

**Objectives**

1. Explain inhalation and exhalation by using the bell jar lung model.
2. Explain acid-base balance due to respiration.
3. Determine respiratory volumes and capacities at rest and following exercise.
4. Explain blood typing.

**Activity 1: Lung Model Diagram**

A. Label each part of the lung model represented on the image on the right.

- a)
- b)
- c)
- d)
- e)

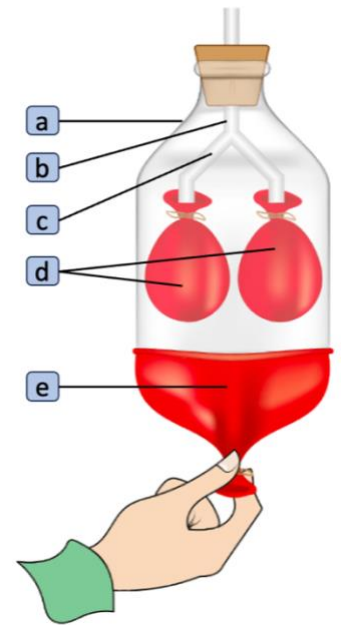
B. What happens as you pull down the balloon at the bottom of the model?

C. What happens as you push the balloon up?

D. How does the movement of the diaphragm cause the air to go in and out of the lungs?

E. What might happen if you prick the bottom balloon?

F. What position will the diaphragm be in when you are exhaling?



## ***Activity 2: Magic Breath***

### **CO<sub>2</sub> Production and Acid-Base Balance.**

Progressive changes in the color of a phenolphthalein solution as CO<sub>2</sub> is added to the solution and pH decreases from alkaline to neutral pH.

#### **Elevated Blood [CO<sub>2</sub>] and its Effect on pH**

- a) Obtain (2) of beakers containing ~150-200 ml of our test solution:
- b) Test solution: Distilled water, a small amount of NaOH to generate a weakly alkaline pH, and a few drops of phenolphthalein.  
\*\*The color of phenolphthalein changes with pH; at a pH > 8.3, phenolphthalein is pink, but below pH 8.3 it is colorless.
- c) Place two straws into one of the two beakers. Have the subject place the straws in their mouth and start timing.
- d) The subject should breathe tidally inspiring through the nose then expiring through their mouth, blowing bubbles into the solution.  
\*\*Be sure to breathe as normally and tidally as possible.
- e) Time how long it takes for the solution to lose all pink coloration.

Once completed, have the person go for a quick run outside or up and down the staircase to elevate their respiration (they should be panting when they return). Immediately give them the second beaker of solution and repeat the procedure. Note any difference in the time it takes to turn the solution clear.

Number of breaths before exercising \_\_\_\_\_

Number of breaths after exercising \_\_\_\_\_

## ***Activity 3: Determining Respiratory Volumes and Capacities at Rest and Following Exercise***

Respiratory volumes and capacities can be measured or calculated to assess respiratory system health. In this activity you will use an instrument called a dry, handheld spirometer.

### **A. Preparing for the Activity**

- a) Wipe the nozzle of the spirometer with an alcohol wipe and place a new disposable mouthpiece on the spirometer tube.
- b) Set the adjustable dial to zero by rotating it.
- c) Read the following instructions for using the spirometer:
  - To obtain the most accurate reading possible, use your thumb and index finger to pinch your nostrils closed to prevent air from leaking out of your nose.
  - When blowing into the spirometer, stand erect, and always hold it in a horizontal position with the dial facing upward.
  - This type of spirometer does not measure inspiratory volumes, so remember to only exhale into the spirometer.

## B. Measuring Lung Volumes and Capacities at Rest:

- a) Tidal Volume (TV) at Rest: Set the dial on the spirometer to 0 and sit quietly for 1 minute. Inhale normally, then place the mouthpiece of the spirometer between your lips and (with nostrils pinched closed) exhale normally.
  - Repeat this process two more times— resetting the dial on the spirometer to 0 each time— and then enter each of the values for tidal volume in table below.
  - Add the values for the three exhalations and divide the total by 3 to obtain the average TV and record it in table below.
- b) Expiratory Reserve Volume (ERV) at Rest: Inhale and exhale normally three times. Inhale normally again, and then place the spirometer between your lips and forcibly exhale as much air as possible. Record the value for ERV in table below.
  - a. Repeat this process two times, resetting the dial on spirometer to zero each time.
  - b. Add the values obtained for the three trials and divide by 3 to obtain the average ERV and record it in table below.
- c) Vital Capacity (VC) at Rest: Inhale and exhale normally three times. Then, inhale as much air as you possibly can; quickly insert the spirometer between your lips and exhale as forcibly as you can. Record your results in table below.
  - Repeat this process two times, resetting the dial on spirometer to zero each time.
  - Add the values obtained for the three trials and divide by 3 to obtain the average VC and record it in table below.

## C. Measuring Lung Volumes and Capacities following Exercise:

Before making the measurements, run in place for 4–5 minutes.

