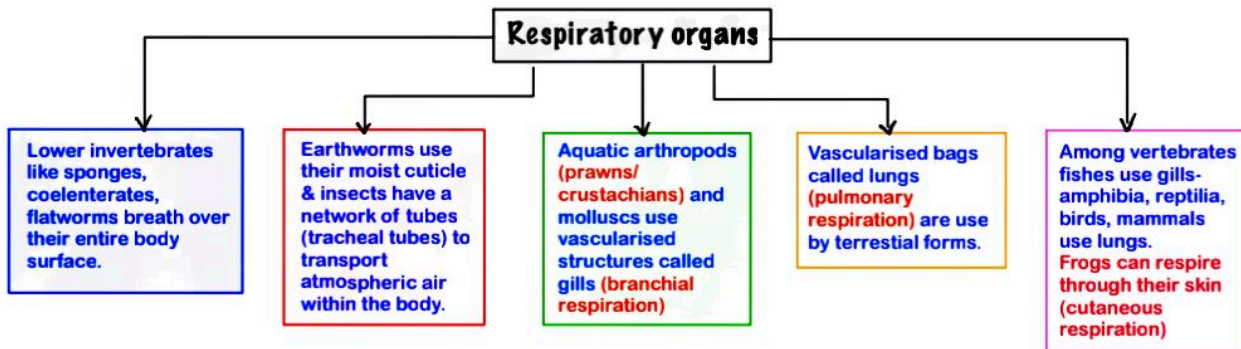


Breathing and exchange of gases

Process of exchange of O₂ from the atmosphere with CO₂ produced by the cells is called breathing/ respiration (physical, chemical & biological process).



HUMAN RESPIRATORY SYSTEM

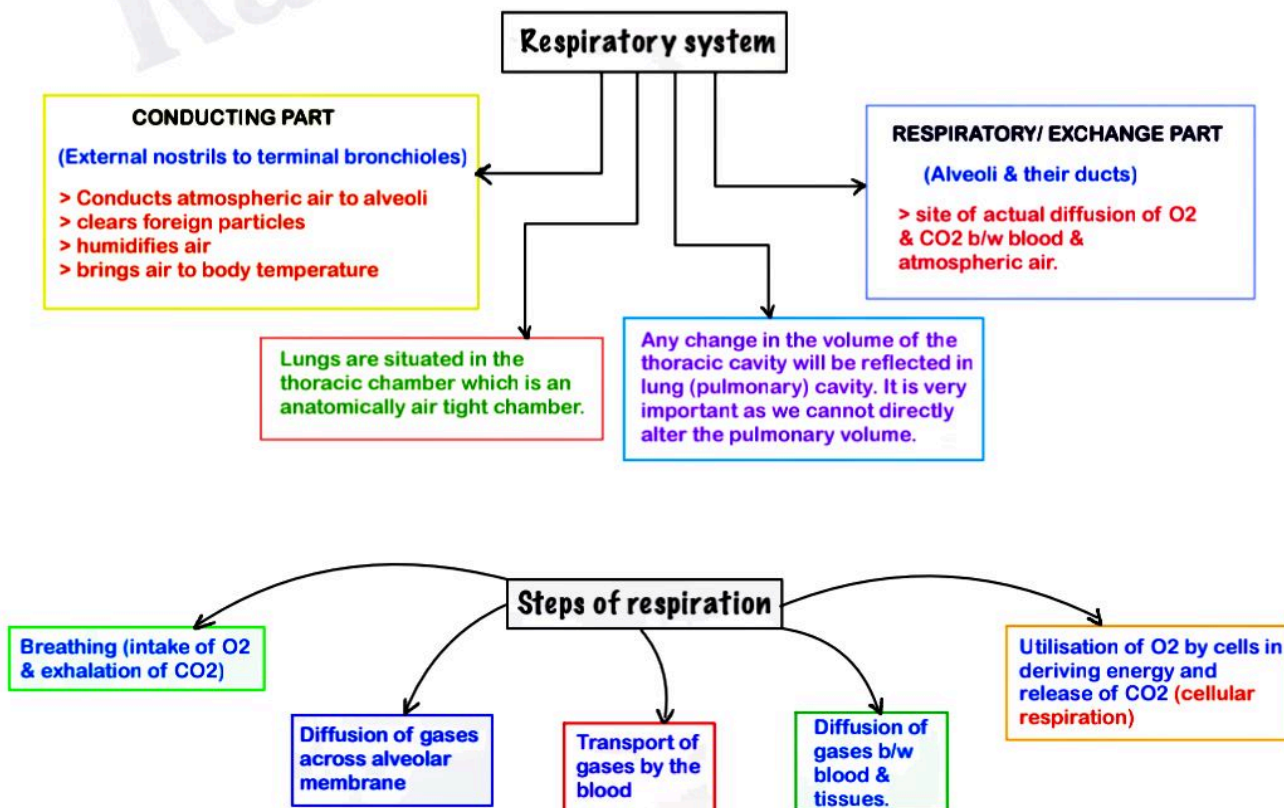
External nostrils → nasal passage → nasal chamber → pharynx (nasopharynx) → larynx region in trachea → trachea divides at 5th vertebra (thoracic) into right & left primary bronchi → secondary & tertiary bronchi & bronchioles → terminal bronchioles (thin) → irregular walled vascularised bag like structure called alveoli (the branching network of bronchi, bronchioles & alveoli comprise the lungs)

