

**Course**

Anatomy & Physiology

**Unit XIII**

Respiratory System

**Essential Question**

How long can the body be without oxygen?

**TEKS**

130.206 (c)

1 (A)(B)

2(A)(D)

3 (A)(B)(E)

5 (B)(C)(D)

6 (B)

8 (A)(B)(C)

9 (A)(B)

10 (A)(B)(C)

**Prior Student Learning**

Cardiovascular system – Pulmonary Circulation

**Estimated time**

4 - 6 hours

**\*Teacher note:**

invite a respiratory therapist to explain respiratory volumes and help with the

**Rationale**

To pursue a career in health care, proficiency in anatomy and physiology is vital.

**Objectives**

Upon completion of this lesson, the student will be able to:

- describe biological and chemical processes that maintain homeostasis;
- analyze forces and the effects of movement, torque, tension, and elasticity on the human body;
- define and decipher terms pertaining to the respiratory system;
- distinguish between the major organs of the respiratory system;
- analyze diseases and disorders of the respiratory system; and
- label a diagram of the respiratory system.

**Engage**

Perform the following in front of the class using a paper towel and a hand mirror:

- Use the paper towel to clean and dry the mirror.
- Hold the mirror near, but not touching, your mouth.
- Exhale onto the mirror two or three times.
- Examine the surface of the mirror.

What happens to the mirror?

Why does the mirror become fogged?

Or

Of all the substances the body must have to survive, oxygen is by far the most critical. Think about the following:

- Without food - live a few weeks
- Without water - live a few days
- Without oxygen - live 4 – 6 minutes

**Key Points**

1. Introduction – Respiratory System

A. General Functions

1. Brings oxygenated air to the alveoli
2. Removes air containing carbon dioxide
3. Filters, warms, and humidifies the air
4. Produces sound
5. Helps with the sense of smell
6. Assists to regulate the pH within the blood

B. Constant removal of carbon dioxide is just as important for survival - maintaining homeostasis

*laboratory  
investigation.*

- C. Organs of respiration serve 3 functions
  1. Distribute air: gets air close enough to the blood for the gas exchange (O<sub>2</sub> load and CO<sub>2</sub> unload)
  2. Gas exchanger: by diffusion, higher to lower concentration (cellular respiration)
  3. Air purifier: filters, warms, humidifies air we breathe
2. Processes of Respiration
  - A. Pulmonary Ventilation (breathing): moving air in and out of lungs
  - B. External Respiration: gas exchange between blood and alveoli
  - C. Transport of Respiratory Gases: cardiovascular system with blood as the transporting fluid
  - D. Internal Respiration: exchange of gases between blood and tissue cells
3. Zones of Respiratory System
  - A. Conducting Zone: conduits by which air reaches sites of gas exchange; cleanse, humidify, warm incoming air
  - B. Respiratory Zone: actual site of gas exchange; includes respiratory bronchioles, alveolar ducts, alveoli
4. Nasal Cavities and Related Structures: Upper Respiratory Tract
  - A. Function
    1. Provides airway for respiration
    2. Moistens and warms air
    3. Filters air
    4. Resonating chamber for speech
    5. Olfactory receptors
  - B. Nostrils/Nares: entrance to the nose
  - C. Ala: wing-like flare of nostrils
  - D. Septum: midline partition that divides 2 cavities: mostly cartilage covered by mucous membrane; posterior part is bone including the ethmoid bone
  - E. Cavities
    1. Lined with mucous membrane and cilia
    2. Rich blood supply - often causes epistaxis
    3. Coarse hairs = vibrissae
    4. Conchae/turbinates: shelf-like partitions/projections that enhance air turbulence and increase the surface area
    5. Olfactory receptors: for smell located in the mucosa; superior part of nasal septum
  - F. Sputum
    1. 125 ml. of mucus produced daily
    2. Contains lysozymes (enzymes that destroy bacteria)
  - G. Paranasal Sinuses
    1. Drain into nasal cavities
    2. Lighten skull, warm/moisten air, resonance for voice
    3. Frontal, sphenoid, ethmoid, maxillary
    4. Rhinitis: inflammation of the nasal passages
    5. Sinusitis: inflammation of the sinuses
  - H. Nasolacrimal Ducts

1. Convey tears into the nose
2. Add moisture to humidify the air
3. Contain lysozyme (destroys bacteria)
- I. Nasal Bones: form bridge of nose; the rest of the nose is cartilage
- J. Floor of Nose: formed by palatine bones
5. Pharynx and Tonsils: Upper Respiratory Tract
  - A. Structure
    1. Throat
    2. 5 inches long
    3. Connects nose and mouth to the larynx and esophagus
  - B. Nasopharynx
    1. Upper portion behind the nasal cavity
    2. Soft palate and uvula close it off during swallowing so food doesn't enter nose
    3. Contains pharyngeal tonsils (adenoids): protects body from bacterial infection; enlarged can block airway and cause snoring and sleep apnea
    4. Contains Eustachian tube: drains middle ear and equalizes pressure; almost horizontal in infants and toddlers - increased risk of ear otitis media
  - C. Oropharynx
    1. Behind oral cavity
    2. Receives both food and air from the mouth
    3. Contains the palatine tonsils: large mass of lymphatic tissue (removal due to repeated tonsillitis)
    4. Contains the lingual tonsils (on back of tongue)
    5. Uvula: small flap hanging down from the soft palate
  - D. Laryngopharynx
    1. Receives both food and air from the mouth
    2. Opens into the esophagus (posterior) and the larynx (anterior)
6. Larynx: Upper Respiratory Tract
  - A. Voice box
  - B. 2 inches long; extends into the trachea
  - C. Lined with ciliated mucous membrane
  - D. Function
    1. Provide patent (open) airway
    2. Act as a switching mechanism to route food and air into the proper tube
    3. Voice production
  - E. Has a framework of 9 cartilage rings
    1. Joined by ligaments, lined with mucous membrane
    2. Controlled by skeletal muscle
    3. Epiglottis: flap of cartilage that closes the trachea during swallowing; elastic cartilage; "guardian of the airways"
    4. Thyroid cartilage: Adam's apple; larger in males
    5. Cricoid cartilage: signet ring shaped cartilage; lowest

cartilage; used to assist in opening the airway especially for intubation

#### F. Vocal Folds

1. True vocal cords
2. Ligaments attaching arytenoids cartilages to the thyroid cartilage
3. Glottis: space/opening between the vocal cords; narrowest part of the laryngeal cavity
4. Speech: air from lungs vibrate the vocal cords
  - a. Depth of voice depends on the length and thickness of the vocal folds
    - (1) Longer/thicker = slower vibrations = deep voice of male
    - (2) Shorter/thinner = faster vibrations = high pitch voice of female
  - b. Loudness of voice depends on force with which air rushes across the vocal cords
5. Valsalva's maneuver: attempt to forcibly exhale with the glottis, nose, and mouth closed; causes increased intrathoracic pressure, slowing of the pulse, decreased return of blood to the heart; contraction of abdominal muscles simultaneously aids in emptying bladder or rectum and stabilizes body trunk when lifting heavy item i.e. squat lifts of weight lifters
6. Laryngitis: inflammation of vocal cords

