Respiratory System Anatomy and Physiology (Part 1)

- ✓ Introduction
- ✓ Anatomy of Respiratory System
- ✓ Anatomy & Physiology of

  Nose, Pharynx, Larynx, Trachea, & Bronchi

Human Anatomy & Physiology

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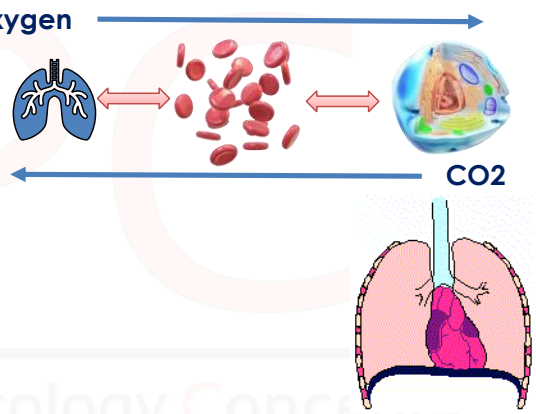
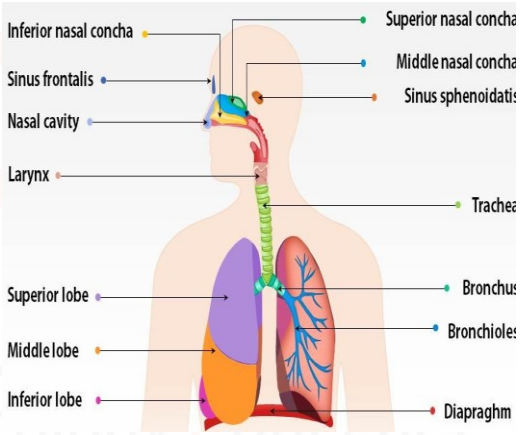
Respiratory System

- **System of Respiration.**
- **Respiration**: Exchange of gases between Lungs & Blood (**External Respiration**) and Blood & Cells (Internal Respiration).
- Respiratory System provides the passage by which the supply of oxygen present in the atmospheric air enters the body, and it provides the route of excretion for waste carbon dioxide.
- Compensate the metabolic demand for oxygen (required for metabolic activity and energy production)



Respiratory System

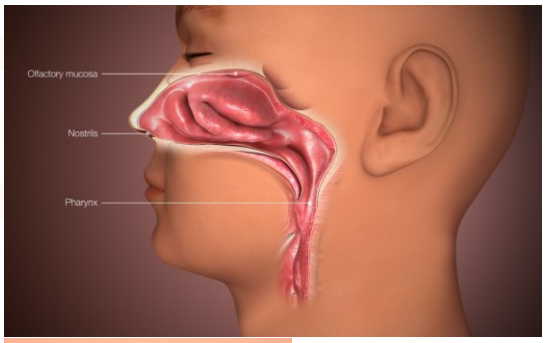
- The organs of the respiratory system are:
  - Nose
  - Pharynx
  - Larynx
  - Trachea
  - Two bronchi (one bronchus to each lung)
  - Bronchioles and smaller air passages
  - Two lungs and their coverings, the pleura
  - Muscles of breathing – the intercostal muscles and the diaphragm.

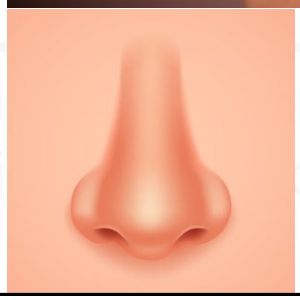


Respiratory System

NOSE

- The external opening of the nose is the nostrils or anterior nares
- The dividing partition between the nostrils is the nasal septum, which forms two nasal cavities.
- Each cavity is divided into 3 air passages: the superior, middle, and inferior conchae

