

Unit 12 – The Respiratory System

12.1 Introduction

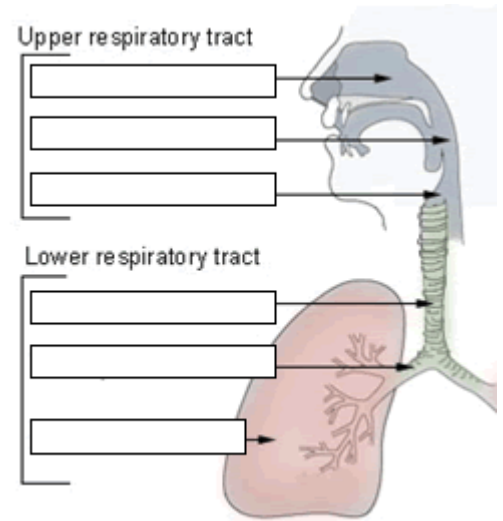
Primary Function: obtaining oxygen and removing carbon dioxide

Other functions: Filter air, produce sounds, sense of smell, regulation of blood pH

Respiration: the process of gas exchange between the atmosphere and body cells

1. Movement of air into the lungs – Ventilation
2. Gas exchange between blood and air (external respiration)
3. Gas transport in blood
4. Gas exchange between the blood and body cells (internal respiration)

Cellular Respiration – the process of oxygen use and CO₂ production at the cellular level



12.2 Organs of the Respiratory System

Upper Respiratory Tract – nose, nasal cavity, paranasal sinuses, pharynx

Lower Respiratory Tract – larynx, trachea, bronchial tree, lungs

Nose – bones and cartilage support nose, two openings (nostrils), hair filters large particles

Nasal Cavity – hollow space behind the nose | Nasal septum – divides the nose (bone)

Nasal conchae – bones that divide the nasal cavity, support the mucus membrane and increase surface area (superior, middle, inferior)

* deviated septum – when the septum bends to one side

-- air is warmed as it enters the nasal cavity, sticky mucus traps particles which are pushed toward the pharynx and swallowed.

Paranasal Sinuses – spaces within the maxillary, frontal, ethmoid and sphenoid bones; reduce the weight of skull and are resonant chambers for voice.

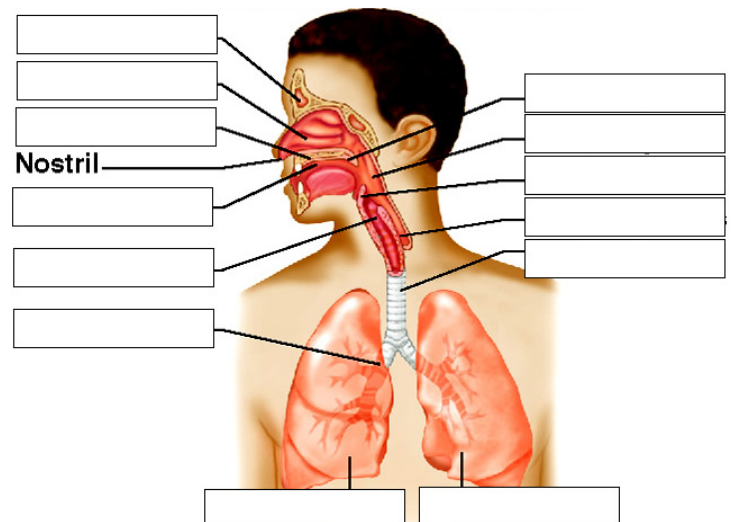
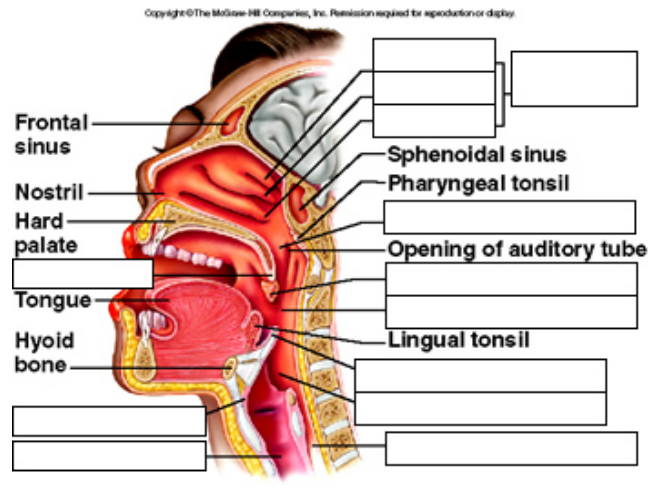
Pharynx – behind the oral cavity, between the nasal cavity and larynx (space, not a structure) - nasopharynx, oropharynx, laryngopharynx

