

## CHAPTER 11 –RESPIRATORY SYSTEM

### OBJECTIVES

**On completion of this chapter, you will be able to:**

- Describe the organs of the respiratory system.
- State the functions of the organs of the respiratory system.
- Define terms that physiologists and respiratory specialists use to describe the volume of air exchanged in breathing.
- State the vital function of respiration.
- Describe respiratory differences of the child and the older adult.
- Analyze, build, spell, and pronounce medical words.
- Comprehend the drugs highlighted in this chapter.
- Describe diagnostic and laboratory tests related to the respiratory system.
- Identify and define selected abbreviations.
- Describe each of the conditions presented in the Pathology Spotlights.
- Review the Pathology Checkpoint.
- Complete the Study and Review section and the Chart Note Analysis.

### OUTLINE

#### I. **Anatomy and Physiology Overview (Fig. 11–1, p. 331)**

The respiratory system consists of the nose, pharynx, larynx, trachea, bronchi, and lungs. Its primary function is to furnish oxygen for use by individual tissue cells and to take away carbon dioxide. This process is accomplished by the act of **respiration (R)**, which consists of **external** and **internal processes**.

- **External Respiration** – the process by which the lungs are ventilated and oxygen and carbon dioxide are exchanged between the air in the lungs and the blood within the capillaries of the alveoli.
- **Internal Respiration** – the process by which oxygen and carbon dioxide are exchanged between the blood in tissue capillaries and the cells of the body.

A. **Nose** – the projection in the center of the face; it consists of an **external** and **internal portion**. The nose is lined with **mucous** membrane, which is covered with **cilia**. The nose has five functions:

- Serves as an air passageway.
- Warms and moistens inhaled air.
- Its cilia and mucous membrane trap dust, pollen, bacteria, and other foreign matters.
- Contains olfactory receptors, which sort out odors.
- Aids in phonation and the quality of voice.

The nasal structures consist of:

1. **External Portion** – a triangle of cartilage and bone that is covered with skin and lined with **mucous membrane**.

- **Nostrils or Anterior Nares** – the external entrances of the nose.
2. **Internal Portion**
    - a. **Septum** – the partition that separates the nose into a right and a left cavity.
    - b. **Superior, Middle, and Inferior Conchae** – three air passages of the nasal cavities. These passages lead to the pharynx and are connected with the paranasal sinuses by openings, with the ears by the eustachian tube, and with the region of the eyes by nasolacrimal ducts.
    - c. **Palatine bones and maxillae** – separate the nasal cavities from the mouth cavity. A congenital defect known as *cleft palate* occurs when the palatine bones fail to unite during fetal development.
    - d. **Paranasal Sinuses (Fig. 11–2, p. 332)** – four cavities that drain into the nose. These are the *frontal*, *maxillary*, *ethmoidal*, and *sphenoidal* sinuses.
- B. Pharynx (Fig. 11–2, p. 332)** – or throat is a musculomembranous tube that extends from the base of the skull, lies anterior to the cervical vertebrae, and becomes continuous with the esophagus. It is divided of three portions:
1. **Nasopharynx** – located behind the nose.
    - a. **Adenoids or Pharyngeal Tonsils** – lymphoid tissue that aids in the filtering of bacteria and other foreign substances from the circulating lymph.
    - b. **Contains two openings from the posterior nares.**
    - c. **Contains two openings from the eustachian tubes.**
  2. **Oropharynx** – located behind the mouth.
    - a. **Faucial or Palatine Tonsils** – lymphoid tissue that aids in the filtering of bacteria and other foreign substances from the circulating lymph.
    - b. **Lingual Tonsils** – lymphoid tissue that aids in the filtering of bacteria and other foreign substances from the circulating lymph.
    - c. **The Fauces** – opening from the mouth into the oropharynx.
  3. **Laryngopharynx** – located behind the larynx.
    - a. Openings from the larynx and esophagus into this structure.
  4. **Functions of the Pharynx** – these include:
    - a. Passageway for air.
    - b. Passageway for food.
    - c. Aid in phonation by changing shape.
- C. Larynx (Figs. 11–1 and 11–2, pp. 331, 332)** – or voicebox, the larynx is a muscular, cartilaginous structure lined with mucous membrane. It is the

enlarged upper end of the trachea below the root of the tongue and hyoid bone.