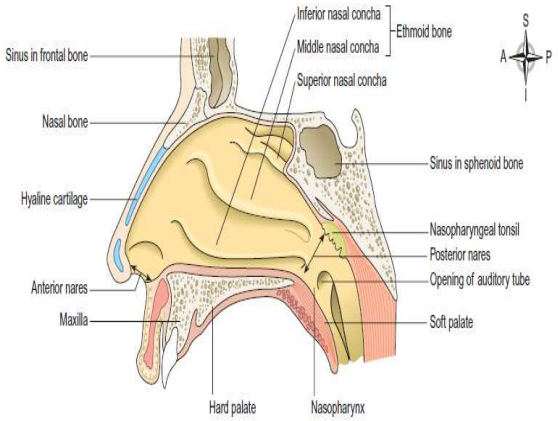




Respiratory System

NOSE

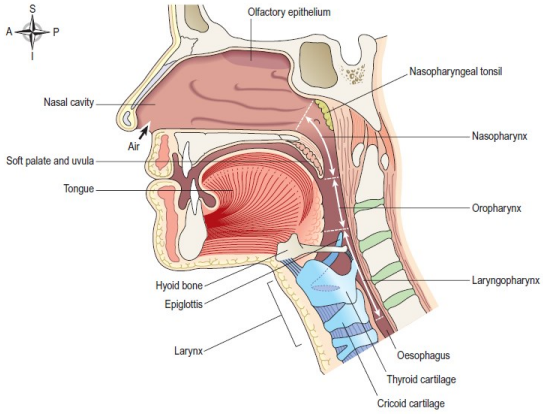
- **Respiratory Function of Nose**:
- The nose is the first of the respiratory passages through which the inspired air passes. In the nasal cavity, air is **warmed**, **moistened** and **filtered**.
- The three projecting *conchae* increase the surface area and cause turbulence, spreading inspired air over the whole nasal surface.
- The large surface area maximises warming, humidification and filtering
- **Sensory Function**
- The nose is the organ of the sense of smell (*olfaction*).



Respiratory System

Pharynx

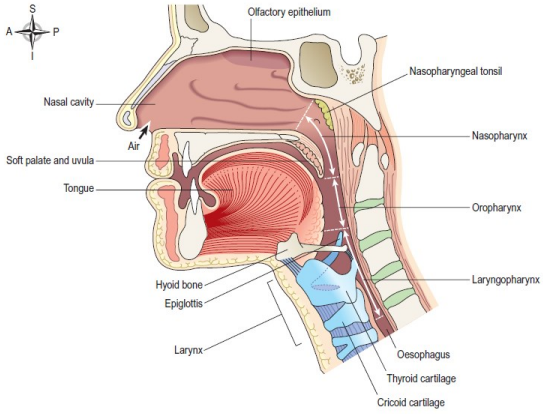
- **Nasopharynx:** Located behind the nose. On its lateral walls are the two openings of the *auditory tubes*. On the posterior wall are the *pharyngeal tonsils* (adenoids), consisting of lymphoid tissues (atrophy after 7 Year of age)
- **Oropharynx:** lies behind the mouth, When swallowing, the soft palate and uvula are pushed upwards, sealing off the nasal cavity and preventing the entry of food and fluids



Respiratory System

Pharynx

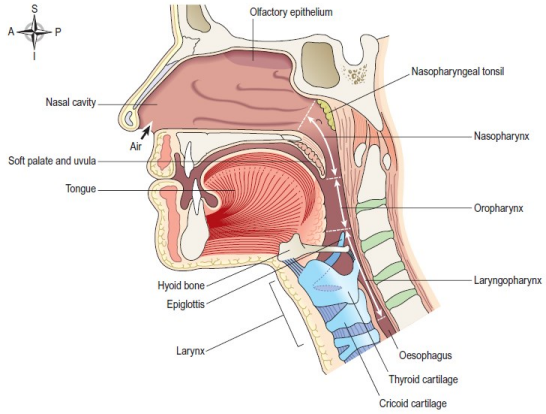
- **Laryngopharynx:** Located behind the larynx.
- The pharynx also contains 3 pairs of tissues that are part of the lymphatic system
  - the pharyngeal tonsils… the adenoids
  - the palatine tonsils
  - the lingual tonsils



Respiratory System

Pharynx

- **Functions:**
- Passage of air and food
- Warming and humidifying the air
- Hearing: The auditory tube, allows air to enter the middle ear. This leads to air in the middle ear being at the same pressure as the outer ear, protecting the tympanic membrane (eardrum) from any changes in atmospheric pressure.
- Protection: Produce by antibodies by Tonsil.
- Speech



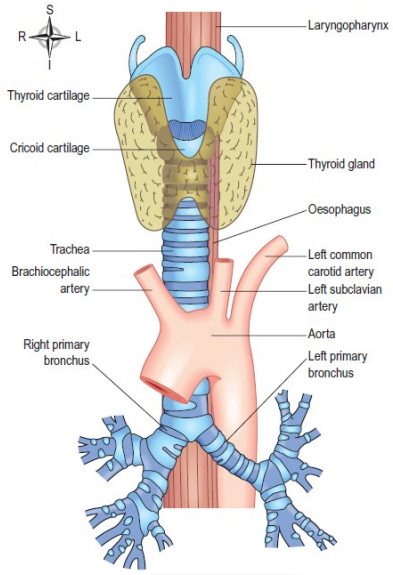
Respiratory System

Larynx

- The larynx or 'voice box' links the laryngopharynx and the trachea
- It lies in front of the laryngopharynx and the 3rd, 4th, 5th and 6th cervical vertebrae.
- Until puberty there is little difference in the size of the larynx between the sexes.
- Thereafter, it grows larger in the male, which explains the prominence of the 'Adam's apple' and the generally deeper voice.
- The larynx is composed of several irregularly shaped cartilages attached to each other by ligaments and membranes
  - 1 thyroid cartilage
  - 1 cricoid cartilage
  - 2 arytenoid cartilages

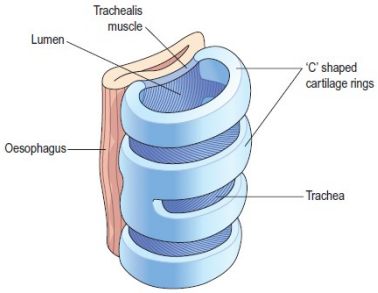
  → hyaline cartilage
  - 1 epiglottis → elastic fibrocartilage.