Larynx – enlargement at the top of the trachea and below pharynx, conducts air in and out of trachea, houses vocal cords
 - composed of a framework of muscles and cartilages (thyroid (Adam's apple), cricoids, epiglottic cartilages)

- false vocal folds (do not produce sound) – help close airway during swallowing

- true vocal folds (produce sound) – changing shape of the pharynx, and oral cavity changes sounds into words

- contracting and relaxing muscles changes pitch (increased tension = higher pitch)



Glottis – triangular slit that opens during breathing/talking, and closes during swallowing

Epiglottis – flaplike structure that stands upright, allows air to enter larynx, during swallowing it presses downward and prevents food from entering air passages

*Laryngitis – when the mucus membrane becomes swollen and prevents the vocal cords from vibrating freely

Trachea (windpipe) – flexible cylinder, about 12.5 cm long, extends downward in front of the esophagus

- contains about 20 C-shaped pieces of hyaline cartilage that prevent trachea from collapsing

Bronchial Tree – branched airways leading from the trachea to the air sacs in the lungs

Primary bronchii – left and right → bronchioles → alveolar ducts → alveolar sacs → alveoli

Gases are exchanged between alveoli and the blood stream

Lungs – soft spongy, cone-shaped organs in the thoracic cavity. The visceral pleura attaches to each lung surface and folds back to form the parietal pleura. The space between the visceral and parietal pleura is called the pleural cavity. Pleural cavity contains serous fluid to lubricate surfaces during breathing.

Left Lung – smaller, 2 lobes

Right Lung – larger than left, 3 lobes

12.3 Breathing Mechanism

Inspiration = inhalation | Expiration = exhalation

INHALATION

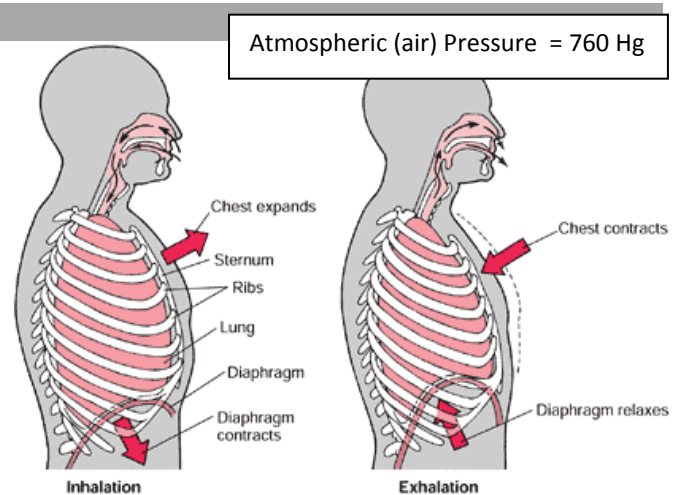
1. The diaphragm moves downward and the atmospheric pressure in the alveoli falls, which forces air into the airways
2. External intercostals muscles contract, raising ribs and sternum and enlarges the cavity even more
3. Pleural membranes held tightly together, move with the contractions of muscles
4. Surface tension in the alveoli (caused by water) makes it difficult to inflate them. Surfactant reduces tendency of alveoli to collapse. (Lack of surfactant in preemies can cause respiratory distress)
5. A deeper breath can be achieved through other muscles – pectoralis minor and sternocleidomastoid
6. The first breath of a newborn is the hardest because all of the alveoli are only partially inflated.

