

## Exercise 8: Respiratory System



Figure 8.1. The above image is 3-dimensional cast of the human upper respiratory system including sinuses and the nasal cavity.

([https://commons.wikimedia.org/wiki/Category:Human\\_upper\\_respiratory\\_tract#/media/File:3D\\_printed\\_upper\\_respiratory\\_airways\\_cast\\_131918.jpg](https://commons.wikimedia.org/wiki/Category:Human_upper_respiratory_tract#/media/File:3D_printed_upper_respiratory_airways_cast_131918.jpg))

## Exercise 8 Learning Goals

After completing this lab, you should be able to:

- Identify and describe the structure of the upper and lower respiratory system
- Describe the mechanism of carbon dioxide and oxygen exchange
- Define the size, shape, and location of the lungs
- Understand the physiology of inspiration and expiration
- Describe the significance of respiratory volumes and capacities

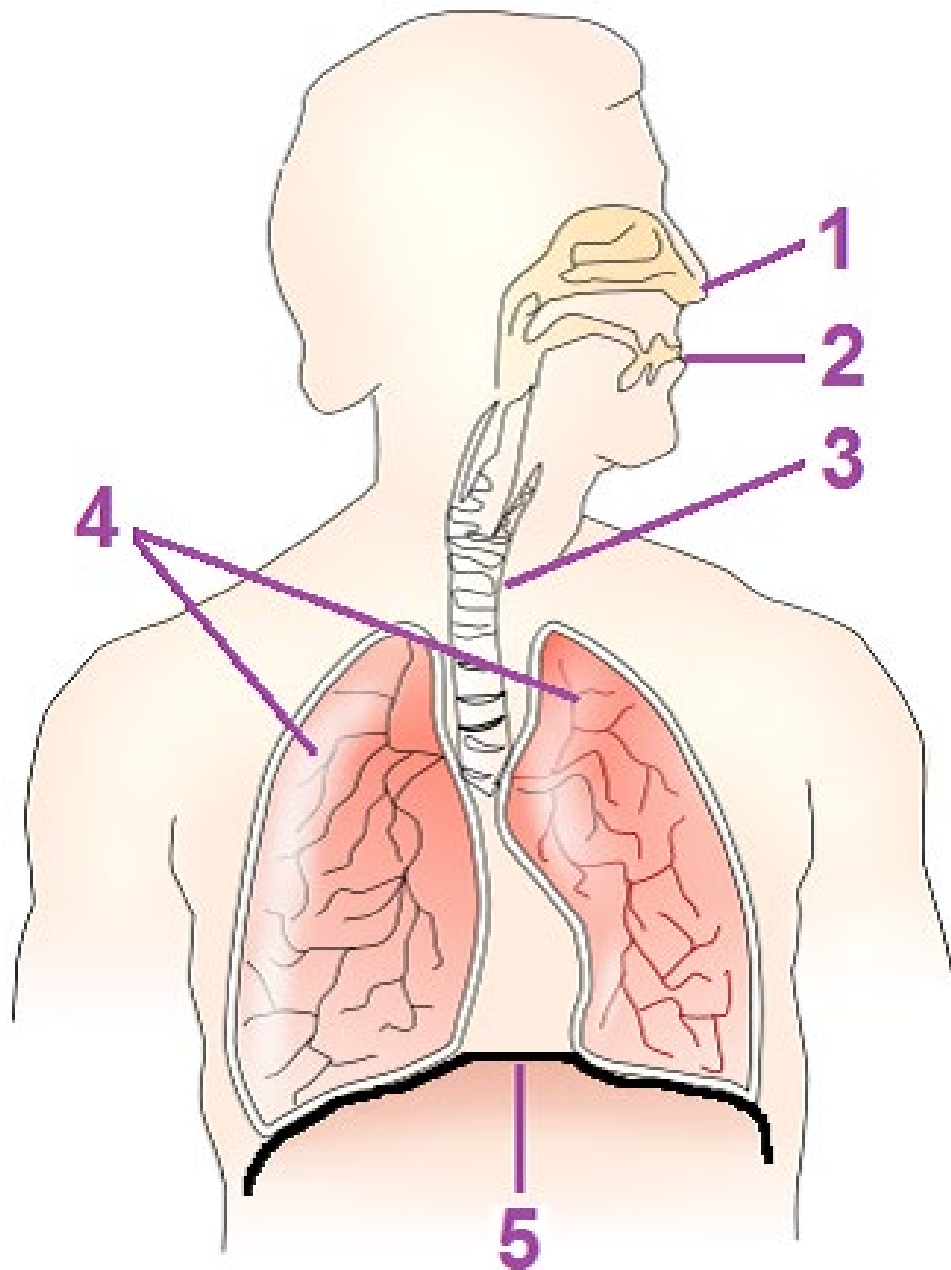
### **Pre-Lab Activity 8.1:** Describe Structures of the Respiratory System