Respiratory System

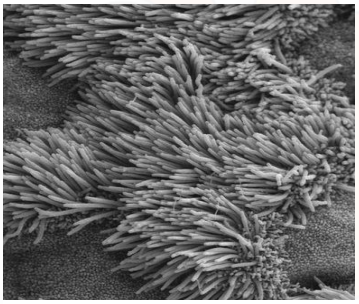


TRACHEA

- The trachea or windpipe is a smooth, muscular tube leading from the larynx to the main bronchi
- Further divides at the carina into the right and left primary bronchi, one bronchus going to each lung
- C-shaped rings of cartilage provide protection on the front and sides

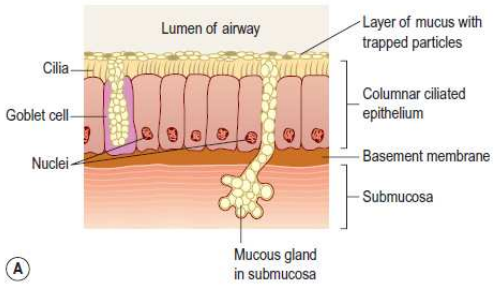


Respiratory System



TRACHEA

- The trachea is the passageway for air to and from the lungs.
- It is lined with cilia (hairs), which sweep foreign matter out of the pathway. It is only about 1 inch in diameter and 4 ½ inches long

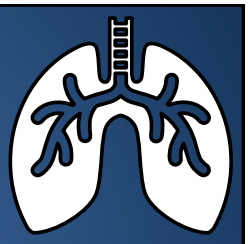


Respiratory System

BRONCHI

- The bronchi are the two main branches at the bottom of the trachea, providing passageway for air to the lungs and futher divided into bronchieal tree.
- As the branches of the bronchial tree get smaller, the 2 primary bronchi become bronchioles, and then very small alveolar ducts

Respiratory System
Anatomy and Physiology (Part 2)



- ✓ Lungs Anatomy & Physiology
- ✓ Respiration (Mechanism & Regulation)

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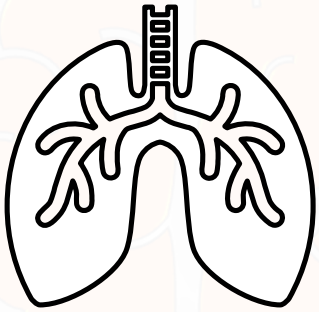
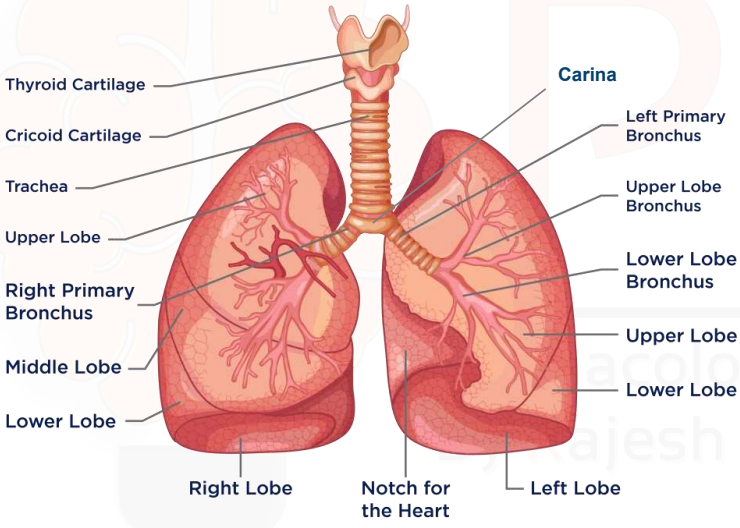
Respiratory System