1. **Cartilages of the Larynx**– the larynx is composed of nine cartilages bound together by muscles and ligaments. The three unpaired cartilages are the thyroid, cricoid, and epiglottis, and the three paired cartilages are the arytenoid, cuneiform, and corniculate.
    - a. **Thyroid Cartilage**– the largest cartilage in the larynx that is commonly called the *Adam’s apple*; larger in men and contributes to the deeper male voice.
    - b. **Epiglottis** – a small cartilage attached to the superior border of the thyroid cartilage. It covers the entrance of the larynx, and during swallowing, it acts as a lid to prevent aspiration of food into the trachea.
    - c. **Cricoid Cartilage** – the lowermost cartilage of the larynx. It is shaped like a signet ring with the broad portion being posterior and the anterior portion forming the arch and resembling the ring’s band.
  2. **The Cavity of the Larynx**– contains a pair of **ventricular folds** (false vocal cords) and a pair of **vocal folds** or true vocal cords. The cavity is divided into the following three regions: vestibule, ventricle, and entrance to the glottis. The **glottis** is a narrow slit at the opening between the true vocal folds.
  3. **Function of the Larynx** – to produce vocal sounds. High notes are formed by short, tense vocal cords. Low notes are produced by long, relaxed vocal cords.
- D. Trachea (Fig. 11–1, p. 331)** – or windpipe is a cartilaginous tube that is the air passageway extending from the pharynx and larynx to the main bronchi. Its function is to provide an open passageway for air to the lungs. It is composed of:
1. **Smooth Muscle** – that is reinforced at the front and side by C-shaped rings of cartilage.
  2. **Mucous membrane** – lining that contains **cilia**, which sweep foreign matter out of the passageway.
- E. Bronchi (Fig 11–1, p. 331)** – two main branches of the trachea, which provide the passageway for air to the lungs. They consist of:
1. **Right Bronchus** – larger and extends down in a more vertical direction than the left bronchus.
  2. **Left Bronchus**
  3. **Hilum** – the depression in the lungs where the bronchi enter.

4. **Bronchioles** – subdivisions of the bronchi.
5. **Alveoli** – are tiny air sacs supporting a network of capillaries from pulmonary blood vessels.

F. **Lungs (Fig. 11–4, p. 336)** – cone-shaped, spongy organs of respiration lying on either side of the heart within the pleural cavity of the thorax. They consist of elastic tissue filled with interlacing networks of tubes and sacs that carry air and with blood vessels carrying blood. The main function of the lungs is to bring air into intimate contact with blood so that oxygen and carbon dioxide can be exchanged in the alveoli. Structures of the lungs include:

1. **Pleura** – a serous membrane composed of six layers that enclose the lungs. The six layers of the pleura are:
  - a. **Costal**
  - b. **Parietal** – extends from the roots of the lungs and lines the walls of the thorax and the superior surface of the diaphragm.
  - c. **Pericardiaca**
  - d. **Phrenica**
  - e. **Pulmonalis**
  - f. **Visceral** – covers the surface of the lungs and enters into and lines the interlobar fissures.
2. **Pleural Cavity** – a space between parietal and visceral pleura and contains serous fluid that lubricates and prevents friction.
3. **Diaphragm** – the musculomembranous wall that separates the thoracic cavity from the abdominal cavity.
4. **Mediastinum** – is the central portion of the thoracic cavity, between the lungs, which contains the heart and other structures.
5. **Lung Base** – broad inferior surface of the lung which rests on the diaphragm.
6. **Lung Apex** – the pointed upper margin that lies above the sternal end of the first rib.
7. **Lobes (Fig. 11–4, p. 336)**
  - a. **Right Lung** – has three lobes.
  - b. **Left Lung** – has two lobes with an indentation, the **cardiac depression**, for the normal placement of the heart.

G. **Respiration**

1. **Volume** – the following are terms used to describe the volume of air exchanged in breathing:
  - a. **Tidal Volume (TV)** – amount of air in a single inspiration or expiration. Approximately 500 mL of air enters the respiratory tract in an adult male during normal quiet breathing.
  - b. **Supplemental Air** – amount of air that may be forcibly expired after a normal quiet respiration. This is also the

*expiratory reserve volume* and measures approximately 1200 mL.

- c. **Complemental Air** – amount of air that may be forcibly inspired over and above a normal inspiration; known as the *inspiratory reserve volume* (IRV); measures 3600 mL.
  - d. **Residual Volume (RV)** – amount of air remaining in the lungs after maximal expiration, approximately 1500 mL.
  - e. **Minimal Air** – small amount of air that remains in the alveoli.
  - f. **Vital Capacity (VC)** – volume of air that can be exhaled after a maximal inspiration. This amount equals the sum of the tidal air, complemental air, and the supplemental air.
  - g. **Functional Residual Capacity** – volume of air that remains in the lungs at the end of a normal expiration.
  - h. **Total Lung Capacity (TLC)** – maximal volume of air in the lungs after maximal inspiration.
2. **Vital Function of Respiration** – the process of respiration is interrelated with other systems of the body. The *medulla oblongata* and the *pons* of the central nervous system regulate and control respiration. Respiration, along with temperature, pulse, and blood pressure, is a vital sign that aids in determining an individual's state of health.
  3. **Respiratory Rate** – regulated by the respiratory center located in the medulla oblongata, the rate of respiration varies with different age groups as follows:
    - **Newborn**      **30 to 80 per minute**
    - **1<sup>st</sup> year**      **20 to 40 per minute**
    - **5<sup>th</sup> year**      **20 to 25 per minute**
    - **15<sup>th</sup> year**     **15 to 20 per minute**
    - **Adult**         **15 to 20 per minute**