#### 7. Trachea: Lower Respiratory Tract

##### A. Windpipe

B. Location: in front of the esophagus; from larynx to primary bronchi

##### C. Anatomy

1. 4 inches long, 1 inch in diameter
2. Tube containing C-shaped cartilages (15-20) to keep it open and to allow the esophagus to bulge when swallowing (open part of the C is on the dorsal surface)
3. Lined with ciliated mucous membrane containing goblet cells
4. Carina: last tracheal cartilage; highly sensitive so that foreign objects contacting it cause violent coughing
5. Smoking inhibits then destroys cilia - coughing is then the only means to rid lungs of mucus (Smoker's cough)

##### D. Tracheal Obstruction

1. Kills over 4000 people each year
2. 5<sup>th</sup> major cause of accidental death in the United States
3. Rx = Heimlich Maneuver

#### 8. Bronchi and Bronchioles: Lower Respiratory Tract

A. Trachea branches at carina into 2 major airways: Right and Left Primary Bronchi

##### B. Anatomy

1. Right is shorter , wider, more vertical - more aspirations occur here
  2. Hilus: notch where each bronchus enters the lung
  3. Secondary bronchi = branches of primary bronchi
  4. Bronchioles = smallest branches of bronchi
  5. Complex branching arrangement
  6. 23 branches in each lung
    - a. 16 bronchi, bronchioles, terminal bronchioles
    - b. 7 respiratory bronchioles, alveolar ducts, alveolar sacs
  7. Anatomical dead space: respiratory structures leading to the respiratory bronchioles; air contained in these structures following inspiration does not reach the alveoli and will be exhaled (150 ml.)
    - a. Conducting zone
    - b. Rule of thumb: anatomical dead space = person's weight in pounds in healthy young adult
    - c. Alveolar dead space: when alveoli cease to act as gas exchange i.e. collapse or filled with mucus
9. Alveoli: Lower Respiratory Tract
- A. Air Sacs at the End of the Alveolar Ducts
  - B. Beyond the Bronchioles
  - C. Anatomy
    1. Adult has 1000 square feet of alveolar membrane or 300 million alveoli
    2. Surrounded by rich capillary network (60 square meters = half of a tennis court) for exchange of oxygen and carbon dioxide between the blood and lungs
    3. Pulmonary (respiratory) membrane: space between the alveoli and the pulmonary capillaries
    4. Movement by diffusion (high concentration to low concentration) with enormous surface area and permeability of the membrane
    5. Surfactant: lines the respiratory membrane of the alveoli
      - a. Interferes with the cohesiveness of water molecules to reduce the surface tension of the alveolar fluid
      - b. Infant Respiratory Distress Syndrome (IRDS) (Hyaline Membrane Disease): insufficient amounts of surfactant (especially in preemies) causes alveoli to collapse
    6. Reduction in alveolar surface area
      - a. Emphysema: walls of adjacent alveoli break through and alveolar chamber become larger
      - b. Tumors, mucus, inflammatory material block gas flow into alveoli
10. Lungs
- A. Spongy Organs in the Right and Left Pleural Cavities of the

- Chest
- B. Right Lung
  1. Three lobes
  2. Superior, Middle, Inferior
- C. Left Lung
  1. Two Lobes
  2. Superior, Inferior
- D. Apex, Base, Costal Surface
  1. Tip above the first rib
  2. Sits on diaphragm
  3. Against the ribs
- E. Hilus: indentation through which blood vessels enter and leave the lung
- F. Lobule: smallest subdivision of the lung that can be seen with the naked eye
- G. Pleura
  1. Membrane, sac enclosing each lung
  2. Thin, double layered serosa
    - a. Parietal: lines the thoracic wall and superior aspect of the diaphragm
    - b. Visceral: covers external lung surface
    - c. Pleural fluid: lubricating secretion
  3. Pleurisy: inflammation of the pleura; dry is more painful than excessive fluid type
- H. Mediastinum: space between the lungs containing the heart
- 11. Diaphragm
  - A. Muscle that Separates the Lower Portion of the Thoracic Cavity from the Abdomen
  - B. Contract to Draw Air into the Lungs
- 12. Mechanism of Breathing: Respiratory Cycle = Inspiration + Expiration
  - A. Inspiration
    1. Diaphragm contracts and descends
    2. External intercostal muscles contract to raise the ribs
    3. Intrapulmonic and intrapleural pressures decrease - air enters lungs until intrapulmonic pressure equals atmospheric pressure
  - B. Expiration
    1. Passive action
    2. Diaphragm and intercostal muscles relax
  - C. Pressures Involved
    1. Atmospheric pressure
    2. Intrapulmonic pressure (within the alveoli)
    3. Intrapleural (intrathoracic) pressure
    4. Atelectasis: lung collapse as a result of intrapleural pressure = intrapulmonic or atmospheric pressure
    5. Pneumothorax: presence of air in intrapleural space; reversed by closing hole and drawing air out of

intrapleural space with chest tubes

#### D. Nervous System

1. Involuntary nervous control regulates depth of respiration and volume of air
2. Respiratory center in **Medulla** (controls rate and depth of respirations; stimulated by increase in CO<sub>2</sub> in the blood, decrease of CO<sub>2</sub> in the blood and increase of O<sub>2</sub> in the blood) send impulses by the **Phrenic Nerve** to the **Diaphragm** and **Intercostal Muscles** and stimulates them to contract and draw air into the lungs (**Inspiration**)
3. **Stretch Receptors** in lung tissue send impulses by the **Vagus Nerve** to the brain to **Inhibit** respiration - lungs recoil/deflate = **expiration (Hering-Breuer Reflex)**