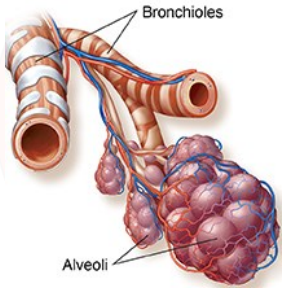


LUNGS

Respiratory System

LUNGS ANATOMY

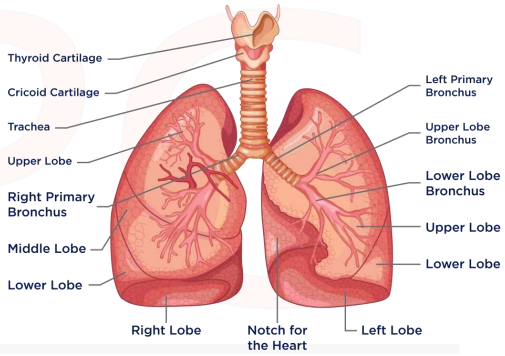




Respiratory System

LUNGS

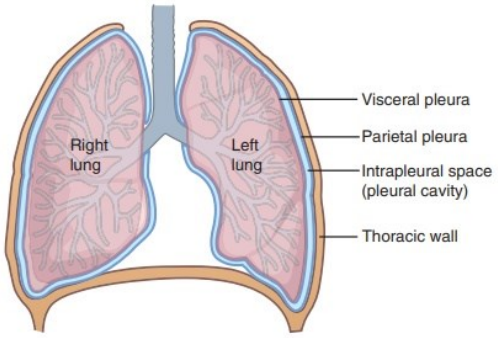
- The lungs are two spongy organs located in the thorax.
- They consist of elastic tissue, filled with an interlacing network of tubes and sacs that carry air and blood vessels that carry blood
- Each lung is divided into lobes by fissures
  - Left lung – two lobes
  - Right lung – three lobes



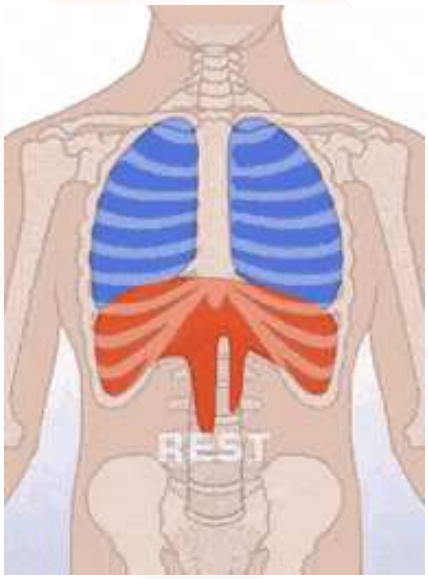
Respiratory System

LUNGS

- **Covering of Lungs**
- Pulmonary (visceral) pleura covers the lung surface
- Parietal pleura lines the walls of the thoracic cavity
- Pleural fluid fills the area between layers of pleura to allow gliding



Respiratory System



LUNGS

- The base of the lungs rest on the diaphragm, a muscular wall separating the thorax from the abdominal cavity.
- It is involved in respiration, drawing downward in the chest during inhalation, and pushing upward during exhalation

Respiratory System

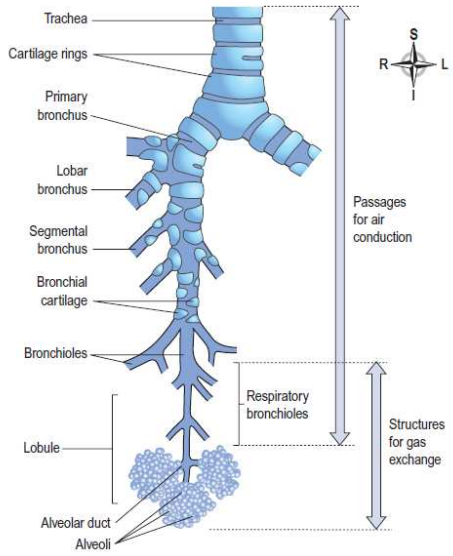


Figure 10.17 The lower respiratory tract.

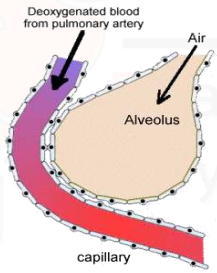
Respiratory Tree

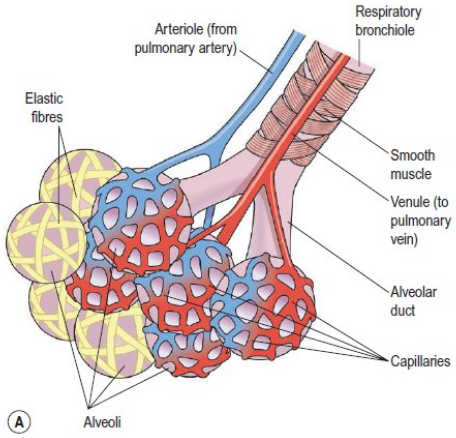
- Primary bronchi
- Secondary bronchi
- Tertiary bronchi
- Bronchioles
- Alveolar duct
- Alveoli

Respiratory System

Gases Exchange through Alveoli

- At the end of each bronchiole are the alveoli.
- The lungs contain about 300 million alveoli sacs, which are the air cells where the exchange of oxygen and carbon dioxide takes place with the capillaries



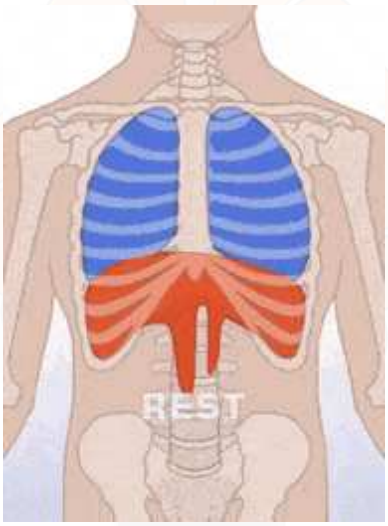


Respiratory System

Major Function of Lung

- External Respiration
- Defense System- by alveolar macrophages
- Warming and Humidification

