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The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. The respiratory system allows air to reach the lungs, from which oxygen enters the blood and circulates to all body cells. This system also removes waste gases from the body and helps prevent disease due to particulate matter.The respiratory system helps prevent the intake of harmful particles— such as dust, fumes, and mist — through coughing, sneezing, or swallowing.The respiratory system is made up of the nose, sinuses, lungs, diaphragm and other organs and structures.This article examines the various parts of the respiratory system, some respiratory conditions, and how a person breathes. It also looks at lung function and the processes of inhalation and exhalation.Click on the interactive Bodymap below to move around the model and read more about the respiratory system.The respiratory system is divided into an upper and lower respiratory tract. The upper tract comprises:the nose and nasal cavitythe sinusesthe pharynxthe larynxThe lower respiratory tract includes:the lungsthe tracheathe diaphragmThe sections below will look at each part of the respiratory system in more detail.Forming the main external opening of the respiratory system, the nose protects the anterior portion of the nasal cavity. The nose is also unique, as it is the only part of the system that is externally visible. The nasal cavity is the uppermost part of the respiratory system, divided into two by the nasal septum. It is the best entrance for outside air, as hairs and mucus line the inside wall and operate as air cleansers.Within this hollow space, the air is warmed, moisturized, and filtered before reaching the lungs. The nose prevents dust, mold, and other contaminants from reaching the lungs.The paranasal (meaning around the nose) sinuses are four paired, hollow spaces above and below the eyes. Sinuses develop after birth and reach their final size around the age of 20.The pharynx, or throat, is a versatile muscular tube, shaped like a funnel, that delivers air from the mouth and nose to the trachea, or windpipe. It also connects the nasal and oral cavities with the larynx and esophagus.The pharynx is key to the respiratory and digestive systems. It allows inhaled air to pass from the nasal cavity to the larynx, trachea, and lungs. A section of the pharynx called the nasopharynx hosts the epiglottis. This keeps the passage to the esophagus covered, preventing air from entering the digestive system.The larynx has a dual function in the respiratory system: as an air canal to the lungs (while stopping food and drink from blocking the airway) and as the “voice box” (which contains vocal cords for speech).The larynx is a 2-inch tube made up of nine cartilage pieces. It connects the pharynx with the trachea and is held together by ligaments, membranes, and fibrous tissue.The lungs are the primary organs of the respiratory system, as they perform a vital role in breathing: gas exchange.The air that a person breathes in through the nose and mouth contains oxygen and other gases. Oxygen enters the lungs, then the bloodstream, allowing the body to function normally. However, the lungs also take the carbon dioxide from the blood and release it into the air when a person breathes out.The grape-like sacs called alveoli in each lung allow the exchange of oxygen and carbon dioxide to take place.The trachea runs down the neck and upper chest. It is a wide, hollow tube that connects the larynx to the bronchi, or airways, of the lungs. Its most vital function is to enable airflow to and from the lungs. The fibroelastic membrane expands and contracts during inhalation and exhalation.The diaphragm is a dome-shaped sheet of muscle located below the lungs. It separates the chest from the abdomen. The diaphragm operates as the major muscle of respiration and aids breathing. The parasympathetic nervous system regulates the contraction and relaxation of the diaphragm and intercostal muscles.There are two phases of breathing: in and out. As a person inhales, the diaphragm contracts and moves downward. The space left in the chest allows the lungs to expand. Muscles in the ribs also help enlarge the chest cavity, pulling the rib cage upward and outward.Once the lungs expand, air moves in through the nose and mouth. The air travels down the trachea and into the lungs, allowing a person to breathe.The exchange of oxygen and carbon dioxide occurs before exhalation. When a person exhales, the diaphragm relaxes, the lungs recoil, and the air moves out of the lungs.Due to the complex nature of the respiratory system, many health conditions can affect it. The following sections will look at some respiratory conditions in more detail.Asthma is a chronic, long-term inflammatory condition that affects the airways. Symptoms are variable and recurring, including coughing, chest tightness, and shortness of breath. According to the Centers for Disease Control and Prevention (CDC), around 7.7% of adults in the United States have asthma.People who smoke heavily may experience inflammation of the airways, which makes it difficult for the lungs to inhale and exhale enough air.Symptoms of COPD include breathlessness, a persistent cough, and frequent chest infections. Learn about COPD triggers here.A symptom of bronchitis is an inflammation of the lung airways. When the airways are inflamed, they produce too much mucus, which causes coughing, wheezing, and fatigue. A doctor may treat bronchitis with antibiotics and recommend that a person drinks plenty of fluids to dilute the thick mucus in the airways.Sinusitis can cause inflammation of the air cavities within the nose and lead to facial pain, headache, and a blocked or runny nose. It usually develops due to an infection and is treatable with nasal sprays, fluids, pain relievers, and decongestants.Bacteria, viruses, and fungi can all cause pneumonia. Symptoms include a high temperature, a cough, difficulty breathing, and chest pain. A doctor will usually treat pneumonia with antibiotics. They may also recommend hospitalization for serious cases.There are two types of lung cancer: small cell and non-small cell lung cancer. They require different treatments, which will depend on how far the condition has progressed.Lung cancer is dangerous because many people do not have any symptoms until the condition is in an advanced stage.On average, people breathe 10–20 times per minute. This means that having an efficient respiratory system is essential to quality of life. If the lungs do not exchange oxygen and carbon dioxide efficiently, it can lead to health issues such as shortness of breath and fatigue. With so many working parts, keeping the respiratory system healthy is important. People can do this by avoiding smoking, eating a healthful diet, and exercising regularly. AsthmaCOPDLung CancerRespiratory The respiratory system consists of several parts, including: 1. Nose and Nasal Cavity: The main entry and exit point for air. 2. Pharynx: A tube that serves as a passageway for both air and food. 3. Larynx: Also known as the voice box, it's responsible for sound production. 