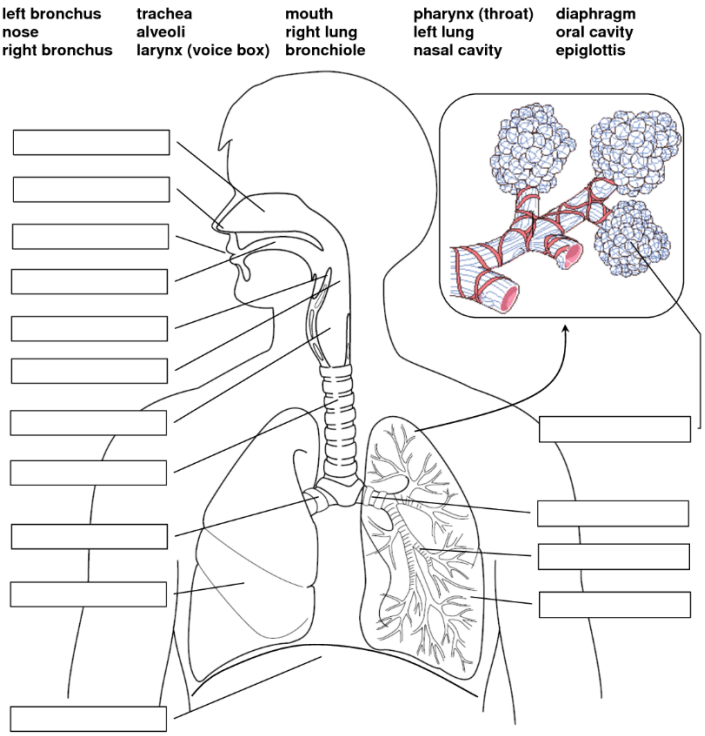
Biology 12
Human Biology

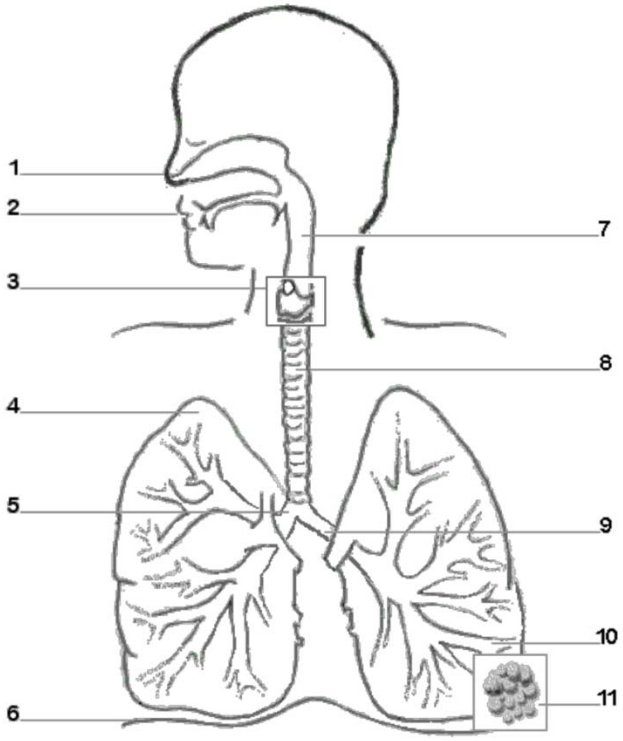
Study Guide – Answer Key

Respiratory System

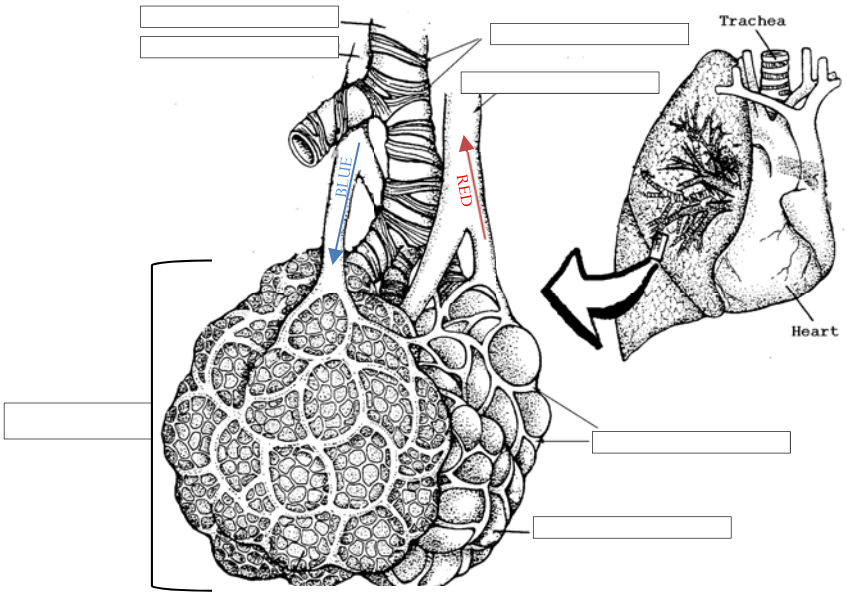
1. Label a diagram of the respiratory system. *See key at the end of the answer key.*

left bronchus, trachea, mouth, pharynx (throat), diaphragm
nose, alveoli, right lung, left lung, oral cavity
right bronchus, larynx (voice box), bronchiole, nasal cavity, epiglottis

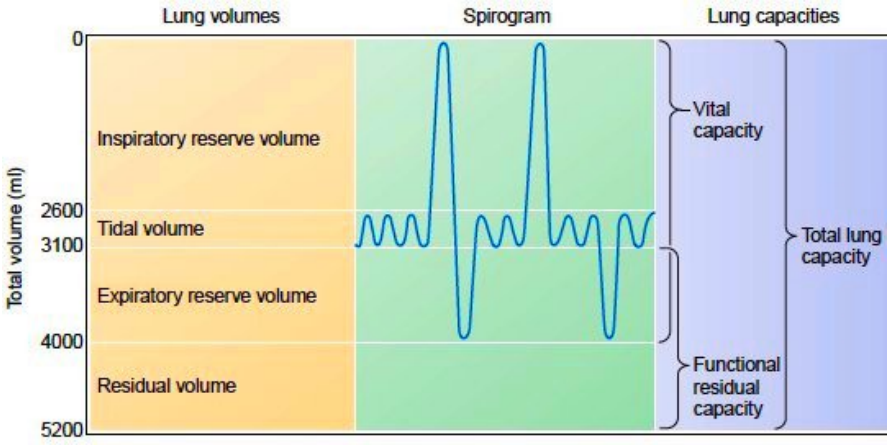




2. Label a diagram of the alveoli. For the sample diagram below, use the terms: alveolus, bronchiole, capillaries, lobule, pulmonary arteriole, pulmonary venule, smooth muscle



3. Name and distinguish between the 4 types of respiration.
    a. ventilation: inhaling and exhaling (getting air in and out of the body)
    b. external respiration: gas exchange between the alveoli and the pulmonary capillaries
    c. internal respiration: gas exchange between the blood and the tissues cells
    d. cellular respiration: performed by the mitochondria, process that produces ATP
4. What are the three ways that inhaled air is conditioned before it gets to the alveoli?
    a. warmed (by the blood vessels lining the nasal cavity)
    b. cleaned (by the small hairs, cilia and mucus)
    c. moistened (by moisture along respiratory tract)
5. How are the large air passageways protected from collapsing?
   C-shaped rings of cartilage
6. Why is the cartilage in the trachea C-shaped and not O-shaped?
   Allows room for the esophagus to expand as needed while swallowing
7. Describe mucociliary transport.
   This is how debris is cleared out of the respiratory tract to ensure the lungs stay clean.
