

Measuring Lung Capacity

Pre-Lab Discussion

The amount of air that you move in and out of your lungs depends on how quickly you are breathing. The amount of air that is moved in and out of the lungs when a person is breathing normally is called the *tidal volume*. This amount of air provides enough oxygen for the body when the person is resting. It is possible to inhale more deeply and exhale more forcefully than usual. The maximum amount of air moved in and out of the lungs when the deepest possible inspiration is followed by the strongest possible expiration is called the *vital capacity*.

In this investigation, you will determine the tidal volume and vital capacity of your lungs.

Problem

How are the tidal volume and vital capacity of the human lungs measured?

Materials (per pair of students)

2 round balloons (1 for each student in the pair)
Metric ruler
Meterstick
Bathroom scale (1 per class is adequate)

* use spirometers

Safety

Do not participate in this investigation if you have any breathing difficulties.

Procedure

Part A. Measuring Tidal Volume

1. Stretch a round balloon lengthwise several times.
2. Inhale normally and then exhale normally into the balloon. **Note:** Do not force your breathing.

3. Immediately pinch the end of the balloon shut so that no air escapes. Place the balloon on a flat surface. Have your partner use the metric ruler to measure the diameter of the balloon at its widest point. See Figure 1. Record this measurement in Data Table 1.
4. Deflate the balloon and repeat steps 2 and 3 two more times. Use your three measurements to calculate an average tidal volume. Record this measurement in Data Table 1.

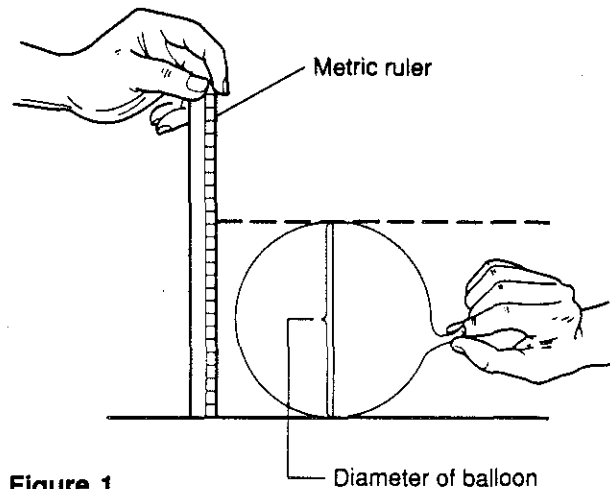


Figure 1

Part B. Measuring Vital Capacity

1. After breathing normally, inhale as much air into your lungs as possible. Exhale as much air as you can from your lungs into the balloon.
2. Immediately pinch the end of the balloon shut so that no air escapes. Place the balloon on a flat surface. Have your partner use the metric ruler to measure the diameter of the balloon at its widest point. Record this measurement in Data Table 1.
3. Deflate the balloon and repeat steps 1 and 2 two more times. Use your three measurements to calculate an average vital capacity. Record this measurement in Data Table 1.
4. Use Figure 2 to convert the balloon diameters in Data Table 1 into lung volumes. On the horizontal (x) axis, locate the diameter of the balloon in centimeters and follow the number up until it meets the curved line. Then move across in a straight line to the vertical (y) axis and approximate the lung volume. Record this measurement in Data Table 2. Repeat this procedure for all of the balloon diameters in Data Table 1.