Use an Anatomy and Physiology textbook to complete the table below.

<b>Structure</b>	<b>Function</b>	<b>Location</b>	<b>Upper or Lower</b>
Nasal Cavity			
Pharynx			
Larynx			
Epiglottis			
Vocal Folds			
Trachea			
Bronchi			
Alveoli			
Lungs			

## Pre-Lab Activity 8.2: Respiratory Structures

Use an Anatomy and Physiology textbook to label the structures numbered 1-5 below.



[https://upload.wikimedia.org/wikipedia/commons/7/7b/Respiratory\\_system\\_numbered.png](https://upload.wikimedia.org/wikipedia/commons/7/7b/Respiratory_system_numbered.png)

### Pre-Lab Activity 8.3: Lung Anatomy

Use an Anatomy and Physiology textbook to label the structures numbered in figures 8.2, 8.3. and 8.4.

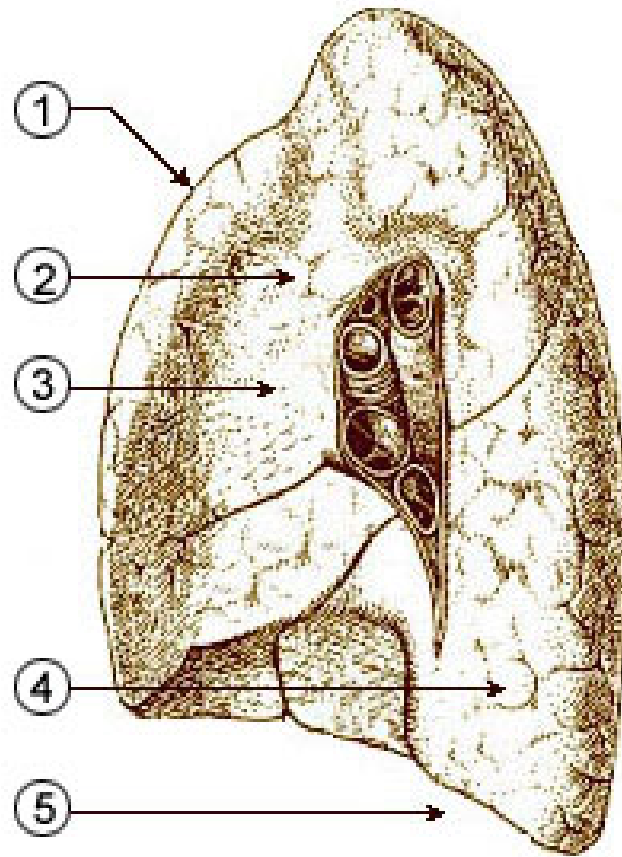


Figure 8.2 Posterior view of the right lung.

([https://commons.wikimedia.org/w/index.php?search=lung+quiz&title=Special:Search&profile=advanced&fulltext=1&advancedSearch-current=%7B%7D&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Illu\\_quiz\\_lung02.jpg](https://commons.wikimedia.org/w/index.php?search=lung+quiz&title=Special:Search&profile=advanced&fulltext=1&advancedSearch-current=%7B%7D&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Illu_quiz_lung02.jpg))

- 1.
- 2.
- 3.
- 4.
- 5.

