

Respiratory System – Physiology

Name: KEY

Read pages 393 – 403 to complete the following guided reading.

Respiratory Physiology

The major function of the respiratory system is to supply the body with Oxygen and to dispose of Carbon Dioxide. Four distinct events called respiration must occur:

Pulmonary Ventilation	<u>Describe – commonly known as breathing. This is the movement of air into and out of the lungs so that the gases being exchanged are constantly being changed and refreshed.</u>
External Respiration	<u>Describe – this is the actual gas exchange occurring between the alveoli and the capillaries containing the pulmonary blood (oxygen is being loaded into the blood and carbon dioxide is being unloaded into the lungs).</u>
Respiratory Gas Exchange	<u>Describe – this is where the blood is being transported towards the many tissues of the body via red blood cells and then picking up CO₂ from the tissues and transporting it back to the lungs so that it can be exhaled out.</u>
Internal Respiration	<u>Describe – this is where the oxygen is delivered to the tissues and carbon dioxide is removed. The exchange occurs between the systemic capillary beds & the tissue cells.</u> <u>Cellular respiration occurs inside the cells and uses the O₂ to break apart food and turn it into chemical energy (ATP) to be used to power all cellular activities.</u>

Mechanics of Breathing

	Inspiration	Expiration
Define	<u>This is the movement of air into the lungs so that oxygen may be taken into the blood; breathing in</u>	<u>This is the movement of air out of the lungs so that waste gases like Carbon Dioxide may be eliminated; breathing out</u>
Process Taking Place / Structures Involved	<u>The inspiratory muscles, the diaphragm and the external intercostal muscles (between the ribs) all contract simultaneously creating a larger volume in the thoracic cavity.</u>	<u>This is a passive force and does not require much energy because the inspiratory muscles, the diaphragm, and the external intercostal muscles all relax causing the volume within the thoracic cavity to decrease.</u>
Intrapulmonary Volume/ Gas Pressure	<u>The intrapulmonary volume increases causing a corresponding decrease in thoracic gas pressure. The air pressure outside is now larger outside than inside creating a vacuum and the net movement of air is from outside the body into the lungs and pulmonary spaces.</u>	<u>The intrapulmonary volume decreases which causes a corresponding increase in the gas pressure within the lungs and thoracic cavity. The pressure within the body now exceeds the pressure outside, so the net movement of air is from the lungs to the external environment.</u>
Details Or Vocabulary	<u>Inspiration – also called inhalation. Intra – Inside/Within, Pulmonary = lungs, vacuum is an area with little or no matter and the movement of matter is always towards the vacuum.</u>	<u>Expiration – also called exhalation. Air always moves from high pressure to low pressure.</u>

Key Concept – Volume changes lead to pressure changes, which then lead to the flow of gases towards equilibrium (equalized pressure).

Non-respiratory Air Movements

Define Non-respiratory Air Movement – is any movement other than breathing that will move air in and/or out of the lungs; usually the result of a reflex activity, but some may be produced voluntarily.

List examples of non-respiratory air movements and explain them. (See Table 13.1)

- **Coughing** – sudden reflex to clear resp. passages by forcing air from lungs; involuntary & voluntary
- **Sneezing** – sudden reflex to clear upper resp. passages via the nasal cavity; involuntary
- **Crying** – due to emotional responses; inspiration followed by several short breaths; involuntary
- **Laughing** – similar to crying in terms of air movement; emotionally controlled; involuntary
- **Hiccapping** – spasming of the diaphragm causing sudden inspirations; involuntary
- **Yawning** – a very deep inspiration usually with jaws wide open; ventilates all alveoli; involuntary

Respiratory Volumes and Capacities

What factors affect respiratory capacity – a person's body size, sex, age, and physical condition.

Complete the worksheet interpreting a Spirograph. Worksheet is attached at end. (Skip ahead)

Respiratory Sounds

What are the two recognizable sounds? Describe them.