4. Trachea: Also known as the windpipe, it's a tube that directs air into the lungs. 5. Bronchi: Two tubes that branch off from the trachea and lead to the lungs. 6. Lungs: Organs that extract oxygen from the air and remove carbon dioxide from the body. 7. Bronchioles: Small branches of the bronchi that lead to the alveoli. 8. Alveoli: Tiny air sacs in the lungs where gas exchange occurs.Analogy / Example Breathe life into your understanding with our guide on the respiratory system anatomy and physiology. Nursing students, immerse yourself in the intricate dance of inhalation and exhalation that fuels every living moment. The functions of the respiratory system are: Oxygen supplier. The job of the respiratory system is to keep the body constantly supplied with oxygen. Elimination. Elimination of carbon dioxide. Gas exchange. The respiratory system organs oversee the gas exchanges that occur between the blood and the external environment. Passageway. Passageways that allow air to reach the lungs. Humidifier. Purify, humidify, and warm incoming air. The organs of the respiratory system include the nose, pharynx, larynx, trachea, bronchi, and their smaller branches, and the lungs, which contain the alveoli. The nose is the only externally visible part of the respiratory system. Nostrils. During breathing, air enters the nose by passing through the nostrils, or nares. Nasal cavity. The interior of the nose consists of the nasal cavity, divided by a midline nasal septum. Olfactory receptors. The olfactory receptors for the sense of smell are located in the mucosa in the slitlike superior part of the nasal cavity, just beneath the ethmoid bone. Respiratory mucosa. The rest of the mucosal lining, the nasal cavity called the respiratory mucosa, rests on a rich network of thin-walled veins that warms the air as it flows past. Mucus. In addition, the sticky mucus produced by the mucosa’s glands moistens the air and traps incoming bacteria and other foreign debris, and lysozyme enzymes in the mucus destroy bacteria chemically. Ciliated cells. The ciliated cells of the nasal mucosa create a gentle current that moves the sheet of contaminated mucus posteriorly toward the throat, where it is swallowed and digested by stomach juices. Conchae. The lateral walls of the nasal cavity are uneven owing to three mucosa-covered projections, or lobes called conchae, which greatly increase the surface area of the mucosa exposed to the air, and also increase the air turbulence in the nasal cavity. Palate. The nasal cavity is separated from the oral cavity below by a partition, the palate; anteriorly, where the palate is supported by bone, is the hard palate; the unsupported posterior part is the soft palate. Paranasal sinuses. The nasal cavity is surrounded by a ring of paranasal sinuses located in the frontal, sphenoid, ethmoid, and maxillary bones; theses sinuses lighten the skull, and they act as a resonance chamber for speech. Size. The pharynx is a muscular passageway about 13 cm (5 inches) long that vaguely resembles a short length of red garden hose. Function. Commonly called the throat, the pharynx serves as a common passageway for food and air. Portions of the pharynx. Air enters the superior portion, the nasopharynx, from the nasal cavity and then descends through the oropharynx and laryngopharynx to enter the larynx below. Pharyngotympanic tube. The pharyngotympanic tubes, which drain the middle ear open into the nasopharynx. Pharyngeal tonsil. The pharyngeal tonsil, often called adenoid is located high in the nasopharynx. Palatine tonsils. The palatine tonsils are in the oropharynx at the end of the soft palate. Lingual tonsils. The lingual tonsils lie at the base of the tongue. The larynx or voice box routes air and food into the proper channels and plays a role in speech. Structure. Located inferior to the pharynx, it is formed by eight rigid hyaline cartilages and a spoon-shaped flap of elastic cartilage, the epiglottis. Thyroid cartilage. The largest of the hyaline cartilages is the shield-shaped thyroid cartilage, which protrudes anteriorly and is commonly called Adam’s apple. Epiglottis. Sometimes referred to as the “guardian of the airways”, the epiglottis protects the superior opening of the larynx. Vocal folds. Part of the mucous membrane of the larynx forms a pair of folds, called the vocal folds, or true vocal cords, which vibrate with expelled air and allows us to speak. Glottis. The slitlike passageway between the vocal folds is the glottis. Length. Air entering the trachea or windpipe from the larynx travels down its length (10 to 12 cm or about 4 inches) to the level of the fifth thoracic vertebra, which is approximately midchest. Structure. The trachea is fairly rigid because its walls are reinforced with C-shaped rings of hyaline cartilage; the open parts of the rings abut the esophagus and allow it to expand anteriorly when we swallow a large piece of food, while the solid portions support the trachea walls and keep it patent, or open, in spite of the pressure changes that occur during breathing. Cilia. The trachea is lined with ciliated mucosa that beat continuously and in a direction opposite to that of the incoming air as they propel mucus, loaded with dust particles and other debris away from the lungs to the throat, where it can be swallowed or spat out. Main Bronchi Structure. The right and left main (primary) bronchi are formed by the division of the trachea. Location. Each main bronchus runs obliquely before it plunges into the medial depression of the lung on its own side. Size. The right main bronchus is wider, shorter, and straighter than the left. Location. The lungs occupy the entire thoracic cavity except for the most central area, the