   "Muco" refers to the mucus along the respiratory tract that traps particles such as dust, pollen and bacteria
   "Ciliary" refers to the cilia that work in a coordinated fashion to sweep the mucus up towards the pharynx
   The result is either swallowed (stomach will kill off any pathogens) or expelled via coughing
8. How do the pleural membranes work?
   Enclose a fluid-filled space surrounding the lungs. This protects the lungs from damage that may result from rubbing along the ribcage, to provide lubrication so the delicate tissue can expand and contract easily, and maybe most importantly to keep them from fully collapsing when exhaling.
9. How are alveoli specialized for their function? (name a minimum of three ways)
    a. small, spherical and numerous: best shape for maximizing surface
    b. moist, thin walls: makes gas exchange easier
    c. surrounded by lots of capillaries: efficient gas exchange
    d. elastin: allows them to expand
    e. surfactant: stops them from collapsing
10. Compare the five measures of total lung capacity (tidal volume, vital capacity, inspiratory reserve volume, expiratory reserve volume and residual volume). Use a graph if desired.
    a. tidal volume: small amount of air inhaled and exhaled at rest (~ 0.5 L)
    b. vital capacity: maximum amount of air that can be moved in and out during a single breath (combination of inspiratory reserve volume, tidal volume, and expiratory reserve volume) (~5 L)
    c. inspiratory reserve volume: maximal volume of air that can be inhaled above vital capacity (~ 3 L)
    d. expiratory reserve volume: maximal volume of air that can be exhaled below vital capacity (~1.5 L)
    e. residual volume: the volume of air remaining in the lungs after a maximal exhalation (~1 L)