- 1) **Bronchial Sounds** – which are produced when air rushes through the large respiratory passages (trachea and primary bronchi).
- 2) **Vesicular sounds** – which are produced when the alveoli are filled; these sounds are soft and often resemble a muffled breeze.

External Respiration

Main Points – this is the actual gas exchange between the alveoli of the lungs and the capillaries that surround the alveoli.

Supporting Details – it is important to note that all exchange of gases are made according to the laws of diffusion where net movement of particles occurs from an area of high concentration to low concentration.

For example, oxygen is high in the lungs and low in the blood capillaries, so it moves from the lungs to the capillaries, and vice versa for carbon dioxide.

Carbon dioxide is high in the blood capillaries and low in the lungs, so movement is from capillaries to lungs. Remember that the alveoli are lined with simple squamous tissue and capillaries are only one-cell layer thick to make easy diffusion possible.

Gas Transport in the Blood

Main Points

Oxygen is transported in the blood in two ways:

- within RBCs attached to hemoglobin molecules forming oxyhemoglobin (most of it does this)
- dissolved in the blood plasma (small amounts)

Carbon dioxide is transported in blood in two ways:

- in blood plasma as bicarbonate ion (HCO_3^-) (most of it does this)
- inside RBCs bound to hemoglobin (20-30 percent)

Supporting Details

Carbon dioxide does not interfere with oxygen transport because it binds to hemoglobin at a different site than oxygen does.

Carbon dioxide must be released from the bicarbonate ion before being released to the lung alveoli. Bicarbonate ion combines with hydrogen ion forming carbonic acid, which quickly splits to form water and carbon dioxide. See Figure 13.11a

Internal Respiration

Main Points

Internal respiration is the exchange of gases between the blood and the tissue cells (opposite of what occurs in the lungs).

Oxygen is unloaded from the blood, and carbon dioxide is loaded into the blood from the cells.

Supporting Details

Oxygen is released from hemoglobin molecules.

Carbon dioxide combines with water to form carbonic acid, which quickly releases the bicarbonate ions (HCO_3^-). See Figure 13.11b

Hypoxia—caused by impaired oxygen transport and delivery to body tissues; skin and mucosae become cyanotic (turn blue).

Carbon monoxide poisoning = unique type of hypoxia; CO binds to hemoglobin at same sites as oxygen and competes with oxygen for binding sites. CO binds easily and out-competes the oxygen. Can be fatal. CO poisoning treated with 100% oxygen.

Control of Respiration – Neural Regulation: Setting the Basic Rhythm

Parts of the brain that control breathing:

Medulla and pons

Effects of exercise:

Breathing is faster and deeper due to brain centers sending more rapid impulses to the respiratory muscles.

	<p>Effects of drug overdose:</p> <p><u>Medulla centers are completely suppressed, respiration stops, and death occurs.</u></p>
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Factors Influencing Respiratory Rate and Depth