mediastinum, which houses the heart, the great blood vessels, bronchi, esophagus, and other organs. Apex. The narrow, superior portion of each lung, the apex, is just deep into the clavicle. Base. The broad lung area resting on the diaphragm is the base. Division. Each lung is divided into lobes by fissures; the left lung has two lobes, and the right lung has three. Pleura. The surface of each lung is covered with a visceral serosa called the pulmonary, or visceral pleura, and the walls of the thoracic cavity are lined by the parietal pleura. Pleural fluid. The pleural membranes produce pleural fluid, a slippery serous secretion that allows the lungs to glide easily over the thorax wall during breathing movements and causes the two pleural layers to cling together. Pleural space. The lungs are held tightly to the thorax wall, and the pleural space is more of a potential space than an actual one. Bronchioles. The smallest of the conducting passageways are the bronchioles. Alveoli. The terminal bronchioles lead to the respiratory zone structures, even smaller conduits that eventually terminate in alveoli or air sacs. Respiratory zone. The respiratory zone, which includes the respiratory bronchioles, alveolar ducts, alveolar sacs, and alveoli, is the only site of gas exchange. Conducting zone structures. All other respiratory passages are conducting zone structures that serve as conduits to and from the respiratory zone. Stroma. The balance of the lung tissue, its stroma, is mainly elastic connective tissue that allows the lungs to recoil passively as we exhale. Wall structure. The walls of the alveoli are composed largely of a single, thin layer of squamous epithelial cells. Alveolar pores. Alveolar pores connect neighboring air sacs and provide alternative routes for air to reach alveoli whose feeder bronchioles have been clogged by mucus or otherwise blocked. Respiratory membrane. Together, the alveolar and capillary walls, their fused basement membranes, and occasional elastic fibers construct the respiratory membrane (air-blood barrier), which has gas (air) flowing past on one side and blood flowing past on the other. Alveolar macrophages. Remarkably efficient alveolar macrophages sometimes called “dust cells”, wander in and out of the alveoli picking up bacteria, carbon particles, and other debris. Cuboidal cells. Also scattered amid the epithelial cells that form most of the alveolar walls are chunky cuboidal cells, which produce a lipid (fat) molecule called surfactant, which coats the gas-exposed alveolar surfaces and is very important in lung function. The major function of the respiratory system is to supply the body with oxygen and to dispose of carbon dioxide. To do this, at least four distinct events, collectively called respiration, must occur. Pulmonary ventilation. Air must move into and out of the lungs so that gasses in the air sacs are continuously refreshed, and this process is commonly called breathing. External respiration. Gas exchange between the pulmonary blood and alveoli must take place. Respiratory gas transport. Oxygen and carbon dioxide must be transported to and from the lungs and tissue cells of the body via the bloodstream. Internal respiration. At systemic capillaries, gas exchanges must be made between the blood and tissue cells. Rule. Volume changes lead to pressure changes, which lead to the flow of gasses to equalize pressure. Inspiration. Air is flowing into the lungs; the chest is expanded laterally, the rib cage is elevated, and the diaphragm is depressed and flattened; lungs are stretched to the larger thoracic volume, causing the intrapulmonary pressure to fall and air to flow into the lungs. Expiration. Air is leaving the lungs; the chest is depressed and the lateral dimension is reduced, the rib cage is descended, and the diaphragm is elevated and dome-shaped; lungs recoil to a smaller volume, intrapulmonary pressure rises, and air flows out of the lung. Intrapulmonary volume. Intrapulmonary volume is the volume within the lungs. Intrapleural pressure. The normal pressure within the pleural space, the intrapleural pressure, is always negative, and this is the major factor preventing the collapse of the lungs. Nonrespiratory air movements. Nonrespiratory movements are a result of reflex activity, but some may be produced voluntarily such as coughing, sneezing, crying, laughing, hiccups, and yawning. Tidal volume. Normal quiet breathing moves approximately 500 ml of air into and out of the lungs with each breath. Inspiratory reserve volume. The amount of air that can be taken in forcibly over the tidal volume is the inspiratory reserve volume, which is normally between 2100 ml to 3200 ml. Expiratory reserve volume. The amount of air that can be forcibly exhaled after a tidal expiration, the expiratory reserve volume, is approximately 1200 ml. Residual volume. Even after the most strenuous expiration, about 1200 ml of air still remains in the lungs and it cannot be voluntarily expelled; this is called residual volume, and it is important because it allows gas exchange to go on continuously even between breaths and helps to keep the alveoli inflated. Vital capacity. The total amount of exchangeable air is typically around 4800 ml in healthy young men, and this respiratory capacity is the vital capacity, which is the sum of the tidal volume, inspiratory reserve volume, and expiratory reserve volume. Dead space volume. Much of the air that enters the respiratory tract remains in the conducting zone passageways and never reaches the alveoli; this is called the dead space volume and during a normal tidal breath, it amounts to about 150 ml. Functional volume. The functional volume, which is the air that actually reaches the respiratory zone and contributes to gas exchange, is about 350 ml. Spirometer. Respiratory capacities are measured with a spirometer, wherein as a person breathes, the volumes of air exhaled can be read on an indicator, which shows the changes in air volume inside the apparatus. Bronchial sounds. Bronchial sounds are produced by air rushing through the large respiratory passageways (trachea and bronchi). Vesicular breathing sounds. Vesicular breathing sounds occur as air fills the alveoli, and they are soft and resemble a muffled breeze. External respiration. External respiration or pulmonary gas exchange involves oxygen being loaded and carbon dioxide being unloaded from the blood. Internal respiration. In