#### E. Chemical: Involuntary Control

1. **Carbon dioxide** in the body is found mostly as **carbonic acid** ( $\text{CO}_2 + \text{H}_2\text{O} = \text{H}_2\text{CO}_3$ ) and some bicarbonate in the plasma
2. Normal pH of blood is 7.35 – 7.45 (pH scale 1 – 14)
3. **Chemoreceptors** in the **aortic arch**, **carotid artery**, and **medulla** are sensitive to the level of CO<sub>2</sub> (pH)
  - a. **CO<sub>2</sub> buildup (decreased pH)** caused by any disorder that impairs ventilation triggers the Chemoreceptors and sends an impulse to the respiratory muscles to contract and **Increase Respirations**. You breathe faster to **Decrease CO<sub>2</sub>** and **Increase pH**.
    - (1) **Respiratory Acidosis**: condition of CO<sub>2</sub> buildup (hypercapnia)
    - (2) S & S: headache, confusion, N&V, arrhythmias
    - (3) Dx: PaO<sub>2</sub> over 45 mm Hg, pH < 7.35
    - (4) Chronic increase in PCO<sub>2</sub> leads to decreased PO<sub>2</sub> so the chemoreceptors provide the respiratory stimulus = hypoxic drive (declining O<sub>2</sub> provide the respiratory stimulus instead of increasing CO<sub>2</sub> levels)
    - (5) Caused by pulmonary disease in which CO<sub>2</sub> is retained i.e. emphysema, bronchitis which create an increased anatomical dead space
  - b. **Decreased CO<sub>2</sub> level (increased pH, hypocapnia)** occurs when the body eliminates too much CO<sub>2</sub> (as in **Hyperventilation**). The Chemoreceptors are triggered to stimulate the **Vagus Nerve** to **Decrease Respirations**. You breathe slower to **Increase CO<sub>2</sub>** and **Decrease pH**.
    - (1) **Respiratory Alkalosis**
    - (2) Lowers PCO<sub>2</sub>

- (3) 20:1 ration of bicarbonate to carbonic acid becomes 40:1 ratio - pH rises
  - (4) Caused by inexperienced mountain climbers and anxiety induced hyperventilation
  - (5) Compensations: stop hyperventilation and kidneys begin eliminating more bicarbonate
13. Factors Facilitating Combining of O<sub>2</sub> with Hemoglobin (Hgb)
- A. pH of Blood
    - 1. Alkaline favors combining of O<sub>2</sub> and Hgb
    - 2. Acid favors dissociation of O<sub>2</sub> from Hgb
    - 3. CO<sub>2</sub> + H<sub>2</sub>O = H<sub>2</sub>CO<sub>3</sub> (carbonic acid)
    - 4. In lungs, CO<sub>2</sub> and H<sub>2</sub>O are being expelled creating and alkaline environment
    - 5. In tissues, CO<sub>2</sub> is being produced creating an acid environment
  - B. Temperature of Blood
    - 1. Increased temperature in peripheral tissues favors dissociation of O<sub>2</sub>
    - 2. Increased temperature in lungs favors combining
14. Gas Transport
- A. CO<sub>2</sub> mainly as bicarbonate and carbonic acid in plasma
  - B. O<sub>2</sub> mainly as potassium oxyhemoglobin in the RBCs
15. Pulmonary Ventilation
- A. Spirometer: instrument used to measure the volume of air exchanged in breathing
  - B. Spirogram: graphic recording of changing volumes
  - C. **TV** = Tidal Volume: approximately 500 ml (1 pint); the amount of air moved in and out of the lungs during normal quiet breathing
  - D. **IRV** = Inspiratory Reserve Volume: approximately 2100 – 3300 ml; the amount of air that can be forcibly inspired over and above normal inspiration
  - E. **ERV** = Expiratory Reserve Volume: approximately 1000 – 1200 ml; the amount of air that can be forcibly exhaled after expiring the tidal volume
  - F. **VC** = Vital Capacity: approximately 4500 – 4800 ml.; the largest amount of air that we can breathe in and out in one respiratory cycle; total amount of exchangeable air; TV + IRV + ERV
  - G. **RV** = Residual Volume: approximately 1200 ml.; air that remains in the lungs after a forceful expiration; helps maintain alveolar patency and prevents lung collapse
  - H. **IC** = Inspiratory Capacity: total amount of air that can be inspired after tidal expiration; The largest volume of gas that can be inspired from the resting expiratory level TV + IRV
  - I. **FRC** = Functional Residual Capacity: combined residual and expiratory reserve volume; amount of air remaining in lungs after tidal expiration
  - J. **TLC** = Total Lung Capacity: approximately 6000 ml in males; sum of all lung volumes; TLC = VC + RV

16. Types of Breathing
  - A. Eupnea: normal, quiet breathing
  - B. Apnea: cessation of breathing
  - C. Hyperpnea: abnormally increased rate of breathing
  - D. Cheyne-Stokes: respirations gradually increase then cease entirely for a few seconds
  - E. Rales: rattling, gurgling sounds heard with breathing
  - F. Hyperventilation: depth and rate of breathing are increased
  - G. Hypoventilation: slow, shallow breathing
17. Pulmonary Diagnostics/Procedures
  - A. Roentgenography
    1. X-rays
    2. Anteroposterior (AP) and lateral views
  - B. Tomography
    1. Body section X-rays
    2. Different depths of thoracic cavity
    3. Defines shape, size, and borders of lesions
  - C. Fluoroscopy: views thoracic cavity in motion
  - D. Sputum Specimens
    1. Diagnose infections
    2. Checks for microbes and antibiotic effectiveness
    3. Detect abnormal cells from tumors
  - E. Bronchoscopy
    1. Visualize upper airway and bronchi
    2. Obtain biopsy specimens
    3. Remove aspirated foreign bodies
    4. Procedure:
      - a. Patient sedated and given local anesthetic
      - b. Rigid, hollow instrument passed into trachea into bronchi
      - c. Fiber optics used
  - F. Bronchogram: radiopaque substance injected into trachea, patient tilted various ways and X-rays taken
  - G. Tuberculin Test
    1. 6 – 8 weeks after body invaded by tubercle bacillus, body develops allergy to organism
    2. Skin tests reveal this reaction
  - H. Lung Scans: inhale or IV gamma ray emitting device and then scanned; visual exam with dye to check ventilation and perfusion
  - I. Pulmonary Angiography
    1. Catheter with radiopaque dye
    2. Through pulmonary artery
    3. Search for pulmonary embolus
  - J. Pulmonary Function Tests: spirometry; to test movement of air in/out of alveoli or O<sub>2</sub>/CO<sub>2</sub> diffusion
  - K. ABG's = arterial blood gases
  - L. Phrenic Pacemaker
  - M. Tracheotomy/Tracheostomy