*Since our breathing is based on atmospheric pressure (and the difference in the pressure in the lungs), if there is a hole in the pleural cavity, the lung collapses (deflates). This can happen if a person is stabbed or a broken rib pierces the lung.

EXHALATION

1. As diaphragm and other muscles relax, elastic recoil from surface tension forces air out
2. If a person needs to exhale more air, internal (expiratory) intercostals muscles contract. Abdominal wall muscles (internal and external obliques, rectus abdominus and transverses abdominus) can help squeeze out more air.
3. These contractions increase the air pressure within the pleural cavity, forcing air out

NON-RESPIRATORY MOVEMENTS - Used to clear air passageways (coughing, sneezing) or express emotion (laughter, crying) – result from reflexes -- A hiccup is a sudden inspiration due to a spasm of the diaphragm, air striking vocal folds makes the sound ---A yawn may be caused by not enough blood becoming oxygenated, a yawn forces a deep breath



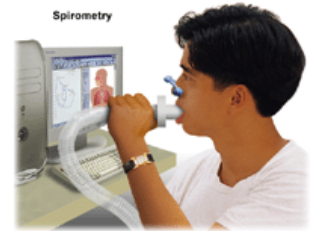
RESPIRATORY AIR VOLUMES AND CAPACITIES

Spirometry – measures volumes of air moving in and out of the lungs. 4 distinct respiratory volumes

Respiratory cycle – 1 inspiration + the following expiration

1. Resting Tidal volume – amount of air that enters the lungs during 1 cycle
2. Inspiratory and 3. Expiratory reserve volume – after forced inhalation or exhalation
4. Residual Volume – air remaining in the lungs even after forceful exhalation

*** Combining two or more of the respiratory volumes = respiratory capacities.



Spirometer – measures respiratory air volumes

Inspiratory Reserve Volume + Expiratory Reserve Volume + Tidal Volume = Vital Capacity (maximum amount of air a person can exhale)

Tidal Volume + Inspiratory Reserve Volume = Inspiratory Capacity (max amount that can be inhaled)

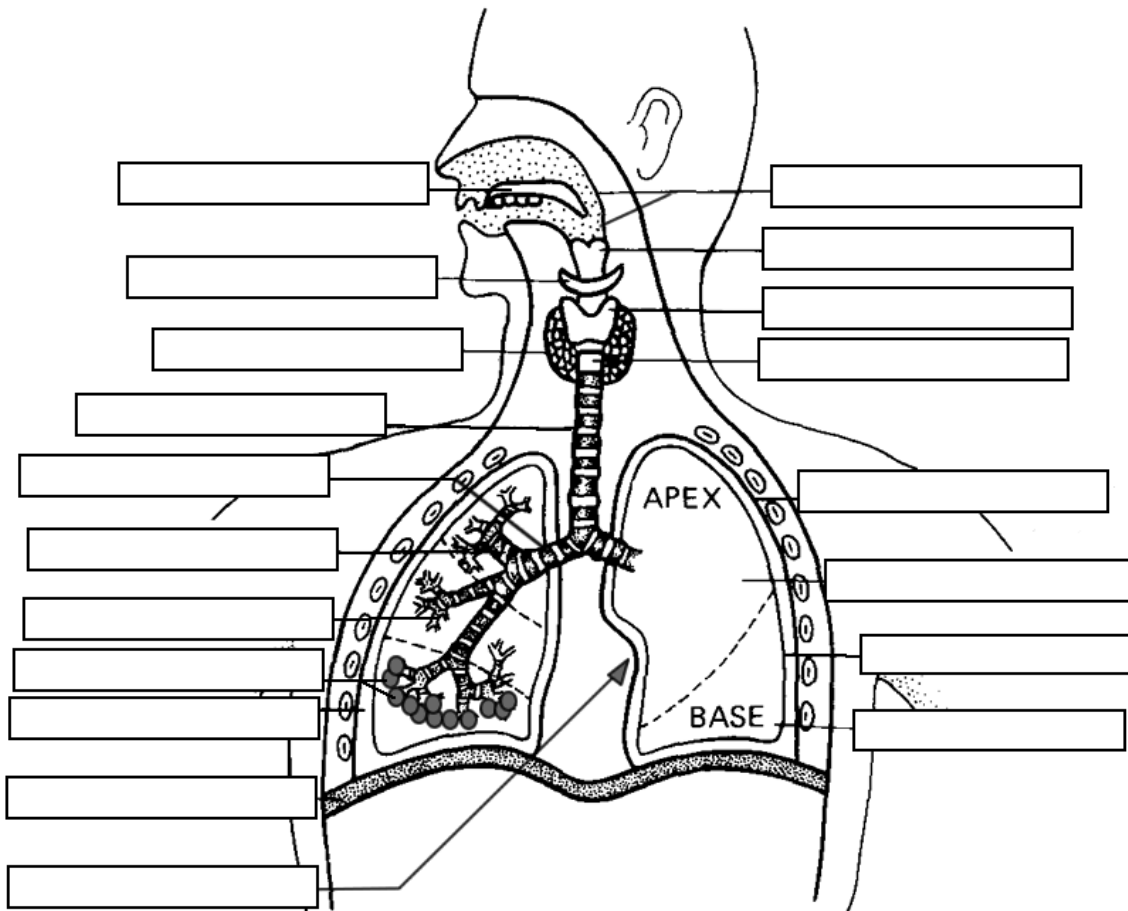
Expiratory Reserve Volume + Residual Volume = Functional Residual Capacity (volume that remains in the lungs, resting)