internal respiration or systemic capillary gas exchange, oxygen is unloaded and carbon dioxide is loaded into the blood. Gas transport. Oxygen is transported in the blood in two ways: most attaches to hemoglobin molecules inside the RBCs to form oxyhemoglobin, or a very small amount of oxygen is carried dissolved in the plasma; while carbon dioxide is transported in plasma as bicarbonate ion, or a smaller amount (between 20 to 30 percent of the transported carbon dioxide) is carried inside the RBCs bound to hemoglobin. Neural Regulation Phrenic and intercostal nerves. These two nerves regulate the activity of the respiratory muscles, the diaphragm, and external intercostals. Medulla and pons. Neural centers that control respiratory rhythm and depth are located mainly in the medulla and pons; the medulla, which sets the basic rhythm of breathing, contains a pacemaker, or self-exciting inspiratory center, and an expiratory center that inhibits the pacemaker in a rhythmic way; pons centers appear to smooth out the basic rhythm of inspiration and expiration set by the medulla. Eupnea. The normal respiratory rate is referred to as eupnea, and it is maintained at a rate of 12 to 15 respirations/minute. Hyperpnea. During exercise, we breathe more vigorously and deeply because the brain centers send more impulses to the respiratory muscles, and this respiratory pattern is called hyperpnea. Non-neural Factors Influencing Respiratory Rate and Depth Physical factors. Although the medulla’s respiratory centers set the basic rhythm of breathing, there is no question that physical factors such as talking, coughing, and exercising can modify both the rate and depth of breathing, as well as an increased body temperature, which increases the rate of breathing. Volition (conscious control). Voluntary control of breathing is limited, and the respiratory centers will simply ignore messages from the cortex (our wishes) when the oxygen supply in the blood is getting low or blood pH is falling. Emotional factors. Emotional factors also modify the rate and depth of breathing through reflexes initiated by emotional stimuli acting through centers in the hypothalamus. Chemical factors. The most important factors that modify respiratory rate and depth are chemical- the levels of carbon dioxide and oxygen in the blood; increased levels of carbon dioxide and decreased blood pH are the most important stimuli leading to an increase in the rate and depth of breathing, while a decrease in oxygen levels become important stimuli when the levels are dangerously low. Hyperventilation. Hyperventilation blows off more carbon dioxide and decreases the amount of carbonic acid, which returns blood pH to the normal range when carbon dioxide or other sources of acids begin to accumulate in the blood. Hypoventilation. Hypoventilation or extremely slow or shallow breathing allows carbon dioxide to accumulate in the blood and brings blood pH back into normal range when blood starts to become slightly alkaline. Respiratory efficiency is reduced with age. They are unable to compensate for increased oxygen need and are significantly increasing the amount of air inspired. Therefore, difficulty in breathing is usually common especially during activities. Expiratory muscles become weaker so their cough efficiency is reduced and the amount of air left in the lungs is increased. Health promotion teaching can include smoking cessation, preventing respiratory infections through handwashing, and ensuring up to date influenza and pneumonia vaccinations. Craving more insights? Dive into these related materials to enhance your study journey! Anatomy and Physiology Nursing Test Banks. This nursing test bank includes questions about Anatomy and Physiology and its related concepts such as: structure and functions of the human body, nursing care management of patients with conditions related to the different body systems.

FacebookEmailPrintBufferPinterestShare MeSH Heading Respiratory System Tree Number(s) A04 Unique IDD012137 RDF Unique Identifier Annotationgeneral or unspecified; prefer specifics; /abnorm: RESPIRATORY SYSTEM ABNORMALITIES is available but consider also specific part of respiratory system with /abnorm or specific abnormality Scope NoteThe tubular and cavernous organs and structures, by means of which pulmonary ventilation and gas exchange between ambient air and the blood are brought about. Entry Term(s) Respiratory Tract Entry Combination abnormalities:Respiratory System Abnormalities physiology:Respiratory Physiological Phenomena Date Established 1966/01/01 Date of Entry 1999/01/01 Revision Date 2022/05/23 Respiratory System Preferred Concept UIM0018913 Scope NoteThe tubular and cavernous organs and structures, by means of which pulmonary ventilation and gas exchange between ambient air and the blood are brought about. Terms Respiratory System Preferred Term Term UI T036154 Date01/01/1999 LexicalTag NON ThesaurusID NLM (1966) Respiratory Tract Term UI T036155 Date05/25/1979 LexicalTag NON ThesaurusID UNK (19XX) By the end of this section, you will be able to: List the structures that make up the respiratory system Describe how the respiratory system processes oxygen and CO_2 Compare and contrast the functions of upper respiratory tract with the lower respiratory tract The major organs of the respiratory system function primarily to provide oxygen to body tissues for cellular respiration, remove the waste product carbon dioxide, and help to maintain acid-base balance. Portions of the respiratory system are also used for non-vital functions, such as sensing odors, speech production, and for straining, such as during childbirth or coughing (Figure 22.1.1). Figure 22.1.1 – Major Respiratory Structures: The major respiratory structures span the nasal cavity to the diaphragm. Functionally, the respiratory system can be divided into a conducting zone and a respiratory zone. The conducting zone of the respiratory system includes the organs and structures not directly involved in gas exchange. The gas exchange occurs in the respiratory zone. The major functions of the conducting zone are to provide a route for incoming and outgoing air, remove debris and pathogens from the incoming air, and warm and humidify the incoming air. Several structures within the conducting zone perform other functions as well. The epithelium of the nasal passages, for example, is essential to sensing odors, and the bronchial