N. Postural Drainage

O. Surgical Resection: Pneumonectomy, Lobectomy

P. Thoracic Deformities

Q. Pulse Oximetry

1. Infrared light source measures light changes of arterial blood and measures peripheral oxygen saturation of Hgb (SaO<sub>2</sub>)
2. Hgb is the oxygen carrier in the blood and maintains a normal saturation of 97 – 99%
  - a. At 92 – 96% the pt needs supplemental oxygen
  - b. At 86 – 91% the pt is experiencing moderate to severe hypoxemia
  - c. Below 85% the pt need ET intubation and BVM or ventilator
  - d. Below 70% is life threatening!
3. COPD has a “normal” SaO<sub>2</sub> of 92% (NOT EVER BETTER!)
4. High altitude normal is 92%
5. False readings can be caused by
  - a. CO Poisoning: CO binds with Hgb better than O<sub>2</sub>, but oximeter doesn't know the difference
  - b. Dyshemoglobin: drugs that bind with Hgb
  - c. Hypothermia
  - d. Hypovolemia/shock
  - e. Aggressive fluid replacement
  - f. High intensity lightening

R. Hyperbaric Oxygen Chambers

1. Contain oxygen at pressures greater than 1 atm.
2. Used to force greater than normal amounts of oxygen into patient's blood in cases of CO poisoning, circulatory shock, asphyxiation, gas gangrene, tetanus poisoning
3. Oxygen toxicity can result: large amounts of free radicals, profound central nervous system disturbances, coma, death

18. Diseases and Disorders of the Respiratory System

- A. **Emphysema** is one of the chronic obstructive pulmonary disorders. Emphysema is an irreversible enlargement of the air spaces distal to the terminal bronchioles due to the destruction of the alveolar walls. The result is decreased elastic recoil properties of the lungs. Signs and symptoms include dyspnea, malaise, barrel-chest, prolonged expiratory periods with pursed lip breathing, and tachypnea. Treatment includes oxygen therapy, stopping smoking, and breathing techniques to help control the dyspnea.
- B. **Influenza**, or flu, is an acute, highly contagious viral infection of the respiratory tract. It occurs sporadically or in epidemics. It tends to affect school children most often, but has its most severe effects on the elderly. Transmission occurs from inhaling

infected respiratory droplets or by contact with a contaminated object. The signs and symptoms include fever, chills, headache, malaise, myalgia, rhinorrhea, and a non-productive cough. Treatment usually includes bed rest, fluid intake, and mild analgesics to relieve the pain. There are some antiviral agents which are effective in treating the disease. Flu vaccines given in the fall are generally effective in reducing susceptibility.

- C. **Lung Cancer** is the most common cause of cancer in the United States. Lung cancer typically develops in the wall or the epithelium of the bronchial tree. The prognosis generally is poor. Lung cancer is attributable to the inhalation of pollutants, especially those found in cigarette smoke. There are no symptoms of lung cancer in the early stages. Later symptoms include dyspnea, hemoptysis, hoarseness, wheezing, and weight loss. Treatment may include surgery, radiation therapy, and/or chemotherapy.
- D. **Pneumonia** an acute infection of the lungs which prevents gas exchange. Pneumonia can be caused by viruses, bacteria, or the aspiration of fluid. Treatment depends on the cause, but may include antibiotics for bacterial infections or antimicrobials for viral infections. Treatment also includes humidified oxygen therapy, adequate fluids, bedrest, and analgesics to relieve the pain. Vaccines are available for those who are elderly or have health problems to prevent the onset of pneumonia during the winter months.
- E. **Sudden Infant Death Syndrome (SIDS)** is a mystery killer which takes the lives of apparently healthy infants between the ages of four weeks and seven months. The exact cause is unknown but may be related to compression of the carotid artery that occurs when infants sleep on their abdomen. Diagnosis of SIDS requires an autopsy to rule out other disorders.
- F. **Tuberculosis**, or TB, is a bacterial infection of the lungs is characterized by pulmonary infiltrates. People who live in crowded conditions or poorly ventilated areas are more likely to be infected. The incidence of TB has risen in the United States due to rising homelessness, drug abuse and HIV infection. The signs and symptoms of TB include fatigue, weakness, anorexia, weight loss, night sweats, and low grade fever. Treatment includes the use of medications that may continue up to one year in order to make sure the bacterial infection has been completely treated.

### Activity

- I. Define the Respiratory System Terminology.
- II. Complete the Construct a Lung Activity.
- III. Complete the Respiratory Volume Laboratory Investigation.
- IV. Complete the Spirometry Laboratory Investigation
- V. Identify anatomical structures of respiratory system on dissected cat.

(This can be accomplished as a virtual tour on the internet or if your budget allows, the students can dissect cats.)

VI. Label the respiratory system.

### **Assessment**

Respiratory System Test  
Laboratory Investigation Rubric

### **Materials**

Activity I Respiratory System Terminology Handout

Activity II

Scissors

2 liter empty, clean soda bottles – label removed

7” and 9” helium balloons

Activity III

Measuring Tape

Rulers

Balloons

Activity IV

Wet Spirometer - Sargent Welch #WL26007 phone # 1-800-727-4368

Mouthpieces - Sargent Welch #WL26009

Activity V

Dissection Cat 1 for every 2-4 students, and dissection tools AND/OR computers with internet access

Activity VI

Label the Respiratory System handout and key

<http://www.bioedonline.org/>

Utah State Office of Education, (2005). *Medical Anatomy and Physiology Teacher Resource CD*. Utah.

### **Accommodations for Learning Differences**

For reinforcement, the student will label a diagram of the lungs then make flashcards of the terminology.

For enrichment, the student will research and report on a respiratory disease/disorder.

### **National and State Education Standards**

National Health Science Cluster Standards

HLC01.01 Academic Foundations

Health care workers will know the academic subject matter required (in addition to state high school graduation requirements) for proficiency within

their area. They will use this knowledge as needed in their role.