Vital Capacity + Residual Volume = Total Lung Capacity (varies by sex, age, body size)

SWF MOVIE: HOW LUNGS WORK

1. Lungs take in [blood / oxygen] and remove carbon dioxide.
2. Contraction of muscles near the lungs make the lungs [expand / contract]
3. The [nose / trachea] warms and wets the air inhaled.
4. Blood travels from the heart to the lungs through the [aorta / pulmonary arteries]
5. Structures that look like bunches of grapes are the [alveoli / capillaries]
6. Exhalation removes air that is rich in [oxygen / carbon dioxide]
7. Exhalation occurs when the muscles around the lungs [contract / relax]

LABELING



12.4 Control of Breathing

Breathing is an involuntary act, the muscles are under voluntary control (we can choose to hold our breath)

Respiratory Center – groups of neurons in the brain that control inspiration and expiration (based in the medulla and the pons)

Medulla Rhythmicity Area (Medulla) – two neuron groups extend the length of the medulla oblongata

Dorsal Respiratory Group – controls basic rhythm of respiration

Ventral Respiratory Group – generate impulses to increase respiratory movements, forceful expiration

Pneumotaxic Area (Pons) – inhibit respiratory bursts originating from the dorsal resp group

Factors Affecting Breathing

*Chemosensitive areas – detect concentrations of chemicals like carbon dioxide and hydrogen

1. Rise in CO₂
2. Low blood oxygen (peripheral chemoreceptors, carotid and aortic bodies, sense changes)
3. Inflation reflex – regulates the depth of breathing, prevents overinflation of the lungs
4. Emotional upset, fear and pain

*hyperventilation – increase breathing for a short time lowers the blood CO₂ concentration and will allow you to hold your breath for a longer period

12.5 Alveolar Gas Exchanges

Alveoli – clusters or air sacs at the end of the bronchioles

Respiratory Membrane – layers of simple squamous cells and capillaries

Oxygen and CO₂ exchange occurs by diffusion

The thin respiratory membrane allows other solutes (alcohol) to diffuse across it and be exhaled → breath analysis

12.6 Gas Transport

Oxygen combines with hemoglobin in the blood (oxyhemoglobin / deoxyhemoglobin)

Hypoxia – oxygen deficiency. Can be caused by inadequate blood flow, poisons (cyanide and carbon monoxide)

Asphyxia – excess CO₂ in the blood, lack of oxygen

ILLNESSES RELATED TO THE RESPIRATORY SYSTEM

1. Cystic Fibrosis (genetic)
2. Asthma
3. Bronchitis
4. Apnea
5. Emphysema
6. Lung Cancer
7. Altitude Sickness
8. Chronic Obstructive Pulmonary Disease (COPD)
9. Sinusitis
10. Bacterial or Viral Infections (cold, flu, pneumonia)