epithelium that lines the lungs can metabolize some airborne carcinogens. The major entrance and exit for the respiratory system is through the nose. When discussing the nose, it is helpful to divide it into two major sections: the external nose, and the nasal cavity or internal nose. The external nose consists of the surface and skeletal structures that result in the outward appearance of the nose and contribute to its numerous functions (Figure 22.1.2). The root is the region of the nose located between the eyebrows. The bridge is the part of the nose that connects the root to the rest of the nose. The dorsum nasi is the length of the nose. The apex is the tip of the nose. On either side of the apex, the nostrils are formed by the alae (singular = ala). An ala is a cartilaginous structure that forms the lateral side of each naris (plural = nares), or nostril opening. The philtrum is the concave surface that connects the apex of the nose to the upper lip. Figure 22.1.2 – Nose: This illustration shows features of the external nose (top) and skeletal features of the nose (bottom). Underneath the thin skin of the nose are its skeletal features (see Figure 22.1.2, lower illustration). While the root and bridge of the nose consist of bone, the protruding portion of the nose is composed of cartilage. As a result, when looking at a skull, the nose is missing. The nasal bone is one of a pair of bones that lies under the root and bridge of the nose. The nasal bone articulates superiorly with the frontal bone and laterally with the maxillary bones. Septal cartilage is flexible hyaline cartilage connected to the nasal bone, forming the dorsum nasi. The alar cartilage consists of the apex of the nose; it surrounds the naris. The nares open into the nasal cavity, which is separated into left and right sections by the nasal septum (Figure 22.1.3). The nasal septum is formed anteriorly by a portion of the septal cartilage (the flexible portion you can touch with your fingers) and posteriorly by the perpendicular plate of the ethmoid bone (a cranial bone located just posterior to the nasal bones) and the thin vomer bones (whose name refers to its plough shape). Each lateral wall of the nasal cavity has three bony projections, called the superior, middle, and inferior nasal conchae. The inferior conchae are separate bones, whereas the superior and middle conchae are portions of the ethmoid bone. Conchae serve to increase the surface area of the nasal cavity and to disrupt the flow of air as it enters the nose, causing air to bounce along the epithelium, where it is cleaned and warmed. The conchae and meatuses also conserve water and prevent dehydration of the nasal epithelium by trapping water during exhalation. The floor of the nasal cavity is composed of the palate. The hard palate at the anterior region of the nasal cavity is composed of bone. The soft palate at the posterior portion of the nasal cavity consists of muscle tissue. Air exits the nasal cavities via the internal nares and moves into the pharynx. Figure 22.1.3 Upper Airway Several bones that help form the walls of the nasal cavity have air-containing spaces called the paranasal sinuses, which serve to warm and humidify incoming air. Sinuses are lined with a mucosa. Each paranasal sinus is named for its associated bone: frontal sinus, maxillary sinus, sphenoidal sinus, and ethmoidal sinus. The sinuses produce mucus and lighten the weight of the skull. The nares and anterior portion of the nasal cavities are lined with mucous membranes, containing sebaceous glands and hair follicles that serve to prevent the passage of large debris, such as dirt, through the nasal cavity. An olfactory epithelium used to detect odors is found deeper in the nasal cavity. The conchae, meatuses, and paranasal sinuses are lined by respiratory epithelium composed of pseudostratified ciliated columnar epithelium (Figure 22.1.4). The epithelium contains goblet cells, one of the specialized, columnar epithelial cells that produce mucus to trap debris. The cilia of the respiratory epithelium help remove the mucus and debris from the nasal cavity with a constant beating motion, sweeping materials towards the throat to be swallowed. Interestingly, cold air slows the movement of the cilia, resulting in accumulation of mucus that may in turn lead to a runny nose during cold weather. This moist epithelium functions to warm and humidify incoming air. Capillaries located just beneath the nasal epithelium warm the air by convection. Serous and mucus-producing cells also secrete the lysozyme enzyme and proteins called defensins, which have antibacterial properties. Immune cells that patrol the connective tissue deep to the respiratory epithelium provide additional protection. Figure 22.1.4 – Pseudostratified Ciliated Columnar Epithelium: Respiratory epithelium is pseudostratified ciliated columnar epithelium. Seromucous glands provide lubricating mucus. LM × 680. (Micrograph provided by the Regents of University of Michigan Medical School © 2012) The pharynx is a tube formed by skeletal muscle and lined by mucous membrane that is continuous with that of the nasal cavities (see Figure 22.1.3). The pharynx is divided into three major regions: the nasopharynx, the oropharynx, and the laryngopharynx (Figure 22.1.5). Figure 22.1.5 – Divisions of the Pharynx: The pharynx is divided into three regions: the nasopharynx, the oropharynx, and the laryngopharynx. The nasopharynx is flanked by the conchae of the nasal cavity, and it serves only as an airway. At the top of the nasopharynx are the pharyngeal tonsils. A pharyngeal tonsil, also called an adenoid, is an aggregate of lymphoid reticular tissue similar to a lymph node that lies at the superior portion of the nasopharynx. The function of the pharyngeal tonsil is not well understood, but it contains a rich supply of lymphocytes and is covered with ciliated epithelium that traps and destroys invading pathogens that enter during inhalation. The pharyngeal tonsils are large in children, but interestingly, tend to regress with age and may even disappear. The uvula is a small bulbous, teardrop-shaped structure located at the apex of the soft palate. Both the uvula and soft palate move like a pendulum during swallowing, swinging upward to close off the nasopharynx to prevent ingested materials from entering the nasal cavity. In addition, auditory (Eustachian) tubes that connect to each middle ear cavity open