By Rakshita Singh Youtube

Larynx is a cartilaginous box helps in sound production & hence called the sound box.

Trachea primary, secondary, tertiary bronchi and initial bronchioles are supported by incomplete cartilaginous rings.

We have 2 lungs - double layered called as pleural membrane with pleural fluid filled b/w them. It reduces friction on the lung surface the outer pleural membrane is in contact with the thoracic lining whereas the inner layer is in contact with the lung surface.



Mechanism of breathing

Pressure gradient b/w lungs & atmosphere

Inspiration

- 1) Atmospheric air is moved in
- 2) there is a negative pressure in the lungs with respect to atmospheric pressure.
- 3) diaphragm contracts (increases volume of antero posterior axis)
- 4) external intercostal muscles contract & ribs/sternum moves upwards which increases volume of the thoracic chamber in the dorso-ventral axis.
- 5) intrapulmonary pressure is decreased.

We have ability to increase the strength of breathing with the help of additional muscles in abdomen. Healthy man breaths 12-16 times per minute. The volume of air involved in breathing movements can be estimated by using spirometer helps in clinical assessment of pulmonary functions.

Expiration

- > alveolar air is released out.
- > intrapulmonary pressure is higher than the atmospheric pressure.
- > relaxation of diaphragm and the intercostal muscle return to their original position & reduce the thoracic volume.
- > intrapulmonary pressure is increased
- > causes expulsion of air from the lungs.

Respiratory volumes & capacities

TIDAL VOLUME(TV)-
Volume of air inspired or expired during a normal respiration. It is approx 500ml. i.e. healthy man can inspire or expire approximately 6000 to 8000 ml per minute.

INSPIRATORY RESERVE VOLUME (IRV)-
Additional volume of air, a person can inspire by a forcible inspiration. This averages 2500 ml to 3000 ml.

EXPIRATORY RESERVE VOLUME (ERV)-
Additional volume of air a person can expire forcefully. This averages 1000ml to 1100ml.

RESIDUAL VOLUME (RV)-
Volume of air remaining in lungs even after forceful expiration. This averages 1100 to 1200ml.

INSPIRATORY CAPACITY (IC)-
Total volume of air a person can inspire after a normal expiration. Sum of tidal volume and inspiratory reserve volume. (TV+IRV).

EXPIRATORY CAPACITY (EC)-
Total volume of air a person can expire after a normal inspiration. Sum of total tidal volume & Expiratory reserve volume (TV+ERV).

