ANSWERS TO CHAPTER 15

CONTENT LEARNING ACTIVITY

Nose and Nasal Cavity
1. Internal nares; 2. Nasal septum; 3. Conchae; 4. Paranasal sinuses; 5. Nasolacrimal duct; 6. Epithelium

Pharynx
1. Nasopharynx; 2. Soft palate and uvula; 3. Nasopharynx; 4. Oropharynx; 5. Laryngopharynx

Larynx
A. 1. Thyroid cartilage; 2. Epiglottis; 3. Arytenoid, corniculate, and cuneiform cartilages; 4. Vestibular folds; 5. Vocal folds
B. 1. Conchae; 2. External naris; 3. Hard palate; 4. Larynx; 5. Epiglottis; 6. Vestibular fold; 7. Vocal fold; 8. Thyroid cartilage; 9. Trachea; 10. Laryngopharynx; 11. Oropharynx; 12. Nasopharynx; 13. Uvula; 14. Soft palate; 15. Internal naris

Trachea, Bronchi
1. Trachea; 2. Trachea; 3. Primary bronchi

Lungs
A. 1. Lobes; 2. Bronchopulmonary segments; 3. Secondary bronchi; 4. Tertiary bronchi; 5. Terminal bronchioles; 6. Alveolar ducts; 7. Alveoli
B. 1. Trachea; 2. Primary bronchi; 3. Secondary bronchi; 4. Tertiary bronchi; 5. Terminal bronchiole; 6. Respiratory bronchiole; 7. Alveolar ducts; 8. Alveoli

Pleural Cavities
1. Thoracic cavity; 2. Pleural cavity; 3. Visceral pleura; 4. Pleural fluid

Lymphatic Supply
1. Superficial lymphatic vessels; 2. Deep lymphatic vessels

Changing Thoracic Volume
1. Muscles of inspiration; 2. Muscles of expiration; 3. Diaphragm; 4. Muscles of inspiration

Pressure Changes and Air Flow
A. 1. Decreases; 2. Increases; 3. Higher; 4. Lower; 5. Volume; 6. Pressure
B. 1. Alveolar pressure; 2. Atmospheric pressure; 3. Equal to; 4. Less than; 5. Into; 6. Equal to; 7. Greater than; 8. Out of

Lung Recoil
A. 1. Elastic fibers and surface tension of alveolar fluid; 2. Surfactant; 3. Surfactant and pleural pressure
B. 1. Expand; 2. Lung recoil; 3. Pleural fluid; 4. Expand

Changing Alveolar Volume
1. Decreases; 2. Decreases; 3. Increases; 4. Decreases; 5. Increases

Pulmonary Volumes and Capacities
A. 1. Pulmonary volumes; 2. Tidal volume; 3. Residual volume; 4. Pulmonary capacity; 5. Vital capacity; 6. Forced expiratory vital capacity
B. 1. Inspiratory reserve volume; 2. Tidal volume; 3. Expiratory reserve volume; 4. Residual volume; 5. Vital capacity

Gas Exchange
A. 1. Alveolar fluid; 2. Alveolar epithelium; 3. Basement membrane of alveolar epithelium; 4. Interstitial space; 5. Basement membrane of capillary endothelium; 6. Capillary endothelium
B. 1. Dead space; 2. Decreases; 3. Decreases; 4. Partial pressure; 5. Increases; 6. Increases; 7. Higher; 8. Lower

Oxygen and Carbon Dioxide Transport in the Blood
A. 1. Oxyhemoglobin; 2. Oxyhemoglobin; 3. Plasma; 4. Low; 5. High; 6. Low; 7. High
B. 1. Plasma; 2. Blood proteins; 3. Bicarbonate ion; 4. Carbonic anhydrase; 5. Carbonic acid; 6. Hydrogen ions; 7. Decreases

Rhythmic Ventilation
A. 1. Medullary respiratory center; 2. Dorsal respiratory groups; 3. Ventral respiratory groups; 4. Pontine respiratory group
B. 1. Threshold; 2. More; 3. Pontine; 4. Stretch receptors

Modification of Ventilation
A. 1. Cerebral cortex; 2. Hering-Breuer reflex
B. 1. Carbon dioxide; 2. Decreases; 3. Increases; 4. Medullary chemoreceptors; 5. Carotid and aortic body chemoreceptors; 6. Increases

Effect of Exercise on Ventilation
1. Increases; 2. Increases; 3. No significant change; 4. Anaerobic threshold