into the nasopharynx. This connection is why colds often lead to ear infections. The oropharynx is a passageway for both air and food. The oropharynx is bordered superiorly by the nasopharynx and anteriorly by the oral cavity. The fauces is the opening at the connection between the oral cavity and the oropharynx. As the nasopharynx becomes the oropharynx, the epithelium changes from pseudostratified ciliated columnar epithelium to stratified squamous epithelium. The oropharynx contains two distinct sets of tonsils, the palatine and lingual tonsils. A palatine tonsil is one of a pair of structures located laterally in the oropharynx in the area of the fauces. The lingual tonsil is located at the base of the tongue. Similar to the pharyngeal tonsil, the palatine and lingual tonsils are composed of lymphoid tissue, and trap and destroy pathogens entering the body through the oral or nasal cavities. The laryngopharynx is inferior to the oropharynx and posterior to the larynx. It continues the route for ingested material and air until its inferior end, where the digestive and respiratory systems diverge. The stratified squamous epithelium of the oropharynx is continuous with the laryngopharynx. Anteriorly, the laryngopharynx opens into the larynx, whereas posteriorly, it enters the esophagus. The larynx is a cartilaginous structure inferior to the laryngopharynx that connects the pharynx to the trachea and helps regulate the volume of air that enters and leaves the lungs (Figure 22.1.6). The structure of the larynx is formed by several pieces of cartilage. Three large cartilage pieces—the thyroid cartilage (anterior), epiglottis (superior), and cricoid cartilage (inferior)—form the major structure of the larynx. The thyroid cartilage is the largest piece of cartilage that makes up the larynx. The thyroid cartilage consists of the laryngeal prominence, or “Adam’s apple,” which tends to be more prominent in males. The thick cricoid cartilage forms a ring, with a wide posterior region and a thinner anterior region. Three smaller, paired cartilages—the arytenoids, corniculates, and cuneiforms—attach to the epiglottis and the vocal cords and muscle that help move the vocal cords to produce speech. Figure 22.1.6 – Larynx: The larynx extends from the laryngopharynx and the hyoid bone to the trachea. The epiglottis, attached to the thyroid cartilage, is a very flexible piece of elastic cartilage that covers the opening of the trachea (see Figure 22.1.3). When in the “closed” position, the unattached end of the epiglottis rests on the glottis. The glottis is composed of the vestibular folds, the true vocal cords, and the space between these folds (Figure 22.1.7). A vestibular fold, or false vocal cord, is one of a pair of folded sections of mucous membrane. A true vocal cord is one of the white, membranous folds attached by muscle to the thyroid and arytenoid cartilages of the larynx on their outer edges. The inner edges of the true vocal cords are free, allowing oscillation to produce sound. The size of the membranous folds of the true vocal cords differs between individuals, producing voices with different pitch ranges. Folds in males tend to be larger than those in females, which create a deeper voice. The act of swallowing causes the pharynx and larynx to lift upward, allowing the pharynx to expand and the epiglottis of the larynx to swing downward, closing the opening to the trachea. These movements produce a larger area for food to pass through, while preventing food and beverages from entering the trachea. Figure 22.1.7 – Vocal Cords: The true vocal cords and vestibular folds of the larynx are viewed inferiorly from the laryngopharynx. Continuous with the laryngopharynx, the superior portion of the larynx is lined with stratified squamous epithelium, transitioning into pseudostratified ciliated columnar epithelium that contains goblet cells. Similar to the nasal cavity and nasopharynx, this specialized epithelium produces mucus to trap debris and pathogens as they enter the trachea. The cilia beat the mucus upward towards the laryngopharynx, where it can be swallowed down the esophagus. The trachea (windpipe) extends from the larynx toward the lungs (Figure 22.1.8a). The trachea is formed by 16 to 20 stacked, C-shaped pieces of hyaline cartilage that are connected by dense connective tissue. The trachealis muscle and elastic connective tissue together form the fibroelastic membrane, a flexible membrane that closes the posterior surface of the trachea, connecting the C-shaped cartilages. The fibroelastic membrane allows the trachea to stretch and expand slightly during inhalation and exhalation, whereas the rings of cartilage provide structural support and prevent the trachea from collapsing. In addition, the trachealis muscle can be contracted to force air through the trachea during exhalation. The trachea is lined with pseudostratified ciliated columnar epithelium, which is continuous with the larynx. The esophagus borders the trachea posteriorly. Figure 22.1.8 – Trachea: (a) The tracheal tube is formed by stacked, C-shaped pieces of hyaline cartilage. (b) The layer visible in this cross-section of tracheal wall tissue between the hyaline cartilage and the lumen of the trachea is the mucosa, which is composed of pseudostratified ciliated columnar epithelium that contains goblet cells. LM × 1220. (Micrograph provided by the Regents of University of Michigan Medical School © 2012) The trachea branches into the right and left primary bronchi at the carina. These bronchi are also lined by pseudostratified ciliated columnar epithelium containing mucus-producing goblet cells (Figure 22.1.8b). The carina is a raised structure that contains specialized nervous tissue that induces violent coughing if a foreign body, such as food, is present. Rings of cartilage, similar to those of the trachea, support the structure of the bronchi and prevent their collapse. The primary bronchi enter the lungs at the hilum, a concave region where blood vessels, lymphatic vessels, and nerves also enter the lungs. The bronchi continue to branch into bronchial a tree. A bronchial tree (or respiratory tree) is the collective term used for these multiple-branched bronchi. The main function of the bronchi, like other conducting zone structures, is to provide a passageway for air to move into and out of each lung. In addition, the mucous membrane traps debris and pathogens. A bronchiole branches