Respiratory System



Mechanism of Respiration

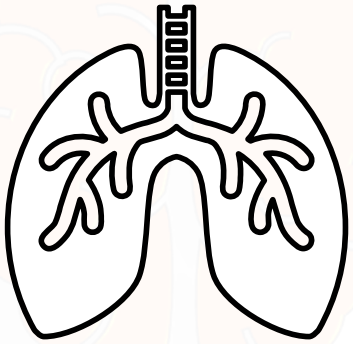
Respiratory System

Respiration

- The term respiration means the exchange of gases between body cells and the environment. This involves two main processes.
- **Breathing (pulmonary ventilation).** This is movement of air into and out of the lungs.
- **Exchange of gases.** This takes place:
  - in the lungs: external respiration
  - in the tissues: internal respiration.

Pharmacology Concepts
By Rajesh Choudhary

Respiratory System



Breathing
(Inspiration & Expiration)

Respiratory System

Breathing (Pulmonary Ventilation)

- Breathing supplies oxygen to the alveoli, and eliminates carbon dioxide.
- It is a mechanical process (muscular activity) depends on volume changes in the thoracic cavity. Volume changes lead to pressure changes, which lead to the flow of gases to equalize pressure
- During the breathing external intercostal muscles (during inspiration), internal intercostal muscles (during Expiration) and the diaphragm are mainly involved

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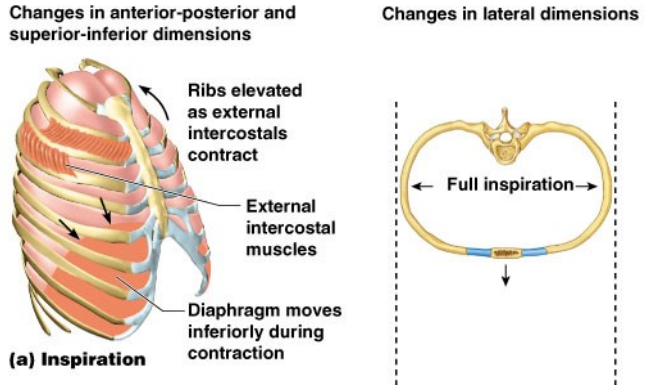
Respiratory System

INSPIRATION/INHALATION

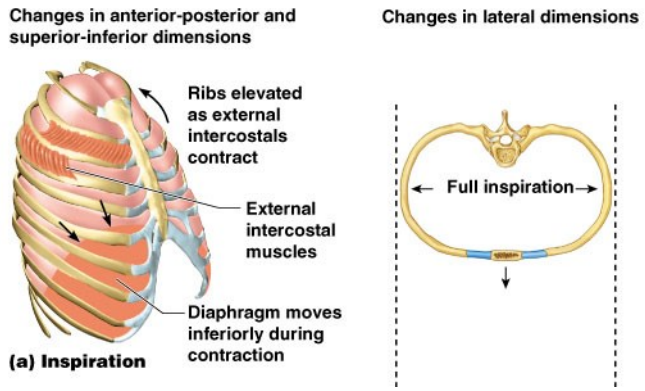
- Movement of air from atmosphere to lungs
- Simultaneous contraction of the external intercostal muscles and the diaphragm, expands the thorax
- External air is pulled into the lungs due to an increase in intrapulmonary volume



Respiratory System

INSPIRATION/INHALATION

- The process of inspiration is **active**, as it **needs energy** for muscle contraction.
- The negative pressure created in the thoracic cavity aids venous return to the heart and is known as the respiratory pump.
- At rest, inspiration lasts about 2 seconds.



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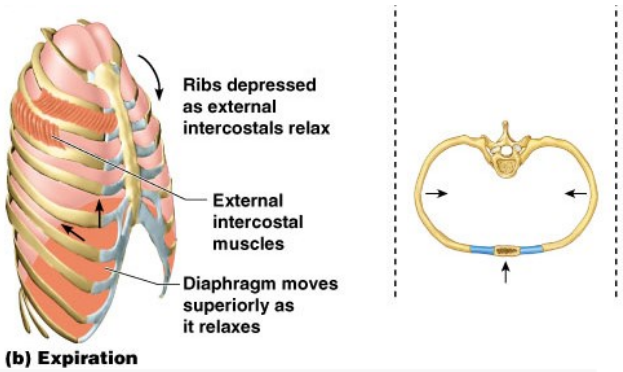
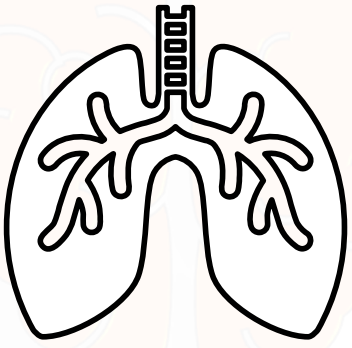
Respiratory System

