Respiratory Laboratory A14 MJM

Mechanics of Breathing
Bell Jar Model

A. Observe the balloon-and-bell jar model (A standard demonstration of the mechanics of breathing.) What organs are represented by the various parts of the model?

Y - tube represents _____ & _____
balloons _____
rubber sheet _____
bell jar _____

B. Pull down on the rubber sheet. What happens to the balloons? _____ This represents the downward movement of the human _____ , which causes the chest cavity to become _____ (larger/smaller). This, in turn, causes the human _____ to expand and fill with air.

C. Release the rubber sheet. What happens to the balloons? _____ This represents relaxed _____ (inhaling/exhaling), when the chest cavity becomes smaller and the lungs deflate. Note that this is a passive process.

D. Now push up on the rubber sheet to represent forced exhalation. What happens to the balloons? _____

E. What part of the model does not move? _____ This represents the _____ of the human. How does this part of the body move during inspiration? _____How does it work during expiration? _____

Changes in Chest size

A. Now measure (with string and meter stick) the diameter of your partner's chest during both relaxed breathing and forced breating. Place the string just under the armpits. First measure after inhaling, then measure after exhaling. In relaxed breathing there will be very little change. In forced respiration, take the deepest possible breath and then exhale as much air as possible.

	Relaxed	Forced
Diameter after inspiration	_____ cm	_____ cm
Diameter after expiration	_____ cm	_____ cm
Change in chest diameter (subtraction)	_____ cm	_____ cm

B. Watch your partner during deep inspiration. How many different parts of the body expand, and in which directions?_____
_____
_____

C. If you observed your partner's abdomen expand forward, this is indirectly due to the downward movement of the diaphragm which, of course, you cannot observe. When the diaphragm drops the intestines are pushed out of the way, and, since there are no bones in the way, they bulge forward.

Inhaled and Exhaled Air

A. Background information:

Gases present	**Inhaled air**	**Exhaled air**
Nitrogen	79.00%	70.00%
Oxygen	20.96%	16.02%
Carbon Dioxide	00.04%	4.38%
Water vapor	Trace	00.60%

B. Breathe on your hand. What is the general temperature of the exhaled air? _____
How did it get this way? _____

C. Breathe on a cold, polished surface such as glass. This shows you the _____ in the exhaled air.

D. Which gas is transferred to the bloodstream after being inhaled? _____
What is its destination? _____ What is it used for? _____

E. Nitrogen is essential for survival because it is part of _____ molecules. However, the volume of nitrogen is the same in inhaled air and exhaled air, indicating that we don't get our nitrogen from the atmosphere. Where do we get it, then? _____

F. Note the great increase in carbon dioxide in the exhaled air. Where does it come from?
_____

G. Explain how exhaled "waste" air can still be used to revive someone in mouth-to-mouth resuscitation. _____
_____

Detection of Carbon dioxide

A. Background information: Carbon dioxide and water combine to form carbonic acid (a

relatively weak acid). Bromthymol blue is an "indicator" substance which is blue in ordinary water but turns yellow in acid. It can thus be used to detect the addition of carbon dioxide to water: as the water is acidified, the indicator in it turns from blue to yellow.

B. To show that there is almost no carbon dioxide in the atmosphere, fill a shallow petri dish with water and add a few droppers of bromthymol blue. Keep an eye on this dish during the lab period. Does it ever change color? _____

C. In a beaker half full of water place sever droppers of bromthymol blue. Next, exhale through a straw into the water. What happens? _____ This proves that there is _____ in the exhaled air.

D. Melt a candle and fasten it to the bottom of the petri dish. Fill the petri dish half full with water and add a few droppers of bromthymol blue. Light the candle and cover it with a beaker. What forms on the inside of the beaker? _____ What happens to the candle? _____ Why? _____ Light the candle again and keep it burning by tilting the beaker to allow some air to enter Watch the color of the water. It eventually turns _____, indicating that the burning candle releases _____ .

E. Summary: Respiration in your body's cells and burning in the candle are a similar process. The candle burns rapidly and cellular "burning" is slow and controlled; but in both cases the fuel is a C-H-O compound, the gas _____ is required, and _____ and _____ are produced as waste.

Control of Respiration

Breath Holding Ability: Breathing Rate

A. Determine how long you can hold your breath under the following conditions:

After inhaling deeply	_____ sec
After exhaling normally	_____ sec
After hyperventilating for 10 sec	_____ sec
After exercise, run down to the second floor and back	_____ sec

B. What is your breathing rate under the following conditions?

Normal, relaxed (*eupnea*)	_____ breaths/minute
After hyperventilation	_____ breaths/minute
During the first minute after exercise	_____ breaths/minute
After breathing in and out of a plastic bag for 3 min	_____ breaths/minute

Chemical control of the breathing Reflex

A. Background information: Hospitals have found that when a patient with respiratory difficulties is given pure oxygen, his breathing may actually become sluggish. But when about 4-8% carbon dioxide is mixed with the oxygen, his breathing is stimulated.

B. Look back at part B above. What happened to your breathing rate (compared to normal) after hyperventilation? _____ What effect would hyperventilation have on blood CO_2 level? _____What happened to your respiration after exercise? _____ What does exercise do to blood CO_2 level? _____ What happened to your respiration after breathing in and out of a plastic bag? _____ When you re-breathe your own exhaled air, what effect does this have on blood levels of CO_2?_____

C. Combine your answers to these questions with the background information given in A. Summarize, in one sentence, the effect of blood CO_2 level on the breathing rate:

_____

_____

Lung Capacity

A. ***Vital capacity***: inhale as deeply as possible and exhale forcefully into the tube as long as you can

B. ***Tidal air at rest:*** inhale normally; exhale normally into the tube, repeat ten times, divide reading by 10.

C. ***Inspiratory reserve:*** inhale normally; exhale forcefully into the tube as long as you can, subtract this reading from your vital capacity. _____ - _____ = _____

D. ***Expiratory reserve:*** inhale normally; exhale normally; put tube in mouth, exhale as much more as you can.

E. ***Residual volume:*** assume 1200 ml for males, 900 ml for females.

F. ***Total capacity:*** add vital capacity plus residual volume.

B. Tidal air	_____ ml	Add B + C + D =
C. Inspiratory reserve	_____ ml	_____
D. Expiratory reserve	_____ ml	Vital capacity
A. Vital capacity	_____ ml	From spirometer
E. Residual volume	_____ ml	
F. Total capacity	_____ ml	

The vital capacity measured with the spirometer or vitalometer should equal the vital capacity obtained by adding tidal air, inspiratory reserve, and expiratory reserve. If these are not approximately equal, do the measurements again.

Vital capacity is the easiest value to determine accurately. The others are harder because it is difficult to breath normally in an experiment, especially into a tube!

Peaole vary tremendously according to size, physical condition, age, and sex. However, you are on the right track if your figures come out something like this:

	Males	Females
Tidal volume	500	375
Inspiratory reserve	3000	2250
Expiratory reserve	1000	750
Vital capacity	4500	3375
Residual volume	1200	900
Total capacity	5700	4275

Identify and color structures

Name: _____