- a) Tidal Volume (TV) following Exercise: Follow the instructions for TV at rest, except do not sit quietly first and make sure that you reset the dial on the spirometer to 0 between measurements.
- b) 2. Expiratory Reserve Volume (ERV) following Exercise: Follow the instructions for ERV at rest, except do not sit quietly first.
- c) 3. Vital Capacity (VC) following Exercise: Follow the instructions for VC at rest, except do not sit quietly first.

Experimental Results: Measured Volumes				
At Rest	Trial 1	Trial 2	Trial 3	Average
Tidal Volume (TV) in mL				
Expiratory Reserve Volume (ERV) in mL				
Vital Capacity (VC) in mL				
Following Exercise	Trial 1	Trial 2	Trial 3	Average
Tidal Volume (TV) in mL				
Expiratory Reserve Volume (ERV) in mL				
Vital Capacity (VC) in mL				

*Briefly summarize the effect of exercise on pulmonary volumes and capacities.*

#### Activity 4: Blood Typing

- A. Obtain 5 well plates numbered 1-5 which correspond to the 5 individuals whom you are trying to determine the blood types for (Victim Mike and the 4 possible donors).
- B. Select one of the test subjects to start with and using the dropper vial, place 1 drop of the selected test subject's blood sample into each of the 3 wells on the numbered well plate for that test subject (one drop in the well labeled A, one drop in the well labeled B, and one drop in the well labeled Rh. Replace the cap on the dropper vial. Always replace the cap on one vial before opening the next vial to prevent cross-contamination.
- C. Add a drop of synthetic anti-A (blue) to the well-labeled A. Replace the cap.
- D. Add a drop of synthetic anti-B serum (yellow) to the well-labeled B. Replace the cap.
- E. Add a drop of synthetic anti-Rh serum (clear) to the well-labeled Rh. Replace the cap.
- F. Using a different color mixing stick for each well (blue for anti-A, yellow for anti-B, white for anti-Rh), gently stir the synthetic blood and anti-serum drops for 30 seconds. Remember to discard each mixing stick after a single use to avoid contamination of your samples.
- G. Carefully examine the thin films of liquid mixture left behind. If a film remains uniform in appearance, there is no agglutination. If the sample appears granular, agglutination has occurred. Determine the blood type of the sample using the chart below. Answer yes or no as to whether agglutination occurred in each sample. A positive agglutination reaction indicates the blood type.
- H. Record the results for the selected test subject blood sample in the data table.
- I. Repeat steps 2 through 8 for each of the blood samples, recording the results of each test as you go.
- J. Thoroughly rinse the blood typing wells when complete and make sure to clean up your lab area.

	Victim Mike	Donor Kim	Donor Ajax	Donor June	Donor Frank
Anti-A					
Anti-B					
Rh					
Blood Type					

- **Blood type A: your red blood cells have antigen A only.**
- **Blood type B: your red blood cells have antigen B only.**
- **Blood type AB: your red blood cells have both A and B antigens.**
- **Blood type O: you have neither A nor B antigens on your red blood cells.**
  - If you are blood group A, you will have antibodies to antigen B.
  - If you are blood group B, you will have antibodies to antigen A.
  - If you are blood type AB, you will not have antibodies to either A or B.
  - If you are blood type O, you will have antibodies to both A and B.

The test to check which Rhesus blood type you are is called RhD typing. In this test, a sample of your red blood cells is mixed with a laboratory solution that contains antibodies to RhD.

- A. You must use a donor whose blood will not agglutinate when mixed with that of the accident victim. Mike got into a very bad car accident. Which, if any, of Mike's friends can donate blood to him?
- B. The transfusion is made, but the emergency team needs more blood. Mike's first friend has donated all the blood that he or she can. Does Mike have a friend who, although not a preferred donor, can be used in this emergency? If you answered yes, who is it? Explain why this person can be used as a donor even though the blood types are not the same.
- C. What causes an agglutination reaction? How does this help in determining blood type?
- D. What do + and - blood types mean? Does it matter if you're + or - to receive a specific blood type?
- E. Tom and Jane participate in a Red Cross blood drive. Both are first time donors. As part of the screening process their blood is typed. Tom is A+ and Jane is AB+.
  - a. What blood group antibody is found in Tom's blood?
  - b. What blood group antigens are found in Janes blood?
- F. Tom and Janes blood donations are sent to a processing center where their blood cells are separated from their plasmas. Both their separated cells and plasma are then sent to a hospital. A blood researcher wishes to use Toms blood to extract and identify the A antigen. **Should she attempt extraction process on his blood cells or his plasma? Explain your answer.**
- G. EMTs bring two accident victims into the ER. One victim is bleeding from a head wound and needs a transfusion of blood cells to replace what she has lost. She is AB+.
  - a) Could Jane's blood cells be used for this transfusion? Explain.
  - b) Could Tom's blood cells be used for this transfusion? Explain.
- H. The second accident victim has also lost blood. He is B+. Could Jane's blood cells be used for this transfusion? Explain.
- I. Could Tom's blood be used for this transfusion? Explain.