from the tertiary bronchi. Bronchioles, which are about 1 mm in diameter, further branch until they become the tiny terminal bronchioles, which lead to the structures of gas exchange. There are more than 1000 terminal bronchioles in each lung. The muscular walls of the bronchioles do not contain cartilage like those of the bronchi. This muscular wall can change the size of the tubing to increase or decrease airflow through the tube. In contrast to the conducting zone, the respiratory zone includes structures that are directly involved in gas exchange. The respiratory zone begins where the terminal bronchioles join a respiratory bronchiole, the smallest type of bronchiole (Figure 22.1.9), which then leads to an alveolar duct, opening into a cluster of alveoli. Figure 22.1.9 – Respiratory Zone: Bronchioles lead to alveolar sacs in the respiratory zone, where gas exchange occurs. An alveolar duct is a tube composed of smooth muscle and connective tissue, which opens into a cluster of alveoli. An alveolus is one of the many small, grape-like sacs that are attached to the alveolar ducts. An alveolar sac is a cluster of many individual alveoli that are responsible for gas exchange. An alveolus is approximately 200 μm in diameter with elastic walls that allow the alveolus to stretch during air intake, which greatly increases the surface area available for gas exchange. Alveoli are connected to their neighbors by alveolar pores, which help maintain equal air pressure throughout the alveoli and lung (Figure 22.1.10). Figure 22.1.10 – Structures of the Respiratory Zone: (a) The alveolus is responsible for gas exchange. (b) A micrograph shows the alveolar structures within lung tissue. LM × 178. (Micrograph provided by the Regents of University of Michigan Medical School © 2012) The alveolar wall consists of three major cell types: type I alveolar cells, type II alveolar cells, and alveolar macrophages. A type I alveolar cell is a squamous epithelial cell of the alveoli, which constitute up to 97 percent of the alveolar surface area. These cells are about 25 nm thick and are highly permeable to gases. A type II alveolar cell is interspersed among the type I cells and secretes pulmonary surfactant, a substance composed of phospholipids and proteins that reduces the surface tension of the alveoli. Roaming around the alveolar wall is the alveolar macrophage, a phagocytic cell of the immune system that removes debris and pathogens that have reached the alveoli. The simple squamous epithelium formed by type I alveolar cells is attached to a thin, elastic basement membrane. This epithelium is extremely thin and borders the endothelial membrane of capillaries. Taken together, the alveoli and capillary membranes form a respiratory membrane that is approximately 0.5 mm thick. The respiratory membrane allows gases to cross by simple diffusion, allowing oxygen to be picked up by the blood for transport and CO_2 to be released into the air of the alveoli. Diseases of the…Respiratory System: Asthma Asthma is common condition that affects the lungs in both adults and children. Approximately 8.2 percent of adults (18.7 million) and 9.4 percent of children (7 million) in the United States suffer from asthma. In addition, asthma is the most frequent cause of hospitalization in children. Asthma is a chronic disease characterized by inflammation and edema of the airway, and bronchospasms (that is, constriction of the bronchioles), which can inhibit air from entering the lungs. In addition, excessive mucus secretion can occur, which further contributes to airway occlusion (Figure 22.1.11). Cells of the immune system, such as eosinophils and mononuclear cells, may also be involved in infiltrating the walls of the bronchi and bronchioles. Bronchospasms occur periodically and lead to an “asthma attack.” An attack may be triggered by environmental factors such as dust, pollen, pet hair, or dander, changes in the weather, mold, tobacco smoke, and respiratory infections, or by exercise and stress. Figure 22.1.11 – Normal and Bronchial Asthma Tissues: (a) Normal lung tissue does not have the characteristics of lung tissue during (b) an asthma attack, which include thickened mucosa, increased mucus-producing goblet cells, and eosinophil infiltrates. Symptoms of an asthma attack involve coughing, shortness of breath, wheezing, and tightness of the chest. Symptoms of a severe asthma attack that requires immediate medical attention would include difficulty breathing that results in blue (cyanotic) lips or face, confusion, drowsiness, a rapid pulse, sweating, and severe anxiety. The severity of the condition, frequency of attacks, and identified triggers influence the type of medication that an individual may require. Longer-term treatments are used for those with more severe asthma. Short-term, fast-acting drugs that are used to treat an asthma attack are typically administered via an inhaler. For young children or individuals who have difficulty using an inhaler, asthma medications can be administered via a nebulizer. In many cases, the underlying cause of the condition is unknown. However, recent research has demonstrated that certain viruses, such as human rhinovirus C (HRVC), and the bacteria Mycoplasma pneumoniae and Chlamydia pneumoniae that are contracted in infancy or early childhood, may contribute to the development of many cases of asthma. Visit this site to learn more about what happens during an asthma attack. What are the three changes that occur inside the airways during an asthma attack? The respiratory system is responsible for obtaining oxygen and getting rid of carbon dioxide, and aiding in speech production and in sensing odors. From a functional perspective, the respiratory system can be divided into two major areas: the conducting zone and the respiratory zone. The conducting zone consists of all of the structures that provide passageways for air to travel into and out of the lungs: the nasal cavity, pharynx, trachea, bronchi, and most bronchioles. The nasal passages contain the conchae and meatuses that expand the surface area of the cavity, which helps to warm and humidify incoming air, while removing debris and pathogens. The pharynx is composed of three major sections: the nasopharynx, which is continuous with the nasal cavity; the oropharynx, which borders the nasopharynx and the oral cavity; and the laryngopharynx, which borders the oropharynx, trachea, and esophagus. The respiratory zone includes the structures of the lung that are directly involved in gas exchange: the terminal bronchioles and alveoli. The lining of the conducting zone is composed mostly of pseudostratified ciliated columnar epithelium with goblet cells. The mucus traps pathogens and debris, whereas beating cilia move the mucus superiorly toward the throat, where it is swallowed. As the bronchioles become smaller and smaller, and nearer the alveoli, the epithelium thins and is simple squamous epithelium in the alveoli. The endothelium of the surrounding capillaries, together with the alveolar epithelium, forms the respiratory membrane. This is a blood-air barrier through which gas exchange occurs by simple diffusion.