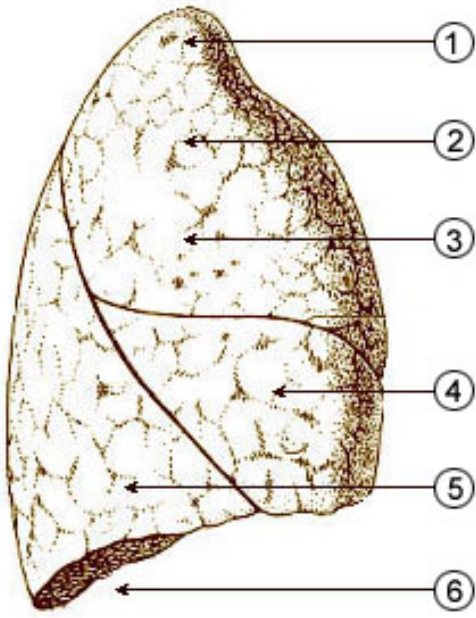


Figure 8.3 Anterior view of the right lung.

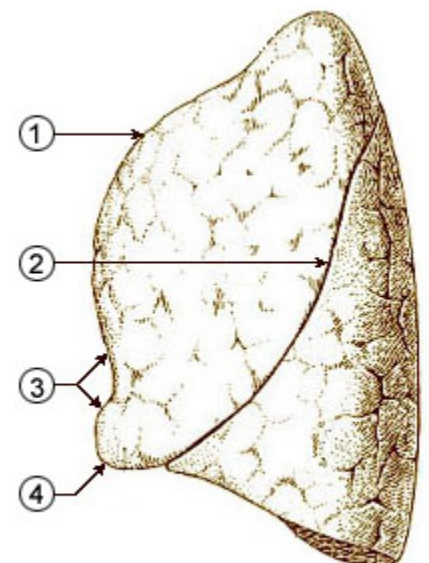
[https://commons.wikimedia.org/wiki/File:Illu\\_quiz\\_lung01.jpg](https://commons.wikimedia.org/wiki/File:Illu_quiz_lung01.jpg)

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Figure 8.4 Anterior view of the left lung.

[https://commons.wikimedia.org/w/index.php?search=lung+quiz&title=Special:Search&profile=advanced&fulltext=1&advancedSearch-current=%7B%7D&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Illu\\_quiz\\_lung03.jpg](https://commons.wikimedia.org/w/index.php?search=lung+quiz&title=Special:Search&profile=advanced&fulltext=1&advancedSearch-current=%7B%7D&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Illu_quiz_lung03.jpg)

- 1.
- 2.
- 3.
- 4.



### **Pre-Lab Activity 8.4: Gas Exchange**

In your own words, describe the structures that oxygen passes through from inhalation in the mouth to the tissues.

In your own words, describe the structures that carbon dioxide passes through from the tissues until exhaled outside of the body.

## Lab Exercise 8: Respiratory Anatomy

### Location of Lungs

The respiratory system includes the **nose**, **pharynx**, **larynx**, **trachea**, **bronchi** and **lungs**. The upper respiratory system consists of the nose and pharynx and the lower respiratory system includes the larynx, trachea, bronchi and lungs. The lungs are situated laterally to **mediastinum** in the thoracic cavity, bilateral to the heart. The lungs are cone-shaped structures surrounded directly by the visceral pleura. The major features include the **base** a broad inferior portion just above the diaphragm, the **apex** a narrow superior portion just under the clavicles, the **costal surface** nearest to the ribs, the **medial** or mediastinal surface, and finally the **hilum** where vessels and nerves enter and exit. Each lung is divided into lobes with the right lung having three, a superior, middle, and inferior lobe. The left lung has two lobes, a superior and inferior. The lobes of the right lung are formed by the horizontal and oblique fissure, while the left lung only has one oblique fissure.