FUNCTIONAL RESIDUAL CAPACITY (FRC)-
volume of air that will remain in lungs after a normal expiration. This includes ERV+RV.

VITAL CAPACITY (VC)-
Maximum volume of air a person can breath in or out after a forced expiration/ inhalation. Includes ERV+TV+IRV.

TOTAL LUNG CAPACITY-
Total volume of air accommodated in the lungs at the end of a forced inspiration. Includes RV, ERV, TV, IRV or VC+RV

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Exchange of gases

It is based on pressure and concentration gradient.
FACTORS RESPONSIBLE-
solubility of gases, thickness of membrane.

Pressure contributed by an individual gas in a mixture of gases is known as partial pressure and is denoted as pO_2 & pCO_2 for O_2 & CO_2 respectively.

As the solubility of CO_2 is 20-25 times higher than that of O_2 , the amount of CO_2 that can diffuse through the diffusion membrane per unit difference in partial pressure is much higher compared to that of O_2 .

DIFFUSION MEMBRANE IS MADE OF 3 LAYERS

Thin squamous epithelium of alveoli

Endothelium of alveolar capillaries

Basement substance b/w them

Its total thickness is less than 1mm. Hence every condition is favourable for respiration in our body.

Transport of gases

Transport of O₂

Oxygen - 97% by RBC + 3% by Plasma

Oxygen bind with Hb to form oxyhaemoglobin (reversible reaction). Then each Hb molecule carries 4 O₂ molecules.

FACTORS RESPONSIBLE FOR BINDING OF Hb WITH O₂:

pO₂, pCO₂, hydrogen ion concentration, temperature.

Oxygen dissociation curve is sigmoid in shape (graph b/w % saturation of Hb with O₂ against O₂).

Factors favourable for the formation of oxyhemoglobin-
In alveoli high pO₂, less pCO₂, less H⁺, less temp.

Factors responsible for breaking of HbO₂-
In tissues less pO₂, high pCO₂, High H⁺, high temperature.

Every 100ml of oxygenated blood can deliver around 5ml of O₂ to tissues.

Transport of CO₂

CO₂ - 70% by bicarbonate + 20-25% by RBC + 7% By plasma

CO₂ carried by Hb (20-25%) thus carbamino haemoglobin is formed.

Conditions for formation of carbaminohaemoglobin - high PCO₂, less pO₂ in tissues.

Conditions for dissociation of Carbaminohaemoglobin - less pCO₂, High pO₂ in alveoli.

RBC Contain a very high concentration of enzyme carbonic anhydrase and some quantity in plasma too. Hence the following reaction takes place.



At tissue the reaction forward in right direction and at alveoli reaction forward in opposite direction.

Every 100ml of deoxygenated blood delivers approximately 4ml of CO₂ to the alveoli.

Regulation of Respiration

Performed by neural system

Respiratory rhythm centre present in the medulla is responsible for the regulation.

Another centre present in the pons region of the brain called pneumotaxic centre can moderate the functions of the respiratory rhythm.

Neural signal from this centre can reduce the duration of inspiration and thereby alter the respiratory rate.

A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO₂ and H⁺ ion increase in these substance can activate this center which in turn can signal the rhythm centre to make necessary adjustment in the respiratory process by which these substance can be eliminated.

Receptors associated with aortic arch and carotid artery also recognise changes in CO₂ & H⁺ conc. And send necessary signals to the rhythm centre for remedial actions the role of oxygen in the regulation of respiratory rhythm is quite insignificant.

By Rakshita Singh Youtube

Disorders of respiratory system

Asthma

Difficulty in breathing causing wheeziness due to inflammation of bronchi & bronchioles.

Emphysema

Chronic (cannot be easily cured) disorder in which alveolar walls are damaged due to which respiratory surface is decreased. Reason is cigarette smoking.

Occupational respiratory disorder

In stone breaking industry, so much dust is produced, long exposure can give rise to inflammation leading to fibrosis (proliferation of fibrous tissue) and causes serious lung damage.

Workers in such industries should wear protective masks.