Section 7.2: Review Answers

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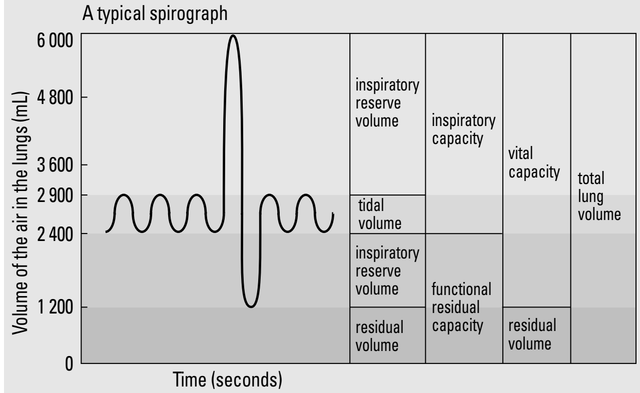
1. The two basic requirements, as summarized in Section 7.1, are (a) a large enough surface area for the quick and efficient exchange of gases and (b) a moist environment for external respiration to take place. Alveoli are thin-walled structures that are surrounded by capillaries. There are about 300 million alveoli in each lung, providing a large surface area for gas exchange. The alveoli of human lungs are lined with a thin film of water, provided by the water vapour that is added to air as it passes through the respiratory tract.
2. The role of the diaphragm is to change the size of the thoracic cavity. This alters air pressure within the lungs and causes air to enter and exit the lungs.

   Inhaling: The diaphragm contracts and moves down, an action that increases the volume of the thoracic cavity. This reduces the pressure in the cavity. Air moves into the lungs when the pressure inside the cavity is lower than air pressure outside (air moves from a region of higher pressure to a region of lower pressure).

   Exhaling: The diaphragm relaxes and resumes its normal, domed shape. This decreases the volume in the thoracic cavity which, in turn, increases air pressure in the area. Air moves out of the lungs when the pressure inside the thoracic cavity is higher than air pressure outside.
3. The model shown represents the thoracic cavity, the lungs and the diaphragm. In Diagram B (inhalation), the pulling down of the elastic membrane (diaphragm) increases the volume and reduces the pressure of the cavity. Air moves into the balloons because the air pressure outside is higher than in the cavity and the balloons. In Diagram A (exhalation), the elastic membrane returns to its normal, flat shape, which decreases the volume and increases the pressure in the cavity. Air moves out of the balloons because the pressure inside the cavity and the balloons is higher than air pressure outside.
4. **(a)** A spirograph shows the volume of air moving in and out of the lungs with each breath.

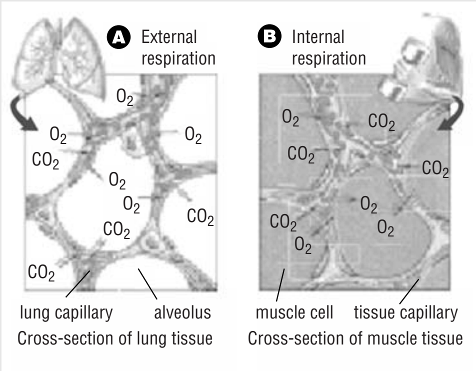
   (b)



   (c) The respiratory volumes represented on this graph are:
   - Tidal volume represents air inhaled and exhaled during a normal breath when at rest.
   - Inspiratory reserve volume represents additional air taken in beyond a normal inhalation.
   - Expiratory reserve volume represents additional air that can be forced out of the lungs beyond a normal exhalation.
   - Vital capacity is the total volume of gas that can be moved in or out of the lungs. Vital capacity = tidal volume + inspiratory reserve volume + expiratory reserve volume. (Note: total lung volume = vital capacity + residual volume)
   - Residual volume is the amount of gas that remains in the lungs and the passageways of the respiratory system after a full exhalation.
5. **(a)** The three volumes of air that make up the vital capacity are the tidal volume, the inspiratory reserve volume, and the expiratory reserve volume.

   (b) The residual volume is the amount of gas that remains in the lungs and passageways of the respiratory system even after a full exhalation. The lungs contain air after a full exhalation due to the presence of cartilaginous rings that keep the airways open, even if the lungs are dissected from the thoracic cavity. Lung tissue is like a sponge that contains air due to its physical structure.

6.



External respiration occurs between the alveoli and the capillaries next to them. As oxygen-poor blood moves through the lung capillaries, oxygen from the air in the alveoli diffuses into the capillaries and carbon dioxide diffuses out of the blood. Internal respiration occurs between the capillaries and the body tissues. Oxygen diffuses from the oxygen-rich blood into the tissues while carbon dioxide diffuses from the tissues into the blood.

7. Hemoglobin has three major functions. It carries about 99% of the O_2 in the blood.

(The remaining 1% is dissolved in the plasma.) Hemoglobin also buffers the pH of the blood by combining with H^+ from the carbonic acid that forms when carbon dioxide combines with water. Its third function is to carry about 23% of the CO_2 in the blood.

Bicarbonate ions form from the dissociation of carbonic acid that results from CO_2 reacting with water in the blood. About 70% of the CO_2 carried in the blood travels as bicarbonate ions (HCO_3^-).

8. The diaphragm is a muscle that contracts to begin inspiration, increasing the volume and decreasing the pressure in the thoracic cavity. If this muscle is damaged, inspiration and normal breathing would be very difficult. The patient would probably rely more heavily on intercostal muscles to carry on the breathing cycle if they were undamaged. If the injury allowed air to move between the pleural membranes, a collapsed lung might occur. (See Answer #9, below.)

9. A pneumothorax allows air into the thoracic cavity so that the pleural membranes no longer adhere to each other. (See the answer to Section 7.1 Review Questions, question 10.) The collapsed lung would fail to expand and contract with the movement of the chest wall and diaphragm. Gas exchange would no longer occur in the collapsed lung. If one lung were to collapse, the total surface area for gas exchange would be reduced by about half.

10. Removing the air from the thoracic cavity would allow a film of water to reattach the pleural membranes. In this way, the lungs would once again expand and contract with the movement of the chest wall and diaphragm.

11. The levels of carbon dioxide in the toddler's blood would increase to the point where the breathing centre in the brain would over-ride the toddler's desire to stop breathing. Normal breathing would resume.