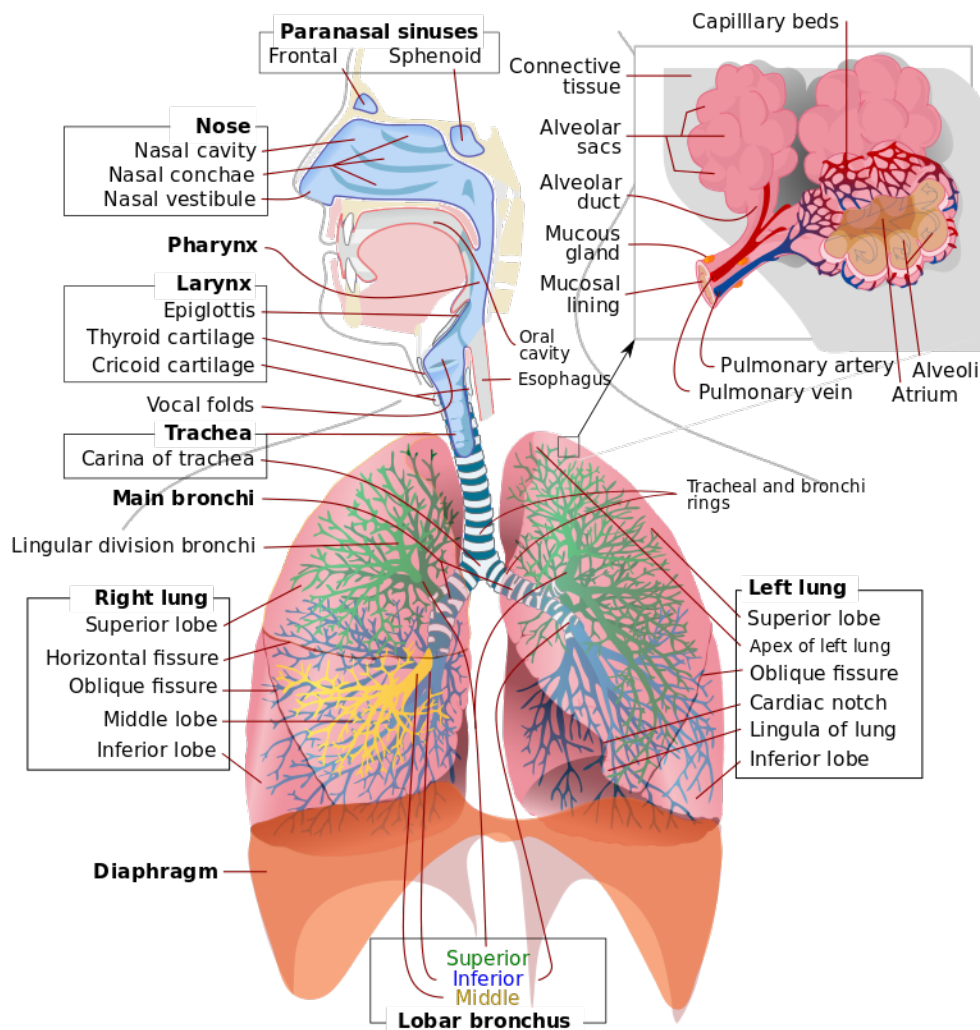


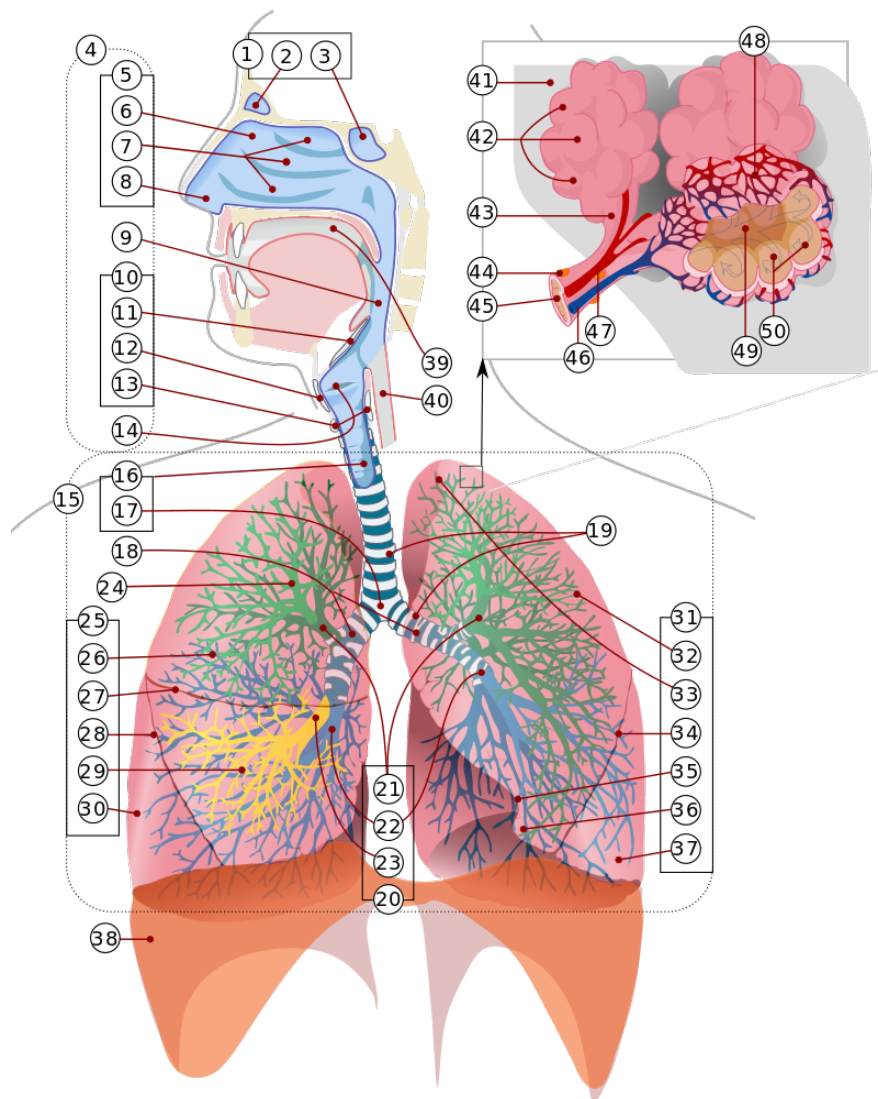
Figure 8.5 The respiratory system.

([https://commons.wikimedia.org/wiki/Lung#/media/File:Respiratory\\_system\\_complete\\_en.svg](https://commons.wikimedia.org/wiki/Lung#/media/File:Respiratory_system_complete_en.svg))



The lungs are connected to the trachea via the right and left primary bronchus which further divide in the lungs into smaller bronchi forming the bronchial tree. The trachea or windpipe is tubular passageway for conveying air from the larynx to the bronchi. The trachea is formed of smooth muscles and c-shaped rings of cartilage which provide structure. The larynx is a short passageway connecting the pharynx and trachea and contains the vocal folds responsible for sound projection (voice box). The pharynx is a funnel-shaped tube that carries both air and food. The nose connects the external environment to the to pharynx. The nose is formed by the external nares and internal cavity. The nose is specialized for warming, moistening and filtering inhaled air.

### Lab Activity 8.1: Label Structures of the Respiratory System



[https://commons.wikimedia.org/w/index.php?search=label+the+respiratory+system&title=Special%3ASearch&go=Go&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Respiratory\\_system\\_complete\\_numbered.svg](https://commons.wikimedia.org/w/index.php?search=label+the+respiratory+system&title=Special%3ASearch&go=Go&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1#/media/File:Respiratory_system_complete_numbered.svg)