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ala (plural = alae) small, flaring structure of a nostril that forms the lateral side of the nares alar cartilage cartilage that supports the apex of the nose and helps shape the nares; it is connected to the septal cartilage and connective tissue of the alae alveolar duct small tube that leads from the terminal bronchiole to the respiratory bronchiole and is the point of attachment for alveoli alveolar macrophage immune system cell of the alveolus that removes debris and pathogens alveolar pore opening that allows airflow between neighboring alveoli alveolar sac cluster of alveoli alveolus small, grape-like sac that performs gas exchange in the lungs apex tip of the external nose bronchial tree collective name for the multiple branches of the bronchi and bronchioles of the respiratory system bridge portion of the external nose that lies in the area of the nasal bones bronchiole branch of bronchi that are 1 mm or less in diameter and terminate at alveolar sacs bronchus tube connected to the trachea that branches into many subsidiaries and provides a passageway for air to enter and leave the lungs conducting zone region of the respiratory system that includes the organs and structures that provide passageways for air and are not directly involved in gas exchange cricoid cartilage portion of the larynx composed of a ring of cartilage with a wide posterior region and a thinner anterior region; attached to the esophagus dorsum nasi intermediate portion of the external nose that connects the bridge to the apex and is supported by the nasal bone epiglottis leaf-shaped piece of elastic cartilage that is a portion of the larynx that swings to close the trachea during swallowing external nose region of the nose that is easily visible to others fauces portion of the posterior oral cavity that connects the oral cavity to the oropharynx fibroelastic membrane specialized membrane that connects the ends of the C-shape cartilage in the trachea; contains smooth muscle fibers glottis opening between the vocal folds through which air passes when producing speech laryngeal prominence region where the two lamina of the thyroid cartilage join, forming a protrusion known as “Adam’s apple” laryngopharynx portion of the pharynx bordered by the oropharynx superiorly and esophagus and trachea inferiorly; serves as a route for both air and food larynx cartilaginous structure that produces the voice, prevents food and beverages from entering the trachea, and regulates the volume of air that enters and leaves the lungs lingual tonsil lymphoid tissue located at the base of the tongue meatus one of three recesses (superior, middle, and inferior) in the nasal cavity attached to the conchae that increase the surface area of the nasal cavity naris (plural = nares) opening of the nostrils nasal bone bone of the skull that lies under the root and bridge of the nose and is connected to the frontal and maxillary bones nasal septum wall composed of bone and cartilage that separates the left and right nasal cavities nasopharynx portion of the pharynx flanked by the conchae and oropharynx that serves as an airway oropharynx portion of the pharynx flanked by the nasopharynx, oral cavity, and laryngopharynx that is a passageway for both air and food palatine tonsil one of the paired structures composed of lymphoid tissue located anterior to the uvula at the roof of isthmus of the fauces paranasal sinus one of the cavities within the skull that is connected to the conchae that serve to warm and humidify incoming air, produce mucus, and lighten the weight of the skull; consists of frontal, maxillary, sphenoidal, and ethmoidal sinuses pharyngeal tonsil structure composed of lymphoid tissue located in the nasopharynx pharynx region of the conducting zone that forms a tube of skeletal muscle lined with respiratory epithelium; located between the nasal conchae and the esophagus and trachea philtrum concave surface of the face that connects the apex of the nose to the top lip pulmonary surfactant substance composed of phospholipids and proteins that reduces the surface tension of the alveoli; made by type II alveolar cells respiratory bronchiole specific type of bronchiole that leads to alveolar sacs respiratory epithelium ciliated lining of much of the conducting zone that is specialized to remove debris and pathogens, and produce mucus respiratory membrane alveolar and capillary wall together, which form an air-blood barrier that facilitates the simple diffusion of gases respiratory zone includes structures of the respiratory system that are directly involved in gas exchange root region of the external nose between the eyebrows thyroid cartilage largest piece of cartilage that makes up the larynx and consists of two lamina trachea tube composed of cartilaginous rings and supporting tissue that connects the lung bronchi and the larynx; provides a route for air to enter and exit the lung trachealis muscle smooth muscle located in the fibroelastic membrane of the trachea true vocal cord one of the pair of folded, white membranes that have a free inner edge that oscillates as air passes through to produce sound type I alveolar cell squamous epithelial cells that are the major cell type in the alveolar wall; highly permeable to gases type II alveolar cell cuboidal epithelial cells that are the minor cell type in the alveolar wall; secrete pulmonary surfactant vestibular fold part of the folded region of the glottis composed of mucous membrane; supports the epiglottis during swallowing This work, Anatomy & Physiology, is adapted from Anatomy & Physiology by OpenStax, licensed under CC BY. 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