EXPIRATION/ EXHALATION

- Largely a passive process which depends on natural lung elasticity
- As muscles relax, air is pushed out of the lungs
- Forced expiration can occur mostly by contracting internal intercostal muscles to depress the rib cage
- At rest, expiration lasts about 3 seconds, and after expiration
- There is a pause before the next cycle begins



Respiratory System



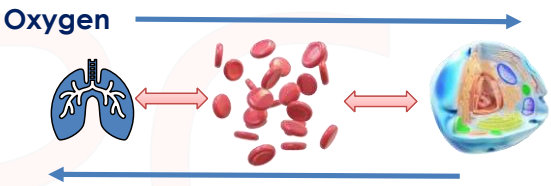
Gaseous Exchange

(External and Internal Respiration)

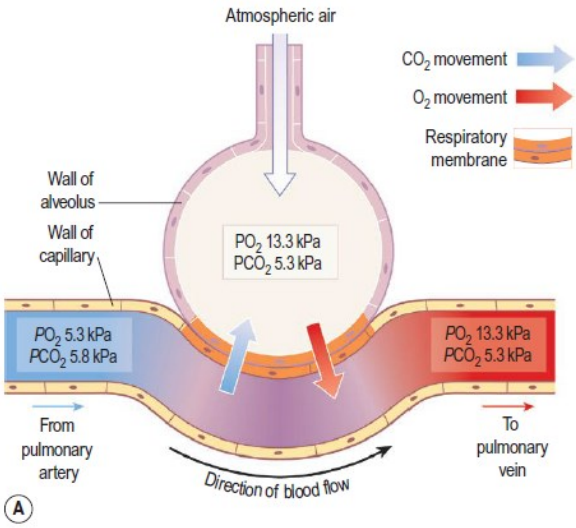
Respiratory System

Exchange of Gases

- Exchange of gases between Lungs & Blood (**External Respiration**) and Blood & Cells (Internal Respiration).
- Although breathing involves inspiration and expiration process, gas exchange at the respiratory membrane and in the tissues is a continuous and ongoing process.
- Diffusion of oxygen and carbon dioxide depends on pressure differences, e.g. between atmospheric air and the blood, or blood and the tissues
- Gases move by diffusion from the higher concentration to the lower until equilibrium is established

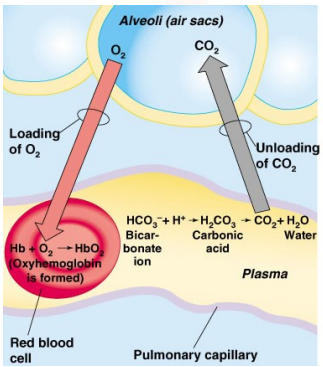


Respiratory System

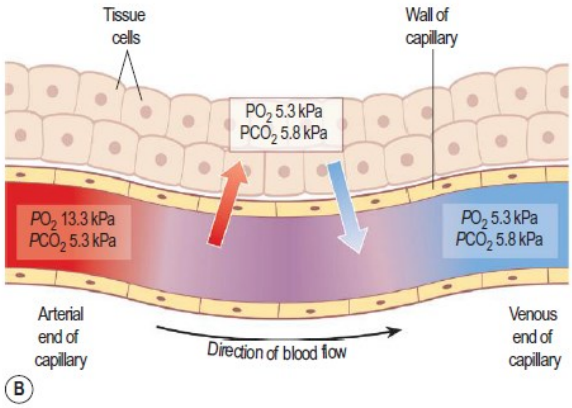


External Respiration

- Exchange of gases by diffusion process between the alveoli and the blood in the alveolar capillaries, across the respiratory membrane.

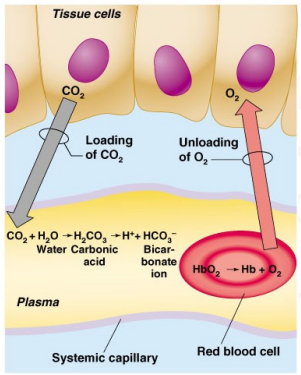


Respiratory System

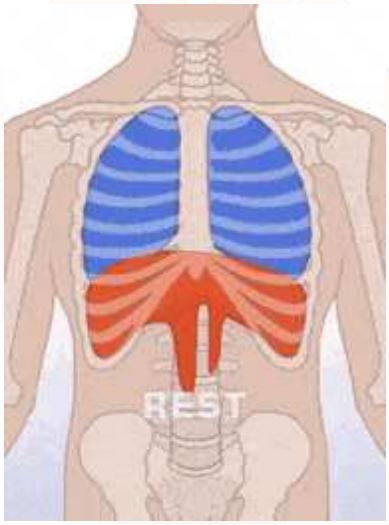


Internal Respiration

- This is exchange of gases by diffusion between blood in the capillaries and the body cells respiratory membrane.