#### HLC10.01 Technical Skills

Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

#### TEKS

130.206(c)(1)(A) demonstrate safe practices during laboratory and field investigations;

130.206(c)(1)(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials;

130.206(c)(2)(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

130.206(c)(2)(D) distinguish between scientific hypotheses and scientific theories;

130.206(c)(3)(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;

130.206(c)(3)(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

130.206(c)(3)(E) evaluate models according to their limitations in representing biological objects or events;

130.206(c)(5)(B) investigate and report the uses of various diagnostic and therapeutic technologies;

130.206(c)(5)(D) analyze and describe the effects of pressure, movement, torque, tension, and elasticity on the human body;

130.206(c)(6)(B) determine the consequences of the failure to maintain homeostasis;

130.206(c)(8)(A) analyze the physical, chemical, and biological properties of transport systems, including circulatory, respiratory, and excretory;

130.206(c)(8)(B) determine the factors that alter the normal functions of transport systems;

130.206(c)(8)(C) contrast the interactions among the transport systems;

130.206(c)(9)(A) identify the effects of environmental factors such as climate, pollution, radioactivity, chemicals, electromagnetic fields, pathogens, carcinogens, and drugs on body systems;

130.206(c)(9)(B) explore measures to minimize harmful environmental factors on body systems;

130.206(c)(10)(A) analyze the relationships between the anatomical structures and physiological functions of systems, including the integumentary, nervous, skeletal, musculoskeletal, cardiovascular, respiratory, gastrointestinal, endocrine, and reproductive;

130.206(c)(10)(B) evaluate the cause and effect of disease, trauma, and congenital defects on the structure and function of cells, tissues, organs, and systems; and

130.206(c)(10)(C) research technological advances and limitations in the treatment of system disorders.

## Texas College and Career Readiness Standards

### VI. Biology

#### A. Structure and function of cells

1. Know that although all cells share basic features, cells differentiate to carry out specialized functions.
6. Know the structure of membranes and how this relates to permeability.

#### F. Systems and homeostasis

1. Know that organisms possess various structures and processes (feedback loops) that maintain steady internal conditions.
2. Describe, compare, and contrast structures and processes that allow gas exchange, nutrient uptake and processing, waste excretion, nervous and hormonal regulation, and reproduction in plants, animals, and fungi; give examples of each.



# Respiratory Volume Laboratory Investigation

## Purpose:

In this lab, students will see a comparative difference in volume lung capacity.

## Background Information:

### Materials:

Measuring Tape

Rulers

Balloons

### Procedure:

Compare internal and external respiration.

1. Vital Capacity.
  - A. Stretch balloon.
  - B. Inhale a deep breath and exhale into your balloon.
  - C. Measure the balloons diameter.
  - D. Record information in column labeled vital capacity.
  - E. Repeat the exercise three additional times
2. Expiratory Reserve.
  - A. Take a normal breath, exhale normally and expel the remainder into your balloon.
  - B. Measure and record.
  - C. Record three additional times.
3. Tidal Volume.
  - A. Breathe normally and exhale into your balloon without disrupting your pattern.
  - B. Measure and record.
  - C. Record three additional times.

### Data:

Show your results with a graph.

	#1	#2	# 3	#4	#5	Average
<b>Vital Capacity</b>						
<b>Expiratory Reserve Volume</b>						
<b>Tidal Volume</b>						

**Conclusions:**

1. Discuss the fact that air has volume, is matter, and can be measured.

2. Explain the following:

A. Vital capacity

B. Expiratory reserve

C. Tidal volume

D. Internal respiration

E. External respiration

# Spirometry Laboratory Investigation

## Purpose:

In this laboratory investigation, the student will identify terms associated with respiratory function by measuring respiratory volumes.

## Background Information:

Students should know that Spirometry procedures are done to determine lung capacity and extent of lung injury in certain conditions such as Asthma, Emphysema, Chronic Bronchitis, COPD, etc...

## Materials:

Wet Spirometer

Mouthpieces

## Procedure:

1. Use a spirometer to measure and calculate the respiratory volumes and capacities listed below.
2. Record results in data table.
3. Repeat twice.
4. Calculate average for 3 attempts.

## Data:

Show your results with a graph.

	Volume I	Volume II	Volume III	Average
Tidal volume				
Inspiratory Reserve Volume				
Expiratory Reserve Volume				
Vital Capacity				
Residual Volume				

## Conclusion:

1. How did your respiratory volumes and capacities compare to the normal average?

2. What are possible explanations for your deviation from the normal averages?
  
3. What are some factors that could **negatively** affect respiratory volumes and capacities?
  
4. What are some factors that could **positively** affect respiratory volumes and capacities?
  
5. What are some of the consequences of unhealthy behavior related to respiratory functions?

## Respiratory Volumes and Capacities

Measurement	Average Volume	Description
<b>Tidal Volume</b>	500 ml	Amount of air inhaled or exhaled normally (normal exhalation in spirometer)
<b>Inspiratory Reserve Volume</b>	2100-3100 ml	Amount of air that can be forcefully inhaled after normal inhalation (force air in, breath out normally into spirometer, subtract tidal volume from #)
<b>Expiratory Reserve Volume</b>	1000-1200 ml	Amount of air that can forcefully exhaled after normal exhalation (normal breath, force exhalation into spirometer)
<b>Vital Capacity</b>	4800 ml	Maximum amount of air that can be exhaled after max. inhalation $VC=TV+IRV+ERV$
Residual Volume	900 ml females 1200 ml males	amount of air left in lungs after forced exhalation. Use average values.

# Respiratory System Test

## Matching 1-10

- |               |                         |
|---------------|-------------------------|
| A. Alveoli    | F. Respiration          |
| B. Pleura     | G. Internal Respiration |
| C. Breathing  | H. Surfactant           |
| D. Pulmonary  | I. Inspiration          |
| E. Expiration | J. Thoracic             |

1. Thin tissue covering the lungs and lining the chest cavity\_\_\_\_\_
2. To breathe in\_\_\_\_\_
3. Minute, balloon-like sacs in the lung through which oxygen and carbon dioxide are exchanged\_\_\_\_\_
4. Pertaining to the chest region\_\_\_\_\_
5. The interchange of gases between organisms and the environment; the taking in of oxygen and the giving off of carbon dioxide\_\_\_\_\_
6. Mechanical process by which atmospheric air is taken in and waste air is expelled\_\_\_\_\_
7. Pertaining to the lungs\_\_\_\_\_
8. Phospholipid produced by the alveoli that forms a lining that prevents the thin membranes of the alveoli from sticking together by decreasing the surface tension\_\_\_\_\_
9. To breathe out\_\_\_\_\_
10. The exchange of gases between the body and the blood cells \_\_\_\_\_

## Matching 11- 17

- |                   |                |
|-------------------|----------------|
| A. Oxygen         | E. Asthma      |
| B. Pollutants     | F. Pneumonitis |
| C. Carbon dioxide | G. Emphysema   |
| D. Tuberculosis   |                |