## Structures to Identify:

- |                                                            |                                                   |
|------------------------------------------------------------|---------------------------------------------------|
| <input type="checkbox"/> Upper lobes (R & L)               | <input type="checkbox"/> Larynx                   |
| <input type="checkbox"/> Middle lobes (R & L)              | <input type="checkbox"/> Pharynx                  |
| <input type="checkbox"/> Diaphragm                         | <input type="checkbox"/> Main bronchi (R & L)     |
| <input type="checkbox"/> Lower lobes (R & L)               | <input type="checkbox"/> Parietal pleura          |
| <input type="checkbox"/> Epiglottis                        | <input type="checkbox"/> Phrenic nerve (R & L)    |
| <input type="checkbox"/> Eustachian tubes (R & L)          | <input type="checkbox"/> Root of the lung (R & L) |
| <input type="checkbox"/> External nares (R & L)            | <input type="checkbox"/> Trachea                  |
| <input type="checkbox"/> Hyoid bone                        | <input type="checkbox"/> Vagus nerves (R & L)     |
| <input type="checkbox"/> Inferior laryngeal nerves (R & L) | <input type="checkbox"/> Visceral pleura          |
| <input type="checkbox"/> Internal nares (R & L)            | <input type="checkbox"/> Vocal folds (true)       |

### Lab Activity 8.2: Fetal Pig Dissection

Supplies needed: Gloves, scalpel/scissors, blunt probe, tweezers

Use human terminology where ever terms for the pig may differ.

#### For the fetal pig respiratory system:

1. Locate the **larynx**, the enlarged structure at the top of the throat. This is the structure commonly called the “voicebox”- in the pig, it produces an “oink”. 😊
2. Trace the tube descending from the inferior aspect of the larynx down toward the lungs, this is the **trachea**. Known as the “windpipe” this structure directs only air (hopefully) down into the lungs. Should the trachea become obstructed, often by food or small objects, choking occurs and potentially death if the blockage is not dislodged quickly enough. The rings encircling the trachea along its length are made of cartilage and act to keep the airway patent (open).
3. Immediately superior to the larynx is the horseshoe-shaped **hyoid bone**. Recall that this is the only bone in the body which does not articulate with any other bony structure. Instead, it serves as an attachment point for many muscles and ligaments of the tongue/throat/neck. Many of these muscles contain ‘hyoid’ in their name.
4. Next, make a medial incision through the larynx so that you can observe its internal anatomy. Locate the **vocal folds**, which appear as small slits/folds within the larynx on each side. Realize that the vocal folds are not well developed because they had not yet been used.
5. Return to the exterior surface of the larynx and trachea. On either side of the trachea, situated somewhat posteriorly, are the thin, thread-like **inferior laryngeal nerves** (right and left).

6. Running laterally alongside the trachea are the much larger **vagus nerves** (right and left). Recall that they are “bundled” with and therefore located next to the carotid arteries and internal jugular veins.
7. Moving into the thoracic cavity, the right-side **phrenic nerve** extends through the cavity and connects with the diaphragm. This nerve is solely responsible for initiating diaphragmatic contraction. It is usually easiest to find where it runs along the length of the inferior vena cava on its right side from the heart to the diaphragm.
8. Trace the trachea down to where it reaches the lungs. In order to see things clearly, remove the heart and its associated blood vessels from the thoracic cavity **CAREFULLY**. There are several nerves which lie adjacent to these blood vessels so be careful that you are only removing the vessels and not the nerves. You may also use your scissors to trim away the anterior and superior portions of the rib cage on each side.
9. In the fetal pig, the lungs are divided into 7 lobes: the uppermost ones are the right and left **apical lobes**, the middle ones are the right and left **cardiac lobes**, and the lower ones are the right and left **diaphragmatic lobes**. The last lobe, the intermediate lob, sits in the middle of the thoracic cavity and wraps partly around the inferior vena cava. Humans do not possess this same lobe.
10. The trachea branches into the lobes of the lung as follows: an apical bronchus branches off the trachea to enter the right apical lobe of the lung. The trachea terminates in the left and right **main bronchi** which go into the other lobes. The **root of the lung** consists of: the main bronchi, associated blood vessels, lymphatics, and nerves which all enter/exit the hilum of the lung together.
11. Scrape away some of the lung tissue from a bronchus to see the branching extending out into the lung.
12. The pleural membrane is the serous membrane covering the individual lungs and the thoracic cavity. The **parietal pleura** is the lining of the thoracic cavity. The **visceral pleura** is the membranous covering over the lung tissue.
13. The remaining structures you need to locate are in the oral cavity.
  1. Make a longitudinal incision through the soft palate. The space underneath the soft palate is the nasopharynx. Within the nasopharynx are two structures: the **internal nares** are the openings from the nasal passageways (the **external nares** are the two external openings of the nose); the **eustachian tubes** (R & L) are located on each side of the nasopharynx and are visible as two small slits or holes. If you place your probe in one of these openings, it should extend back toward the ear.
  2. Locate the **epiglottis**, the flap of tissue at the back of the oral cavity. The oropharynx is the space between the soft palate and the epiglottis.
  3. Look inside the epiglottis. You should see two openings, one above the other. Put your probe inside each opening to see where it goes. The upper (ventral) opening is the laryngopharynx, which extends from the epiglottis to the larynx. The bottom, dorsal, opening is the esophagus.

