minute

2. Now run on the spot vigorously for 1 minute and count your breathing rate again for 30 seconds. Repeat four times as in task 1.

   ..... ……. ……. ……. breaths per 30 seconds

   ……. average breathing rate after exercise per minute

3. Draw a bar chart to show the breathing rates at rest and after exercise.

4. With your partners discuss reasons for the different breathing rates at rest and after exercise. (hints: oxygen, glucose, energy, heat, mitochondria, ATP, ...).

   Explanation in words:

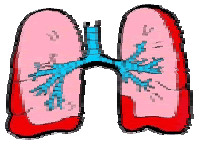
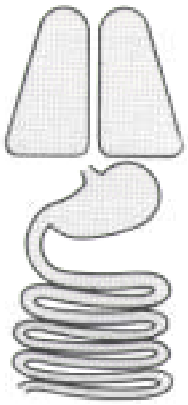
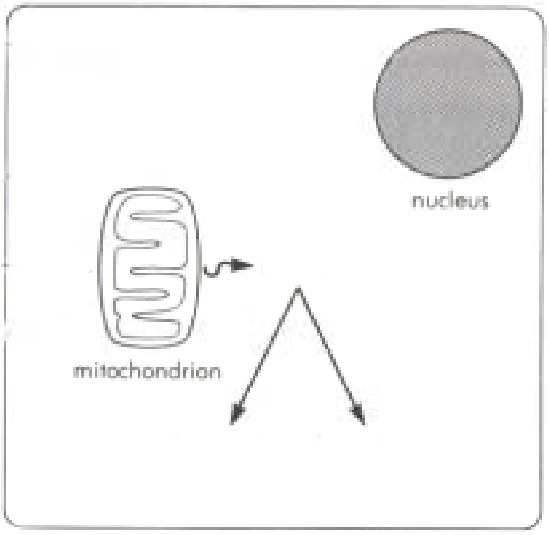
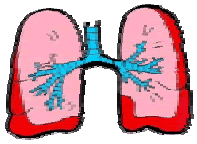


Illustration in a diagram "**Breathing and Energy**".

Connect the organs on the left with the structures of a cell on the right. Label the organs and the arrows you add.







Breathing Lab

Station II: Ventilation of the Lungs

Tasks:

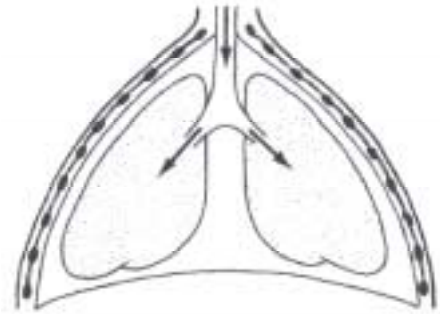
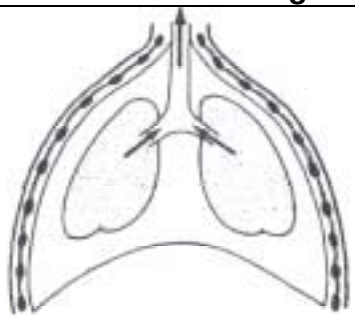
1. Put one hand on your chest. Breathe in and out deeply.
   Describe your observation.

2. Now try to breathe in and out without any movement of your chest. Put your hand on your belly just below the ribs. Describe your observation.

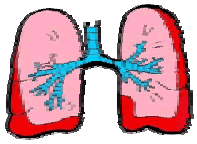
3. Study the following text on the **ventilation of the lungs**, i.e. the mechanisms responsible for the sucking in and the pushing out of air. Sum up the main details in the table.

When your inhale, the external intercostal muscles contract, which moves the ribcage up and out. At the same time the diaphragm contracts, which makes it become flatter and move downwards. These muscle movements increase the volume of the chest cavity or thorax. As a result the pressure in the thorax drops below the atmospheric pressure. Thus air flows into the lungs from the outside of the body until the pressure inside the lungs rises to atmospheric pressure.
When you exhale, the internal intercostal muscles contract, which makes the ribcage move down and in. As the diaphragm relaxes, the belly organs push the diaphragm back upwards into a curved shape. These movements decrease the volume of the thorax, which raises the pressure inside the thorax above atmospheric pressure. So air flows out from the lungs to the outside until the pressure inside the lung falls to atmospheric pressure.