11. Alveoli are stretched and unable to force carbon dioxide out\_\_\_\_\_
12. Essential life giving element\_\_\_\_\_
13. The walls of the bronchial tubes become narrow and less air passes through them\_\_\_\_\_
14. Waste product of the cell\_\_\_\_\_
15. Inflammation of the lungs\_\_\_\_\_

16. Unclean\_\_\_\_\_

17. Infection that can be determined by a PPD test or a CXR; opportunistic infections especially among AIDS patients\_\_\_\_\_

### Multiple Choice

18. The special piece of cartilage that closes the opening of the larynx during swallowing is called

- a. epiglottis
- b. epistaxis
- c. thyroid cartilage
- d. glottis

19. The pouch containing a cordlike framework that creates voice sounds is called

- a) pharynx
- b) oral cavity
- c) larynx
- d) trachea

20. The hair-like objects that help move mucus, dust, and pathogens up and out of the lungs are called

- a) rhonchi
- b) cilia
- c) glottis
- d) conchae

21. The muscular wall that divides the chest cavity from the abdominal cavity is called the

- a. intercostals
- b. myocardium
- c. deltoid
- d. diaphragm

22. External respiration occurs in the

- a. cells of the body
- b. in the left atrium
- c. in the alveoli
- d. in the nose

23. Internal respiration occurs in the
- a. cells of the body
  - b. in the left atrium
  - c. in the alveoli
  - d. in the nose
24. The turbinates (conchae) that increase the surface area of the nasal cavity aide in doing all of the following EXCEPT
- a. warm the air
  - b. moisten the air
  - c. filter the air
  - d. add nutrients
25. The following are the 4 paranasal sinuses
- a. occipital, ethmoid, sphenoid, maxillary
  - b. frontal, ethmoid, sphenoid, maxillary
  - c. parietal, maxillary, occipital, ethmoid
  - d. frontal, occipital, sphenoid, mastoid
26. The sinuses give resonance to our voices and lightness to our heads.
- a. True
  - b. False
27. The nasolacrimal ducts transport chyme to our Eustachian tube.
- a. True
  - b. False
28. The tears contain lysozyme which when conveyed into our nasal cavities fights bacterial and viral invasion.
- a. True
  - b. False
29. The Eustachian tube is located between the middle ear and the pharynx to help equalize pressure on both sides of the eardrum.
- a. True
  - b. False

30. The Hering-Breuer reflex makes a person withdraw their hand when heat is applied.
- True
  - False
31. Anatomical dead space is that area of the respiratory tree in which the air is never used; the air is inhaled and exhaled and never reaches the alveoli.
- True
  - False
32. Sputum specimens are obtained for the following reasons:
- to cleanse the nose and lungs of excess mucus
  - to culture the causative agent for a respiratory infection
  - to look for cancerous cells from the lungs
  - both b and c
33. The nonrespiratory movement characterized by sudden inspiration, resulting from spasms of the diaphragm is called a/an
- epistaxis
  - sneeze
  - cough
  - hiccup
34. The nonrespiratory movement where a deep breath is taken, the glottis is closed, and air is forced out of the lungs against the glottis (used to clear the lower respiratory passageways) is called a/an
- epistaxis
  - sneeze
  - cough
  - hiccup
35. The nonrespiratory movement that clears the upper respiratory passageways is called a/an
- epistaxis
  - sneeze
  - cough
  - hiccup

**Matching: Each term will be used only once (not all will be used)**

- a. Inspiratory Capacity (IC)
- b. Expiratory reserve volume (ERV)
- c. Inspiratory reserve volume (IRV)
- d. Residual volume (RV)
- e. Tidal volume (TV)
- f. Total lung capacity (TLC)
- g. Vital capacity (VC)

36. Respiratory volume inhaled or exhaled during normal breathing\_\_\_\_\_
37. Air that remains in the lungs after a forceful expiration; helps maintain alveolar patency and prevents lung collapse \_\_\_\_\_
38. The largest volume of gas that can be inspired from the resting expiratory level \_\_\_\_\_
39. Amount of air that can still be exhaled (forcibly) after a normal exhalation\_\_\_\_\_
40. Sum of all lung volumes\_\_\_\_\_

**Matching: The following terms may be used once, more than once, or not at all**

- A. Apnea
- B. Hypoxia
- C. Chronic bronchitis
- D. Lung cancer
- E. Dyspnea
- F. Sleep apnea
- G. Emphysema
- H. Cheyne-Stokes
- I. Eupnea
- J. Rales

41. Lack or cessation of breathing\_\_\_\_\_
42. Normal breathing in terms of rate and depth\_\_\_\_\_
43. Labored breathing, or “air hunger” \_\_\_\_\_
44. Chronic oxygen deficiency\_\_\_\_\_
45. Respirations gradually increase in rate then cease entirely for a few seconds\_\_\_\_\_
46. Condition characterized by Bronchial lining inflamed; victims known as “blue bloaters” \_\_\_\_\_
47. Condition characterized by increased mucus production that clogs respiratory passageways and promotes coughing\_\_\_\_\_
48. Together called COPD\_\_\_\_\_
49. Incidence strongly associated with cigarette smoking; has increased dramatically in women recently\_\_\_\_\_
50. Victims become barrel-chested because of air retention\_\_\_\_\_

51. Temporary cessation of breathing during sleep \_\_\_\_\_

**Matching: Each term may be used once or not at all**

A. Bronchioles

B. Epiglottis

C. Esophagus

D. Glottis

E. Palate

F. Trachea

G. Uvula

52. Narrowest portion of the respiratory tree \_\_\_\_\_

53. Smallest respiratory passageways \_\_\_\_\_

54. Closes the nasopharynx during swallowing \_\_\_\_\_

55. Separates the oral and nasal cavities \_\_\_\_\_

56. Windpipe \_\_\_\_\_

57. Food passageway posterior to the trachea \_\_\_\_\_

## Respiratory System Test **Key**

- |       |       |
|-------|-------|
| 1. B  | 30. B |
| 2. I  | 31. A |
| 3. A  | 32. C |
| 4. J  | 33. D |
| 5. F  | 34. B |
| 6. C  | 35. C |
| 7. D  | 36. E |
| 8. H  | 37. D |
| 9. E  | 38. A |
| 10. G | 39. C |
| 11. G | 40. F |
| 12. A | 41. A |
| 13. E | 42. I |
| 14. C | 43. E |
| 15. F | 44. B |
| 16. B | 45. H |
| 17. D | 46. C |
| 18. A | 47. G |
| 19. C | 48. G |
| 20. B | 49. G |
| 21. D | 50. G |
| 22. D | 51. F |
| 23. C | 52. A |
| 24. D | 53. A |
| 25. B | 54. G |
| 26. A | 55. E |
| 27. B | 56. F |
| 28. A | 57. C |
| 29. A |       |