11. What triggers inhalation? exhalation?

Inhalation is triggered by the respiratory center stimulating the intercostal and diaphragm to contract via the phrenic nerve.

Exhalation is triggered by the stretch receptors in the alveoli sending messages to inhibit nerve impulses via the vagus nerve.

12. Compare the physical changes that occur to the thoracic cavity during inhalation versus exhalation.

Inhalation (active phase of ventilation)

- diaphragm contracts and moves down, rib cage moves up and out… enlarging thoracic cavity

Exhalation (passive phase of ventilation)

- diaphragm relaxes and moves up, rib cage moves down and in… reducing thoracic cavity

13. Explain the following statement "*we do no force air into our lungs rather we breathe by negative pressure*".

Enlargement of the thoracic cavity due to the movement of the diaphragm and rib cage results in an area of low pressure in the lungs. As the atmospheric pressure around our body is now higher, the air flows into the lungs moving from an area of high pressure to an area of low pressure.

14. How are the levels of carbon dioxide, oxygen and hydrogen ions monitored by our body?

Carbon dioxide and hydrogen ions are monitored in the respiratory center of the brain located in the medulla oblongata. Increased levels of either results in increased breathing rate and depth.

Oxygen is monitored by carotid and aortic bodies found in the neck and aorta. Decreased levels of oxygen results in increased breathing rate and depth.

15. List the five ion/molecule complexes necessary for internal and external respiration and briefly state the function of each.

a. bicarbonate ions (HCO_3^-): main form of carbon dioxide transport
b. carbonic acid (H_2CO_3): middle step when producing bicarbonate ions o
c. oxyhemoglobin (HbO_2): main form of oxygen transport in red blood cells
d. carbaminohemoglobin ($HbCO_2$): carries some carbon dioxide to lungs to be expelled
e. reduced hemoglobin (HHb): acts as a blood buffer to maintain the pH

16. In what ways is O_2 transported in the blood?

a. What percentage is transported in each way?
b. Write the reaction of the main method of transport.

- Combined with hemoglobin (98%) as oxyhemoglobin

$$Hb + O_2 \underset{\text{tissues}}{\overset{\text{lungs}}{\rightleftharpoons}} HbO_2$$

- Dissolved in plasma (2%)

17. In what ways is CO_2 transported in the blood?

a. Rank them from most common to least common.
b. Write the reaction of the main method of transport.

- Carried as bicarbonate ions (~75%)

$$CO_2 + H_2O \underset{\text{lungs}}{\overset{\text{tissues}}{\rightleftharpoons}} H_2CO_3 \underset{\text{lungs}}{\overset{\text{tissues}}{\rightleftharpoons}} H + HCO_3^-$$

- Combined with hemoglobin as carbaminohemoglobin (10%)
- Dissolved in plasma (~15%)

18. Producing bicarbonate ions results in an excess of hydrogen ions in the blood. How is the body able to maintain a homeostatic pH level?
    By using other blood buffers such as hemoglobin to pick up the excess.
19. Describe two differences in conditions that hemoglobin encounters in blood and the effect of these conditions on hemoglobin's transport abilities.
    - Temperature: slightly lower in the lungs, slightly higher at the tissues
        - Lower temperature INCREASES hemoglobin's affinity for oxygen
    - pH: slightly lower at the tissues, slightly higher in the lungs
        - Higher pH INCREASES hemoglobin's affinity for oxygen

DIAGRAM KEYS