Respiratory Adaptations to Training
1. Increases; 2. No change; 3. Increases; 4. Increases; 5. Increases

QUICK RECALL

1. Gas exchange, regulation of blood pH, voice production, olfaction, and innate immunity
2. Trachea, primary bronchus, secondary bronchus, tertiary bronchus, bronchiole, terminal bronchiole, respiratory bronchiole, alveolar duct, alveolus
3. The trachea divides to form the primary bronchi, which supply each lung; secondary bronchi supply the lobes; and tertiary bronchi supply the bronchopulmonary segments
4. As volume increases pressure decreases, and as volume decreases, pressure increases

5. The lungs tend to recoil because of the elastic fibers in the lungs and the surface tension of alveolar fluid. The lungs are prevented from collapsing by surfactant and pleural pressure
6. Pulmonary volumes: tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume; vital capacity is the sum of inspiratory reserve volume, tidal volume, and expiratory reserve volume
7. Alveolar fluid, alveolar epithelium; basement membrane of alveolar epithelium; interstitial space; basement membrane of capillary endothelium; capillary endothelium
8. Hemoglobin 98.5%, dissolved in plasma 1.5%
9. Bicarbonate ions 70%, blood proteins (mainly hemoglobin) 23%, and dissolved in plasma 7%
10. Carbon dioxide and water combine to form carbonic acid, which dissociates into hydrogen ions and bicarbonate ions
11. Carbon dioxide, pH (hydrogen ions), and oxygen. Chemoreceptors in the medulla oblongata are most sensitive to small changes in carbon dioxide and pH. An increase in carbon dioxide or a decrease in pH stimulates respiration. Chemoreceptors in the carotid and aortic bodies are most sensitive to changes in oxygen. A large decrease in oxygen stimulates respiration.
12. At rest: changes in pH, which can be caused by changes in carbon dioxide; during exercise: input from the motor cortex and proprioceptors

WORD PARTS

1. bronchus; bronchiole
2. pleural; pleurisy
3. pharynx; nasopharynx; oropharynx; laryngopharynx
4. oropharynx
5. inspiration; expiration; spirometer
6. pneumothorax; pneumonia

MASTERY LEARNING ACTIVITY

1. A. The nasal cavity warms and humidifies air. It also filters the air, removing debris. The nasal septum divides the nasal cavity into left and right parts; the hard palate forms the floor of the nasal cavity and separates the nasal cavity from the oral cavity. The auditory tubes open into the nasopharynx.
2. D. The nasopharynx contains the pharyngeal tonsils. The palatine and lingual tonsils are in the oropharynx. The nasopharynx is closed off during swallowing by the soft palate and uvula. The nasopharynx connects to the oropharynx, not the oral cavity. The paranasal sinuses open into the nasal cavity.
3. D. The larynx contains the vestibular folds (false vocal cords), which close off the opening to the larynx. They also contain the vocal folds (true vocal cords), which are responsible for voice production. The larynx has 3 unpaired cartilages and 3 sets of paired cartilages. C-shaped cartilages are part of the trachea. The larynx connects the pharynx to the trachea.
4. C. The walls of the bronchioles are smooth muscle that can constrict and impede air flow during an asthma attack. The trachea and bronchi are held open by C-shaped cartilages.
5. B. The parietal pleura lines the walls of the thoracic cavity and the visceral pleura covers the surfaces of the lungs. Gas exchange takes place across the respiratory membrane.
6. C. During quiet expiration, the elastic properties of the thorax and lungs cause a passive decrease in thoracic volume. The diaphragm relaxes and moves superiorly. The external intercostal muscles, which elevate the ribs during inspiration, relax.
7. B. Normally, pleural pressure is less than alveolar pressure. Contraction of the diaphragm increases thoracic volume, which causes a decrease in pleural pressure. As pleural pressure decreases, the alveoli expand. The increase in volume of the alveoli results in a decrease in alveolar pressure below atmospheric pressure, and air moves from outside the body (higher pressure) to the alveoli (lower pressure).
8. A. Surfactant lowers the surface tension of the alveolar fluid and helps to prevent collapse of the lungs. Elastic recoil of lung tissue and surface tension of alveolar fluid are responsible for collapse of the lungs.
9. A. Because the pleural pressure within the pleural cavity is less than atmospheric pressure, a hole as described allows air to flow into the pleural cavity. This condition, called pneumothorax, results in collapse of the lung.
10. B. By definition this is expiratory reserve.
11. C. Vital capacity is the sum of the inspiratory reserve plus the tidal volume plus the expiratory reserve (2500 mL + 500 mL + 1000 mL = 4000 mL).
12. E. Gases must pass through the parts of the respiratory membrane: thin layer of alveolar fluid, alveolar epithelium (simple squamous epithelium), basement membrane of alveolar epithelium, thin interstitial space; basement membrane of capillary endothelium, and capillary endothelium (simple squamous epithelium).
13. C. Increasing the partial pressure difference increases diffusion of gases. The other changes listed decrease gas exchange.