## Respiratory System Terminology

Parts of the Respiratory System:

NOSE, PHARYNX, LARYNX, TRACHEA, BRONCHI, ALVEOLI, LUNGS

**Define the following terms related to the Respiratory System:**

<b>Term</b>	<b>Meaning</b>
<b>ox/o ox/li –oxia</b>	<b>oxygen</b>
hypoxia	
anoxia	
hypoxemia	
oxyhemoglobin	
oximetry	
oximeter	
<b>-capnia</b>	<b>carbon dioxide</b>
acapnia	
hypercapnia	
hypocapnia	
<b>-pnea</b>	<b>breathing</b>
apnea	
dyspnea	
eupnea	
hyperpnea	
orthopnea	
tachypnea	
bradypnea	
<b>nas/o</b>	<b>nose</b>
nasology	
nasoscope	
nasitis	
nasopharyngitis	
<b>rhin/o</b>	<b>nose</b>
rhinitis	
rhinomycosis	
rhinorrhagia	
rhinoplasty	
rhinorrhea	
rhinocheiloplasty	
rhinostenosis	
rhinodynia	
rhinovirus	

<b>muc/o</b>	<b>mucus</b>
mucous	
mucus	
mucopurulent	
<b>sinus/o</b>	<b>sinus</b>
paranasal sinuses	
sinusitis	
sinusotomy	
<b>pharyng/o</b>	<b>pharynx</b>
nasopharynx	
oropharynx	
laryngopharynx	
pharyngitis	
pharyngorrhea	
pharyngodynia	
pharyngotomy	
pharyngoxerosis	
pharyngoscope	
pharyngoplegia	
pharyngoplasty	
pharyngomycosis	
pharyngalgia	
pharyngectomy	
pharyngopathy	
<b>tonsill/o</b>	<b>tonsil</b>
tonsillitis	
tonsillectomy	
tonsillotome	
<b>adenoid/o</b>	<b>adenoids (adeno=gland, oids=like/resembling)</b>
adenoid hypertrophy	
adenoiditis	
adenoidectomy	
adenotome	
<b>laryng/o</b>	<b>larynx (voice box)</b>
laryngitis	
laryngectomy	
laryngectomee	
laryngocentesis	
laryngoplasty	
laryngoplasty	
laryngoplasty	
laryngoscope	
laryngoscopy	
laryngospasm	

laryngoplegia	
laryngalgia	
laryngostenosis	
laryngoedema	
laryngomalacia	
laryngopathy	
<b>-phonia</b>	<b>pertaining to sound or voice</b>
aphonia	
dysphonia	
<b>epiglott/o epiglottid/o</b>	<b>epiglottis</b>
epiglottitis	
epiglottidectomy	
<b>trache/o</b>	<b>trachea</b>
endotracheal intubation	
tracheitis	
tracheostenosis	
tracheoplasty	
tracheostomy	
tracheostoma	
tracheotomy	
<b>bronch/i bronch/o bronchiol/o</b>	<b>bronchiole</b>
bronchitis	
bronchogenic carcinoma	
bronchopneumonia	
bronchoplasty	
bronchoscope	
bronchiectasis	
bronchoscopy	
bronchospasm	
bronchodilator	
bronchiostenosis	
bronchoedema	
bronchomycosis	
bronchopathy	
bronchoplegia	
bronchorrhagia	
bronchorrhea	
bronchotomy	
<b>alveol/o</b>	<b>alveoli (air sacs in the lungs)</b>
alveolitis	
<b>pulmon/o</b>	<b>lung</b>
pulmonectomy	
pulmonary edema	
pulmonary embolism	
<b>pneum/o pneumat/o pneumon/o</b>	<b>lung, air</b>

pneumonia	
pneumorrhaphy	
pneumonectomy	
pneumatocele	
pneumomalacia	
pneumohemothorax	
<b>thorac/o</b>	<b>thorax (chest)</b>
thoracalgia	
thoracocentesis/thoracentesis	
thoracotomy	
thoracodynia	
<b>-thorax</b>	<b>chest</b>
hemothorax	
pyothorax	
hydrothorax	
pneumothorax	
<b>pleur/o pleura</b>	<b>pleura</b>
pleurocentesis	
pleuropexy	
pleuralgia	
pleurisy	
<b>lob/o</b>	<b>lobe</b>
lobar pneumonia	
lobectomy	
lobitis	
<b>atel/</b>	<b>- imperfect</b>
atelectasis	
<b>diaphragmat/o diaphragm/o</b>	<b>diaphragm (partition)</b>
diaphragmatic	
diaphragmalgia	
diaphragmodynia	
<b>phren/</b>	<b>diaphragm</b>
phrenic nerve	
phrenoplegia	
phrenospasm	
<b>spir/o</b>	<b>breathe</b>
spirometer	
spirometry	
spirograph	
spirogram	