## Lab Activity 8.3 Data Collection for Respiratory Lab Report

Your height in inches: \_\_\_\_\_ x 2.54 = \_\_\_\_\_ cm

Follow the instructions provided to you for the handheld spirometers; your instructor will demonstrate the wet spirometer (used only for inspiratory measurement).

Measure each variable three times and record your 3 measurements below. Calculate the average for each lung volume below.

### Measurements:

Tidal Volume (TV): ( \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ )/3 = \_\_\_\_\_

Expiratory Reserve Volume (ERV): ( \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ )/3 = \_\_\_\_\_

Inspiratory Reserve Volume (IRV): ( \_\_\_\_\_ + \_\_\_\_\_ + \_\_\_\_\_ )/3 = \_\_\_\_\_

Residual Volume (RV):    Males: use 1.2 liters        Females: use 0.9 liters

Using the above measurements, calculate the following lung capacities:

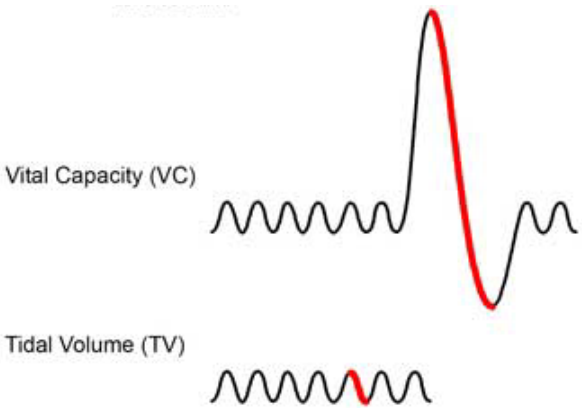
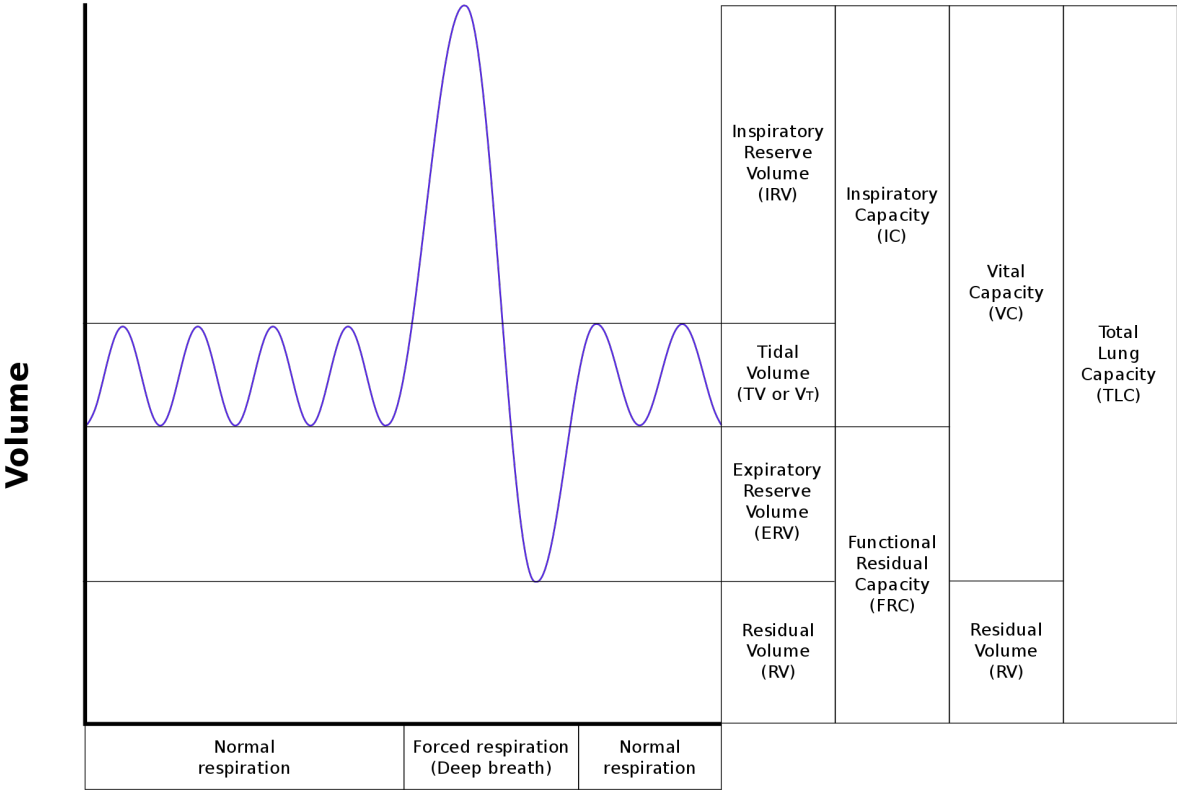
1. Inspiratory Capacity = TV + IRV \_\_\_\_\_