14. C. Carbon dioxide is mostly (70%) transported as bicarbonate ions. It is also transported dissolved in plasma (7%) and bound to blood proteins (23%) such as the globin portion of hemoglobin. The heme portion of hemoglobin transports oxygen.

15. A. Because the partial pressure of carbon dioxide is lower in venous blood than in tissues, carbon dioxide diffuses from the tissues into the venous blood. The air in the alveoli has a lower partial pressure of carbon dioxide than blood, so carbon dioxide diffuses out of the blood into the alveolar air.

16. E. The medullary respiratory center stimulates the muscles of respiration and the pontine respiratory group plays a role in switching between inspiration and expiration. Input from receptors monitoring blood gas levels or body movements can reach threshold and stimulate inspiration. The cerebral cortex can voluntarily start or stop respiration, and can modify it for speech.

17. D. In response to stretch, the Hering-Breuer reflex is activated. It inhibits the respiratory center and stops inspiration.

18. C. The chemoreceptors most sensitive to oxygen are in the carotid and aortic bodies. However, it takes a large change in oxygen to produce a change in respiration through these receptors. The chemoreceptors in the medulla oblongata are most sensitive to small changes in carbon dioxide or pH, which are the chemical factors most important in the regulation of respiration.

19. D. Input from the cerebral motor cortex and from proprioceptors stimulates the respiratory center and causes an increase in respiration rate and depth during exercise. Blood oxygen and carbon dioxide levels do not change much during exercise if respiration is matched to the amount of exercise being performed.

20. D. In response to exercise training, tidal volume at rest does not change. At maximal exercise, tidal volume and respiratory rate increase, resulting in an increased minute ventilation compared to before training. The brain does learn to match ventilation to exercise intensity.

☆ FINAL CHALLENGES ☆

1. The inspiratory reserve volume is 3000 mL. It is equal to the vital capacity minus the sum of the tidal volume and the expiratory reserve, that is, 4500 - (500 + 1000) = 3000.

2. Compression causes a decrease in thoracic volume and therefore lung volume. Consequently, air pressure in the lungs increases over atmospheric pressure and air moves out of the lungs. Raising the arms expands the thorax and lungs. This produces an air pressure in the lungs that is lower than atmospheric pressure and air moves into the lungs.

3. The victim's lungs expand because of the pressure generated by the rescuer. This fills the victim's lungs with air that has a greater pressure than atmospheric pressure. Air flows out of the victim's lungs because of this pressure difference and because of the recoil of the victim's lungs. The partial pressure of oxygen in the rescuer's air is less than that of atmospheric air because the rescuer has used some of the oxygen. Nonetheless, it can provide enough oxygen to sustain the victim. In addition, the rescuer's air has a higher partial pressure of carbon dioxide than atmospheric air because the rescuer has added carbon dioxide. The increased carbon dioxide levels could help to stimulate the victim to take a breath by stimulating the chemoreceptors in the medulla oblongata.

4. The phrenic nerves supply the diaphragm. Damaging these nerves could paralyze the diaphragm and tidal volume could so greatly decrease that death might result. Damaging the spinal nerves to the intercostal muscles could inhibit movement of the ribs. This could decrease tidal volume unless the diaphragm compensates. Damaging the nerves from stretch receptors could block the Hering-Breuer reflex and tidal volume could increase.

5. While hyperventilating and making ready to leave your instructor behind you might make the following arguments:
   A. Hyperventilation increases the oxygen content of the air in the lungs. Therefore, you have more oxygen to use when holding your breath.
   B. Although hemoglobin is holding as much oxygen as it can, hyperventilation increases the amount of oxygen dissolved in plasma.
   C. Hyperventilation decreases the amount of carbon dioxide in the blood. This makes it possible to hold one's breath for a longer period of time because it decreases the urge to take a breath. This could be quite useful while underwater.