# Laboratory Investigation Rubric

Student: \_\_\_\_\_

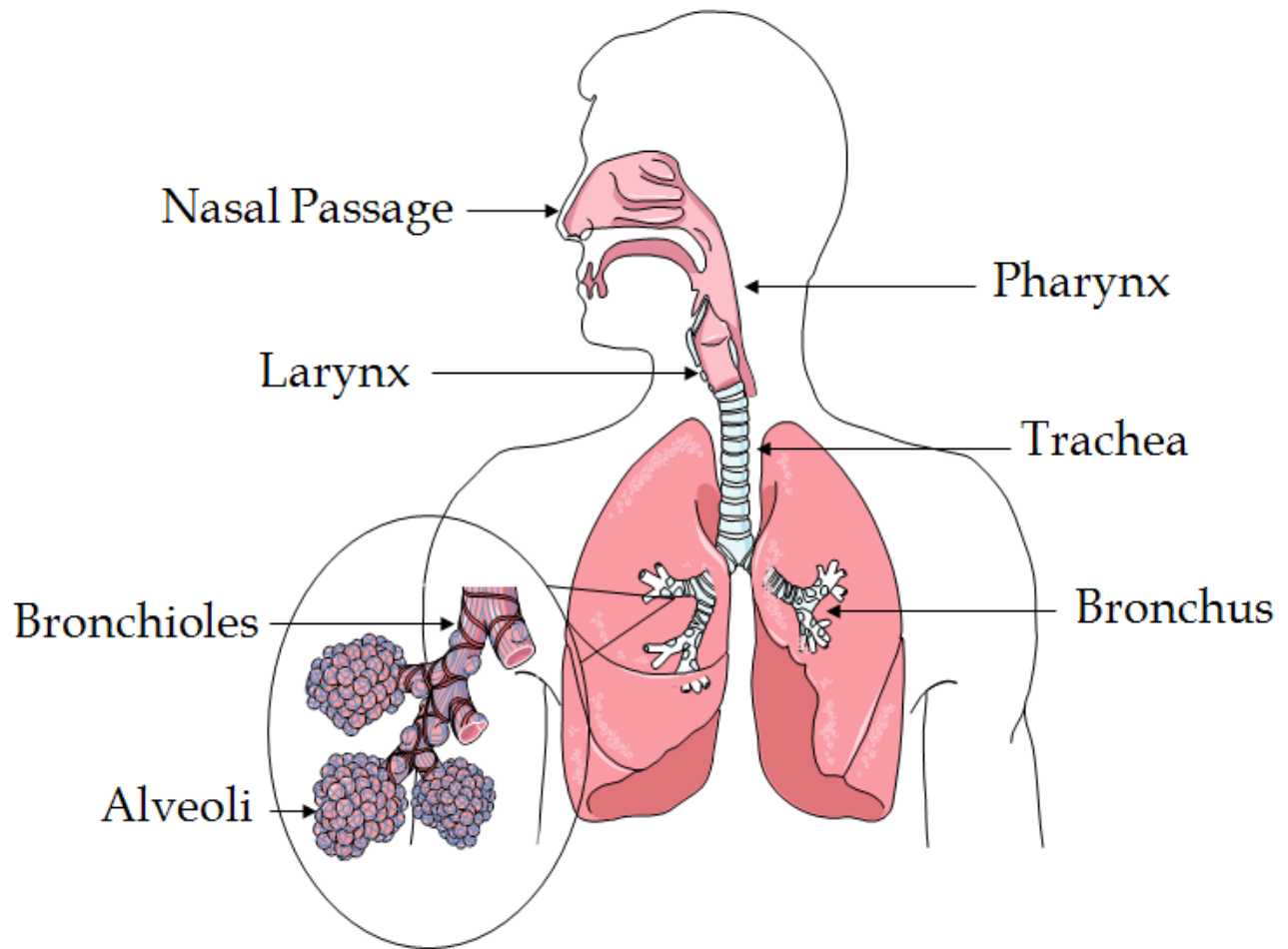
Course: \_\_\_\_\_

Date: \_\_\_\_\_

Scoring Criteria	4	3	2	1	N/A
	Excellent	Good	Needs Some Improvement	Needs Much Improvement	
Problem is appropriately identified.					
Problem is precise, clear, and relevant.					
Association between the problem and the predicted results is direct and relevant.					
All variables are clearly operationalized.					
Demonstrates comprehension of the use of scientific concepts and vocabulary.					
All significant data is measured.					
Data is recorded effectively and efficiently.					
Data table is well designed to the task requirements.					

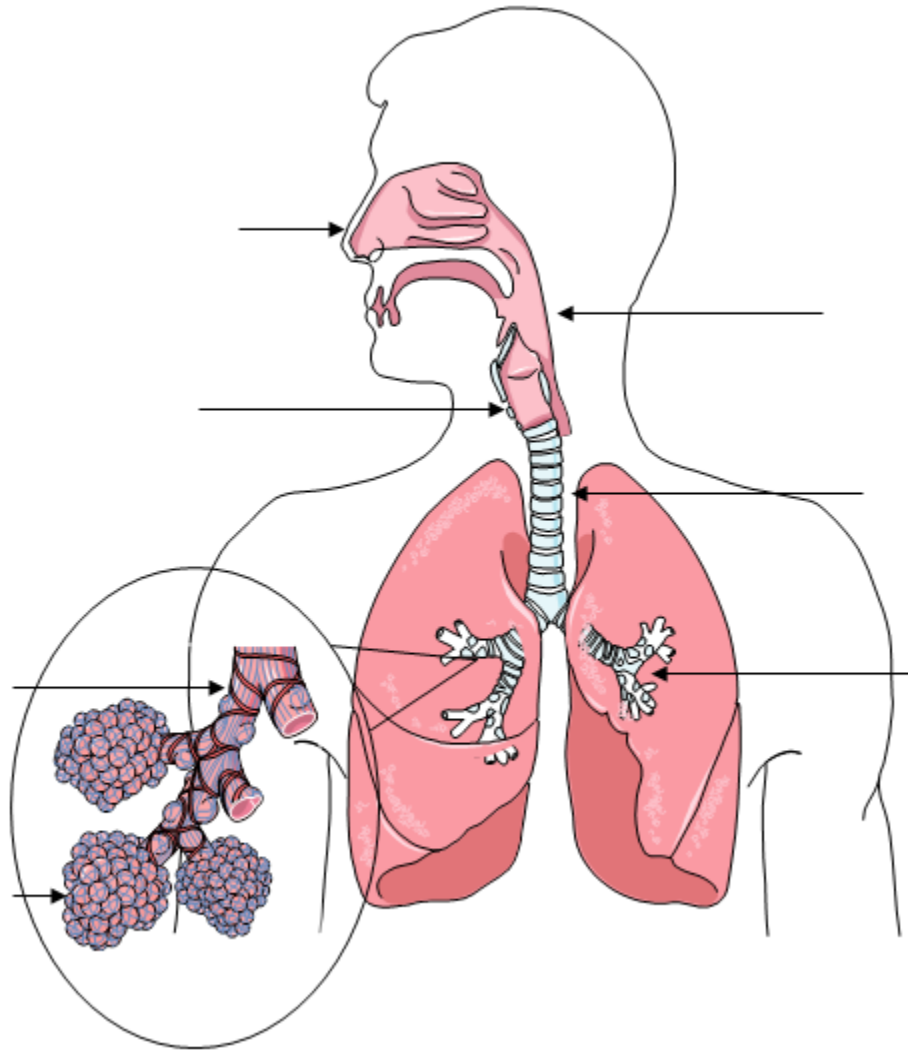
All graphs are appropriate.					
All data accurately plotted.					
Graph visually compelling; highlights conclusions of the study.					
Conclusion relates directly to hypothesis.					
Conclusion has relevancy in resolution of the original problem.					
Conclusion relates the study to general interest.					

# Human Respiratory System Diagram



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# Label Human Respiratory System



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