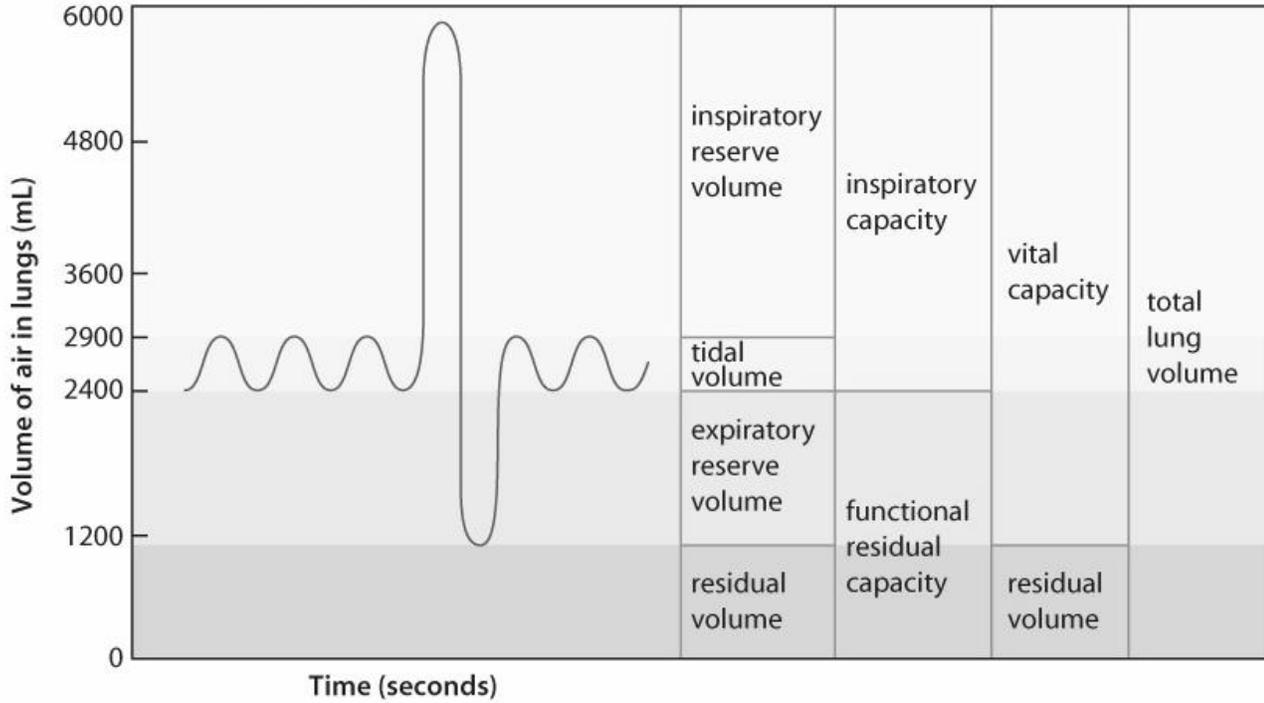
Factor	Define and Give Examples
Physical Factors	<u>Respiratory rate and depth can be altered by talking, coughing, and exercise. Increased body temperature increases breathing rate.</u>
Volition (Conscious Control)	<u>Respiratory rate and depth can be consciously controlled temporarily due to singing, swallowing, holding your breath, etc. Eventually involuntary controls take over and normal respiration returns.</u>
Emotional Factors	<u>Respiratory rate and depth can be modified by reflexes initiated by emotional stimuli (fear, surprise, disgust) acting through the hypothalamus in the brain. Fear could cause an increase or decrease in breathing rate.</u>
Chemical Factors	<p><u>Respiratory rate and depth can be altered by chemical factors such as levels of carbon dioxide and oxygen in the blood.</u></p> <p><u>The most important stimuli are increased levels of carbon dioxide and decreased blood pH that act on the medulla centers of the brain, increasing respiration rate.</u></p> <p><u>Also, decreased oxygen levels are detected by the chemoreceptors in the aorta and carotid arteries, which communicate with the medulla, increasing respiration rate.</u></p>

A Spirograph represents the amount of air that moves into and out of the lungs with each breath.

1. Define each of the following terms:

Term	Definition
tidal volume (TV)	The volume of air moved in and out of the lungs with each breath.
inspiratory reserve volume (IRV)	The volume of air that can be taken in forcibly over the tidal volume.
expiratory reserve volume (ERV)	The volume of air that can be forcibly exhaled after a tidal expiration.
vital capacity (VC)	The total volume of exchangeable air. Vital capacity = TV + IRV + ERV
residual volume	The volume of air that remains in the lungs, and cannot be voluntarily expelled.

Study the Spirograph below and answer the following questions:



2. What is the typical tidal volume for humans? (in mL) 500 mL
3. What is the typical expiratory reserve volume for humans? (in mL) 1200 mL
4. What is the typical vital capacity for humans? (in mL) 4800 mL