## II. Life Span Considerations

- A. **The Child** – at 12 weeks gestation, the lungs of the fetus have a definite shape. At 20 weeks, the alveoli of the lungs are complete. At 24 weeks, the nostrils open and respiratory movements occur. At 28 to 32 weeks, **surfactant** is produced. This is a substance formed in the lungs that regulates the amount of surface tension of the fluid lining the alveoli. In preterm infants, the lack of surfactant contributes to respiratory distress syndrome.
  1. **Fetal Life** – gaseous exchange occurs at the placental interface.
  2. **Infant Life** – diaphragmatic abdominal breathing is common.
  3. **Children** – have a higher oxygen consumption and metabolic rates than adults and their airway diameter is smaller, so there is an increased potential for airway obstruction.
- B. **The Older Adult** – the respiratory system is vulnerable to injuries caused by infections, environmental pollutants, and allergic reactions.

Age-related changes include:

1. Decline in protection by intact mucous barrier.
2. Decrease in effectiveness of bronchial cilia.
3. Changes in composition of connective tissues of the lungs and chest.
4. Use of diaphragm for inspiration, and when lying down, breathing requires more effort.
5. Vital capacity declines.
6. Increase in stiffness of chest wall, which makes it more difficult to inspire or expire air.
7. Atrophy can occur in the pharynx and larynx muscle, causing slackening of the vocal cords and loss of elasticity. These changes can cause a gravelly, softer voice with a rise in pitch, making communication more difficult, especially if there is impaired hearing.

### III. Building Your Medical Vocabulary

A. **Medical Words and Definitions** – this section provides the foundation for learning medical terminology. Medical words can be made up of four types of word parts:

1. **Prefix (P)**
2. **Root (R)**
3. **Combining Forms (CF)**
4. **Suffixes (S)**

By connecting various word parts in an organized sequence, thousands of words can be built and learned. In the text, the word list is alphabetized so one can see the variety of meanings created when common prefixes and suffixes are repeatedly applied to certain word roots and/or combining forms. Words shown in *pink* are additional words related to the content of this chapter that have not been divided into word parts. Definitions identified with an *asterisk icon* (\*) indicate terms that are covered in the Pathology Spotlights section of the chapter.

### IV. Drug Highlights (Fig. 11-16, p. 350)

- A. **Antihistamines** – act to counter the effects of histamine by blocking histamine 1 (H<sub>1</sub>) receptors. They are used to treat allergy symptoms, prevent or control motion sickness, and in combination with cold remedies to decrease mucus secretion and produce bedtime sedation.
- B. **Decongestants** – act to constrict dilated arterioles in the nasal mucosa. These agents are used for temporary relief of nasal congestion associated with the common cold, hay fever, other upper respiratory allergies, and sinusitis.
- C. **Antitussives** – can be classified as:
1. **Non-narcotic Agents** – anesthetize the stretch receptors located in the respiratory passages, lungs, and pleura by dampening their activity and thereby reducing the cough reflex at its source.

2. **Narcotic Agents** – depress the cough center located in the medulla, thereby raising its threshold for incoming cough impulses.
- D. **Expectorants** – promote and facilitate the removal of mucus from the lower respiratory tract.
- E. **Mucolytics** – break chemical bonds in mucus, thereby lowering its thickness.
- F. **Bronchodilators** – used to improve pulmonary airflow by dilating air passages.
- G. **Inhalational Glucocorticoids** – used in the treatment of bronchial asthma and in seasonal or perennial allergic conditions when other forms of treatment are not effective.
- H. **Antituberculosis Agents** – used in long-term treatment of tuberculosis. Often used in combination of two or more drugs.