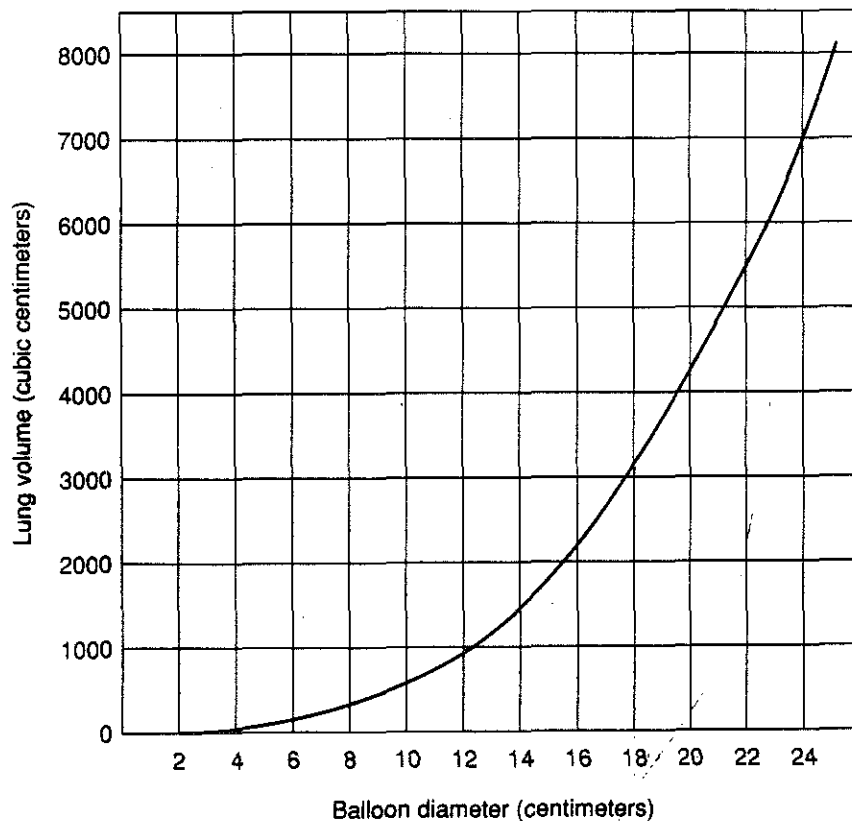


Figure 2

Part C. Calculating Estimated Vital Capacity

1. Research has shown that the capacity of a person's lungs is proportional to the surface area of his or her body. To find the surface area of your body, you will need to know your height in centimeters and your mass in kilograms. Use a meterstick to find your height and the bathroom scale to find your mass. Record these measurements in Data Table 3.
2. Use Figure 3 to estimate the surface area of your body. Find your height in centimeters on the left scale. Mark this point. Find your mass in kilograms on the right scale. Mark this point. Use a metric ruler to draw a straight line connecting these two points. Now look at the center scale. The point at which your line crosses this scale gives your surface area in square meters. Record this number in Data Table 3.

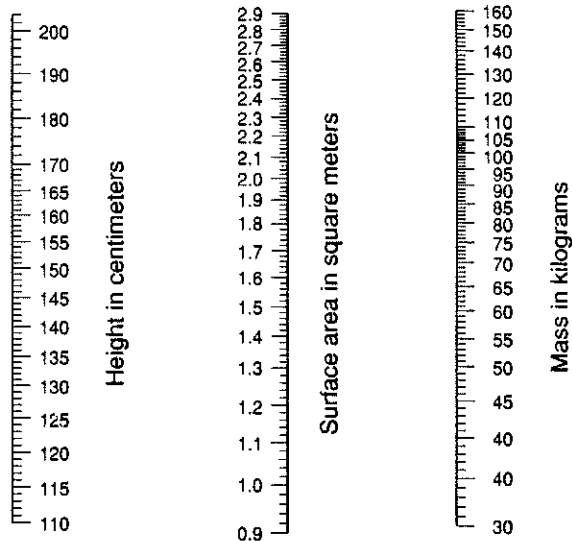


Figure 3

3. To calculate the estimated vital capacity of your lungs, multiply your surface area by the ratio of vital capacity to surface area. For females this ratio is 2000 mL per square meter. For males this ratio is 2500 mL per square meter. Record the estimated vital capacity of your lungs in Data Table 3.

Observations

Data Table 1

Balloon Diameter (cm)		
Trial	Tidal Volume	Vital Capacity
1		
2		
3		
Average		

Data Table 2

Lung Volume (cm ³)		
Trial	Tidal Volume	Vital Capacity
1		
2		
3		
Average		

Data Table 3

Body Component	Data
Height (cm)	
Mass (kg)	
Surface area (m ²)	
Vital capacity (cm ³)	

Analysis and Conclusions

1. Why is it important to measure tidal volume and vital capacity three times and calculate averages for these measurements? _____

2. How do your tidal volume and vital capacity compare with those of other class members? Why might there be some variation in the measurements of different people?