Respiratory System



Regulation of Respiration

Respiratory System

The respiratory centre

- This is formed by groups of nerves in the medulla, the *respiratory rhythmicity centre*, which control the respiratory pattern, i.e. the rate and depth of breathing.

Neuronal control

- Parasympathetic slowdown the respiration and sympathetic increase the respiration

Chemoreceptors

- These are receptors that respond to changes in the partial pressures of oxygen and carbon dioxide in the blood and cerebrospinal fluid. They are located centrally and peripherally.
- **Central chemoreceptors.** These are located on the surface of the medulla oblongata and are bathed in cerebrospinal fluid. When arterial *P*CO2 rises (hypercapnia), even slightly, the central chemoreceptors respond by stimulating the respiratory centre, increasing ventilation of the lungs and reducing arterial *P*CO2.

Respiratory System

Chemoreceptors

- The sensitivity of the central chemoreceptors to raised arterial *P*CO2 is the most important factor in controlling normal blood gas levels. A small reduction in *P*O2 (hypoxaemia) has the same, but less pronounced effect, but a substantial reduction depresses breathing
- **Peripheral chemoreceptors.** These are situated in the arch of the aorta and in the carotid bodies and convey the signals vis glossopharyngeal and vagus nerves.
- They respond to changes in blood CO2 and O2 levels, but are much more sensitive to carbon dioxide than oxygen
- This stimulates an immediate rise in the rate and depth of respiration. An increase in blood acidity (decreased pH or raised [H+]) also stimulates the peripheral chemoreceptors, resulting in increased ventilation, increased CO2 excretion and increased blood pH.
- These chemoreceptors also help to regulate blood pressure

Respiratory System

- **Exercise and respiration:** Physical exercise increases both the rate and depth of respiration to supply the increased oxygen requirements of the exercising muscles. Exercising muscles produces higher quantities of CO2, which stimulates central and peripheral chemoreceptors.

Others

- Breathing may be modified by the higher centres in the brain by:
- speech, singing
- emotional displays, e.g. crying, laughing, fear
- drugs, e.g. sedatives, alcohol
- sleep.

Respiratory System
Anatomy and Physiology (Part 2)

- ✓ Lungs Volume & Capacities
- ✓ Aartificial respiration, and Resuscitation methods

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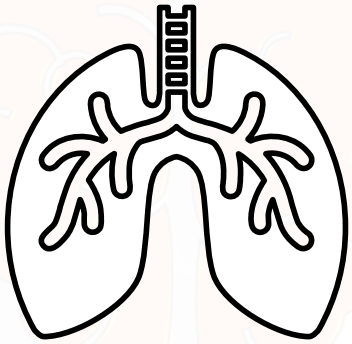
Respiratory System



Lungs Volume & Capacity

Respiratory System

Respiratory Volume and Capacity

- Breathing rate: 15/min
- Anatomical dead space: 150 ml
- **Tidal volume**: This is the amount of air passing into and out of the lungs during each cycle of breathing (about **500 mL** at rest).
- **Inspiratory reserve volume (IRV; 3.1L).** This is the extra volume of air that can be inhaled into the lungs during maximal inspiration, i.e. over and above normal TV.
- **Inspiratory capacity (IC; 3.6L).** This is the amount of air that can be inspired with maximum effort. It consists of the tidal volume (500 ml) plus the inspiratory reserve volume.

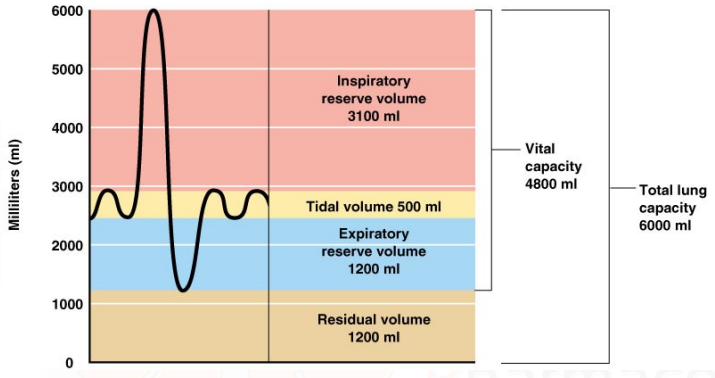
Respiratory System

Respiratory Volume and Capacity

- **Expiratory reserve volume (ERV; 1.2L):** This is the largest volume of air which can be expelled from the lungs during maximal expiration.
- **Residual volume (RV; 1.2L):** This cannot be directly measured but is the volume of air remaining in the lungs after forced expiration.
- **Vital capacity (VC):** This is the maximum volume of air which can be moved into and out of the lungs
  - VC= TV+IRV+ERV
  - **VC= 0.5+3.1+1.2 = 4.8 L**
- **Total lung capacity (TLC):** This is the maximum amount of air the lungs can hold. In an adult of average build, it is normally around 6L
  - **TLC = VC+RV = 4.8+1.2 = 6L**