2. Functional Residual Capacity = ERV + RV \_\_\_\_\_

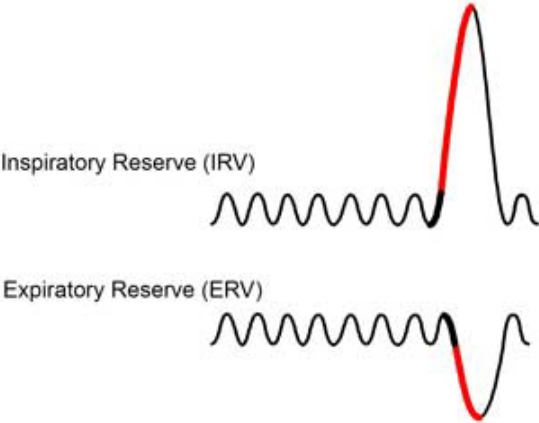
3. Vital Capacity = ERV + TV + IRV \_\_\_\_\_

4. Total Lung Capacity = ERV + TV + IRV + RV \_\_\_\_\_

Enter all data collected in the appropriate columns on the class Excel spreadsheet.



Note:  
VC, TV and ERV measurements are made by blowing out. IRV is made by sucking in. HAVE YOUR ASSISTANT hold the spirometer chain at the 5.0 mark prior to sucking in your IRV.



Note:  
It takes a bit of practice and focus on your breathing, but you can pause at the top or bottom of your tidal volume in order to measure IRV and ERV. It may feel more natural to include the tidal volume in your IRV & ERV measurements, but don't forget to subtract it out later (try both ways!)

# Respiratory Lab Report

## Data Graphs:

1. Vital Capacity vs. Height (entire lab section; scatterplot graph)
2. Respiratory Volumes & Capacities (your individual data)
3. Class Averaged Volumes & Capacities (use the average class #'s)

## Critical Thinking:

After creating the above graphs, analyze the results and answer the following questions. Always support any claims/theories with physiological evidence.

- **Graph 1 :**
  - Do you see any correlation between lung vital capacity and body size?
  - If there is a correlation, what type is it?
  - Which factor impacts the other? Why is it not the other way around?
- **Graphs 2 & 3**
  - What differences, if any, are present between your individual respiratory data graph (#2) and the class data averages (#3)?
  - Compare and contrast the differences & similarities. Give reasons for them based on physiological facts.