Ventilation Flow-Chart

Inhaling	Exhaling
	
intercostal muscles	
diaphragm	
volume of thorax	
pressure in thorax	
air flow	

4. Now use the models from your Biology department to illustrate the ventilation mechanisms.



Station III: Air Capacity of the Lungs

Tasks:

Image Source: www.usneurologicals.com/ spirometer.jpg

Use the **spirometer** to determine the air volume you exchange when breathing normally and the air volume you are able to exchange when breathing in and out as hard as you can.

Important: Use a new cardboard mouthpiece for each student.

1. Inhale normally without force. Hold your nose and exhale normally through your mouth into the spirometer. Repeat four times to determine the average volume.

2. Now breathe in as deeply as you can. Then holding your nose force out all the air you can through your mouth into the spirometer. Repeat four times to determine the average volume.

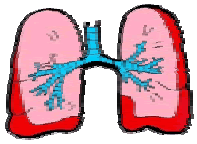
	breathing volume in ml	
name of student	normal breathing (= tidal air)	forced breathing (= vital capacity)

Facts, facts, facts …..

Under normal conditions you exchange about 400 to 500 cm^3 of air each time you inhale and exhale.
Your vital capacity depends on your age, your sex and your lifestyle.
How do you compare with these statistical data?

	vital capacity in cm^3	
age	male	female
12	1850	1600
13	2000	1800
14	2200	2000
15	2500	2200
16	2700	2250
17	3150	2300
18	3200	2350

	vital capacity in cm^3
athlete	4800
swimmer	4900
oarsman	5400

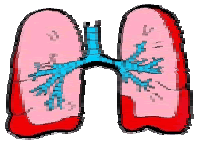


3. Now determine your breathing volume per minute.

   …… ml air exchange per minute.

4. So, how many litres of air do you exchange in a day (24 hours)?

   …… l air exchange per day



Station IV: Respiratory Surfaces under the Light Microscope

Tasks:

Study the following slides of tissue from human respiratory organs.
Make labelled pencil drawings of the structures.

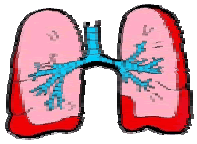
Tissue A.
Cross section through the trachea.

	The lumen[1] of the trachea is lined with a thin layer of cells, an epithelium[2]. The epithelium of the trachea consists of cells which are columnar[3] in shape and ciliated[4], i.e. which carry small cilia on their surface. The cells produce mucus, which forms a thin film on the outside of the epithelium. The epithelium sits on a basement membrane which rests on a layer of connective tissue.[5]

Function of this type of tissue:

Dust particles and bacteria become trapped in the sticky mucus film. The mucus is constantly carried upwards away from the lungs by the rapid movement of the cilia. In this way, harmful particles are prevented from reaching the sensitive alveoli.

[1] lumen = Lumen, Innenraum
[2] epithelium = Epithel
[3] columnar = säulenförmig
[4] ciliated = mit Flimmerhaaren versehen; ciliated epithelium = Flimmerepithel
[5] Compare: http://cellbio.utmb.edu/microanatomy/respiratory/olfactory_trachea.htm



Tissue B.
Cross section through lung tissue with alveoli[6].

	Each alveolus is lined by its own thin epithelium consisting of thin flat cells. Determine the number of cells forming the lining around the alveolus visible here. Remember: Each alveolus is only about 0,25 mm wide.

<u>Function of this type of tissue:</u>

The epithelium of the alveoli is very thin, which facilitates[7] the exchange of gases between the air spaces inside and the blood capillaries outside. The numerous tiny alveoli provide an enormous surface of about the size of tennis court for gaseous exchange.

[6] Compare: http://www.kumc.edu/instruction/medicine/anatomy/histoweb/resp/resp.htm
[7] to facilitate = erleichtern