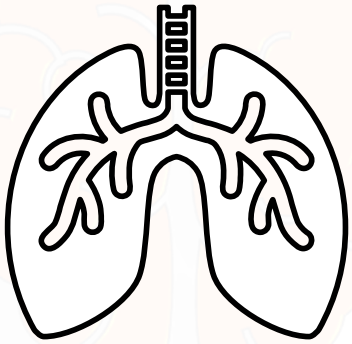
Respiratory System

Respiratory Volume and Capacity



- **Alveolar ventilation.** This is the volume of air that moves into and out of the alveoli per minute. AV = (TV-Anatomical Dead space) x Respiration Rate
- AV = (500-150)x15 = 5250 L (5.25 L)

Respiratory System



Artificial Respiration & Resuscitation Methods

Respiratory System

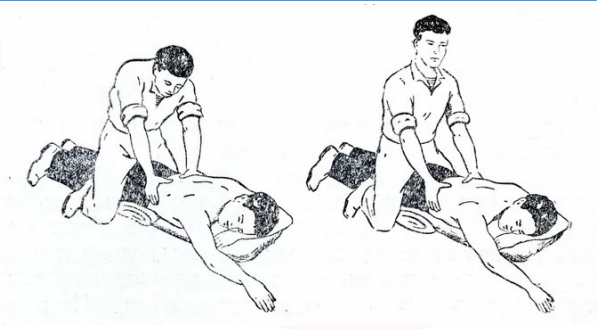
Artificial Respiration

- Artificial respiration, breathing induced by some manipulative technique when natural respiration has ceased or is faltering. Such techniques, if applied quickly and properly, can prevent some deaths from drowning, choking, strangulation, suffocation, carbon monoxide poisoning, and electric shock
- Resuscitation by inducing artificial respiration consists chiefly of two actions
- (1) establishing and maintaining an open air passage from the upper respiratory tract (mouth, throat, and pharynx) to the lungs and
- (2) exchanging air and carbon dioxide in the terminal air sacs of the lungs while the heart is still functioning.
- To be successful such efforts must be started as soon as possible and continued until the victim is again breathing.

Respiratory System

Artificial Respiration Methods

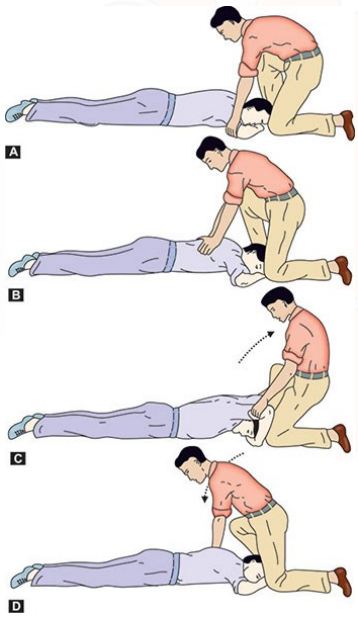
- 1) Prone- Schafer's Method (Prone Pressure Method)
- 2) Holger Nilson's Method (Arm Lift back pressure method)
- 3) Sylvester's method (Arm lift chest pressure method)
- 4) Mouth to mouth respiration



1) Prone- Schafer's Method (Prone Pressure Method)

a method of artificial respiration invented by **Sharpey-Schafer**, in which the patient is placed face downward, pressure then being rhythmically applied with the hands to the lower part of the thorax.

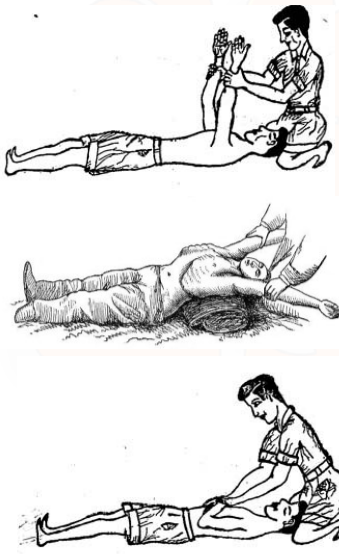
Respiratory System



Artificial Respiration Methods

- **2) Holger Nilson's Method (Arm Lift back pressure method)**
- This method is an alternate technique used when other methods are not possible.
- Read more on Sarthaks.com - https://www.sarthaks.com/1382683/explain-nelsons-arm-method-of-artificial-respiration

Respiratory System



Artificial Respiration Methods

- **3) Sylvester's method (Arm lift chest pressure method)**
- This method is illustrated in Figure The patient is laid on his back.
- His arms are grasped above the wrists and drawn first upward and then above the head until they touch the floor.
- Then they are brought back to the chest and pressure is exerted in a downward direction.

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Artificial Respiration Methods

- **4) Mouth to mouth respiration**

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