#### V. Diagnostic and Lab Tests

- A. **Acid-Fast Bacilli (AFB)** – test performed on sputum to detect the presence of *Mycobacterium tuberculosis*, an acid-fast bacillus. Positive test results indicate tuberculosis.
- B. **Antistreptolysin O (ASO)** – test performed on blood serum to detect the presence of streptolysin enzyme O, which is secreted by beta-hemolytic streptococcus. Positive results indicate streptococcal infection.
- C. **Arterial Blood Gases (ABGs)** – series of tests performed on arterial blood to establish acid-base balance. Important in determining respiratory acidosis, and/or alkalosis, metabolic acidosis and/or alkalosis.
- D. **Bronchoscopy** – visual examination of the larynx, trachea, and bronchi with a flexible bronchoscope. With the use of biopsy forceps, tissue and secretions can be removed for analysis.
- E. **Culture, Sputum** – examination of the sputum to determine the presence of *microorganisms*. Abnormal results can indicate tuberculosis, bronchitis, pneumonia, bronchiectasis, and other infectious respiratory diseases (RD).
- F. **Culture, Throat** – test to identify the presence of microorganisms in the throat, especially beta-hemolytic streptococci.
- G. **Laryngoscopy** – visual examination of the larynx via a laryngoscope.
- H. **Nasopharyngography** – x-ray examination of the nasopharynx.
- I. **Pulmonary Function Test** – series of tests performed to determine the diffusion of oxygen and carbon dioxide across the cell membrane in the lungs. Tests are done on all phases of respiration with abnormal results indicating various respiratory diseases and conditions.
- J. **Rhinocopy** – visual examination of nasal passageways.

#### VI. Abbreviations (p. 352)

#### VII. Pathology Spotlights

- A. **Apnea** – a temporary cessation of breathing. **Sleep Apnea** is the cessation of breathing during sleep. Sleep apnea is classified according to the mechanisms involved:
1. **Obstructive Apnea** – caused by an obstruction to the upper airway. Occurs most often in middle-aged men who are obese and have a history of excessive daytime sleepiness and is associated with loud snorting, snoring, and gasping sound.
  2. **Central Apnea** – marked by absence of respiratory muscle activity. A person with this type of apnea exhibits excessive daytime sleepiness, but the snorting and gasping sounds during sleep are absent.
- B. **Asthma (Fig. 11–17, p. 353)** – an inflammatory disease of the bronchi characterized by **wheezing**, **dyspnea**, and a feeling of **constriction** in the chest. Inflammation of the airways causes airflow into and out of the lungs to be restricted. Wheezing is the characteristic sound produced by breathing against an obstructed airway. Symptoms can be triggered by inhaled allergens, respiratory infections, exercise, cold air, tobacco smoke and other pollutants, stress, and food or drug allergies (**Fig. 11–18, p. 354**). Treatments are aimed at avoiding known allergens and respiratory irritants and controlling the airway inflammation through medication. There are two types of medications:
1. **Long-Term Control Medications** – used to prevent attacks.
  2. **Quick Relief Medications** – used to relieve symptoms during an attack.
- C. **Pneumonia (Fig. 11–19, p. 355)** – inflammation of the lung(s) caused by many different organisms including:
1. **Bacteria**
  2. **Viruses**
  3. **Fungi**
  4. **Chemical irritants**
- Symptoms include a cough with greenish mucus or puslike sputum, chills, fever, fatigue, chest pain, and muscle aches. Rales and other abnormal breathing sounds can be heard. Initial diagnosis is made through auscultation of the chest with a stethoscope. Tests that are used to confirm the diagnosis include a chest x-ray, and a sputum culture. Treatment of pneumonia is cause dependent.
- D. **Tuberculosis (TB)** – a contagious disease caused by the bacillus *Mycobacterium tuberculosis*, which is carried in **droplets**. Symptoms depend on where in the body the TB bacteria are growing. The disease is characterized by the development of **granulomas** in the infected tissues. TB bacteria usually grow in the lungs; symptoms include a chronic cough, hemoptysis, and — in the early stages — scanty, whitish or grayish-yellow frothy sputum. Other symptoms are fatigue, low-grade fever, night sweats, weakness, chills, anorexia, and weight loss. Diagnosis includes examination of the lungs by stethoscope (auscultation), which can reveal rales or crackles. Enlarged or tender lymph nodes can be present in the

neck or other areas. Fluid can be detected around a lung (pleural effusion). Test to confirm diagnosis often include a chest x-ray, sputum cultures, a tuberculin skin test, and bronchoscopy. Treatment requires long-term drug therapy, often using a regimen that includes a combination of antituberculosis agents. A balanced diet and rest are also important aspects of the treatment plan.

- E. Multidrug-Resistant TB (MDR TB)** – occurs when the TB bacteria becomes resistant to two of the drugs that are used to treat tuberculosis. This is one of the most alarming trends in health care.

### **VIII. Pathology Checkpoint**

### **IX. Study and Review (pp. 358–363)**

### **X. Practical Application: SOAP: Chart Note Analysis**