3. How does your estimated vital capacity compare to your measured vital capacity?

4. If there is a difference, suggest a reason for this. _____

5. Why might it be important to know a person's tidal volume or vital capacity?

6. Even when you exhale as forcefully as possible, some air remains in the lungs. Why is this an important occurrence? _____

Critical Thinking and Application

1. Figure 4 shows measurements of a jogger's vital capacity. The measurements were taken using a method similar to the one you used in this investigation. The vital capacity was measured at the beginning of the jogger's training period and then every five days after that. Use the data in Figure 4 to construct a line graph on the graph provided.

Day of Training Period	Vital Capacity (cm ³)
0	4800
5	4830
10	4890
15	4910
20	4960
25	5040
30	5130

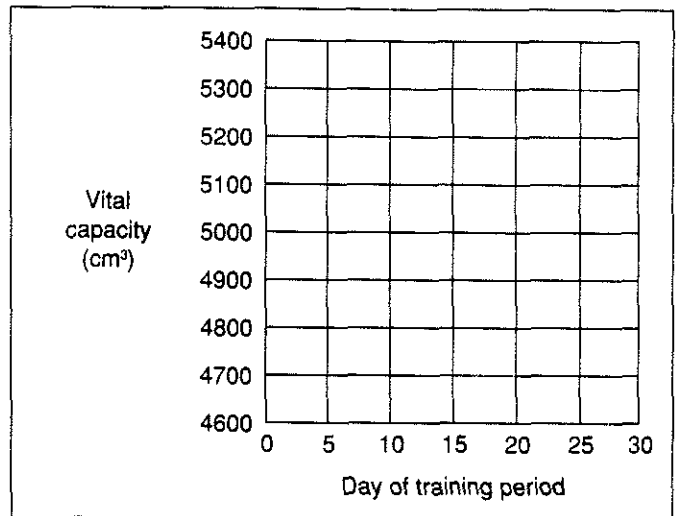


Figure 4

2. What happened to the jogger's vital capacity as the training period progressed?

3. What probably caused the change in the jogger's vital capacity? _____

4. How might vital capacity be important to some musicians? _____

5. How do you think smoking would affect vital capacity? _____

Going Further

1. The vital capacity of the lungs is affected by the anatomical build of a person, the position of the person during the vital capacity measurement, and the stretching capability of the lungs and chest cavity. Measure the vital capacity of your lungs while sitting up and then while lying down. In each position, inhale as much air into your lungs as possible and exhale as much air as you can into a balloon. Measure the diameter of the balloon each time. Compare your vital capacity in each position.
2. If a bell jar is available, construct a model of human lungs as shown in Figure 5. To make the model "breathe," pull down and then push up on the rubber sheet. Describe what happens. How does the working of this model relate to the working of your diaphragm and lungs?

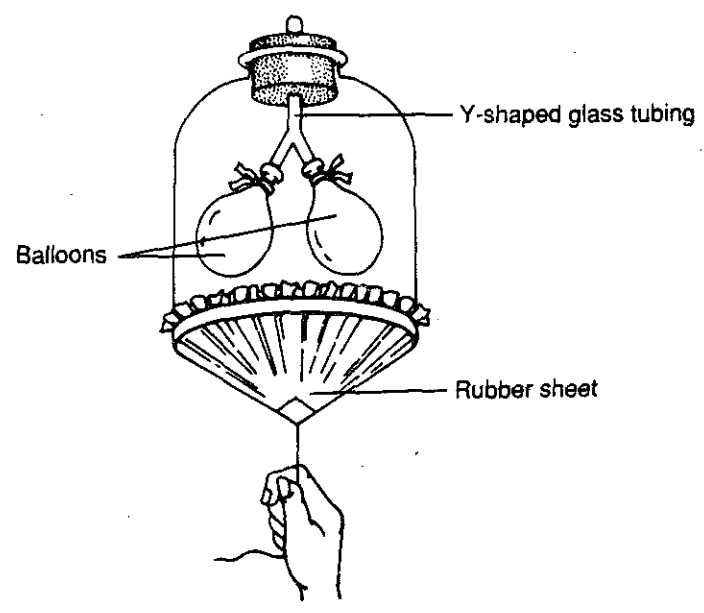


Figure 5

define tidal capacity
vital capacity
residual volume
inspiratory reserve
expiratory reserve
dead space