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* Physiological anatomy of Respiratory System ?

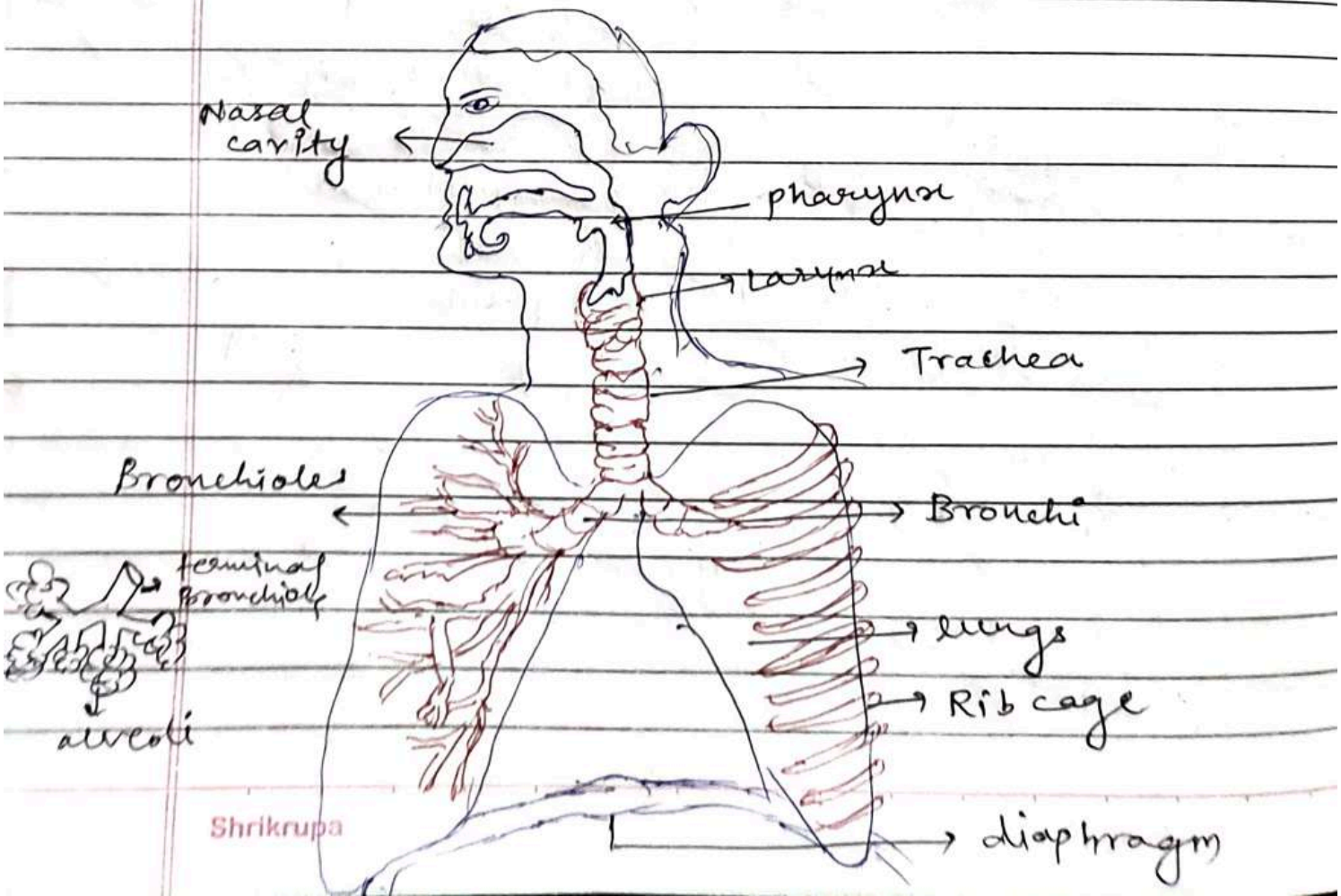
→

Respiratory system is the network of organs and tissues that help you to breath. The primary function of this system is to introduce oxygen into the body and expel carbon dioxide from the body.

Respiratory system composed of Nose, oropharynx, larynx, trachea, bronchi, bronchioles, and lungs. (alveoli)

Lungs further divided into individual lobes which subdivided into millions of alveoli.

Alveoli are the primary location for gas exchange. The important respiratory organs in livingbeings include- Lungs, gills, trachea and skin.



- there are also muscles and vast network of blood vessel that facilitate the process of respiration.

- Parts of respiratory system -

(a) External Nostril, Internal Nostril.

1) Nose - Humans have exterior nostrils, which are divided by framework of cartilagenous structure called the septum.
- septum is the structure that seperates the right nostril from the left nostril. (external Nostril is for the intake of air)

(b) Nasal chamber
- Tiny hair follicles that cover the interior lining of nostrils; act as the body's first line of defence against foreign pathogens.
- Nasal hair provide additional humidity for inhaled air. (Nasal chamber lined by hair and mucous to filter the air from dust and dirt)

(3) 2) Larynx - It is the area of the throat containing the vocal cord and used for breathing, swallowing and talking.
- It is also called as Voice box or sound Box.
- Larynx is often divided into three sections i.e. Sublarynx Larynx and supralarynx.
- It is formed by nine cartilages that are connected to each other by muscle and ligaments.
- Larynx plays important role in human speech.

fun^n of larynx - The primary function of the larynx in humans and other vertebrates is to protect the lower respiratory tract from aspirating food into the trachea while breathing. It also contains vocal cords and functions as a voice box for producing sounds i.e. phonation.

(c)

3) Pharynx - It is the hollow tube inside the neck that starts behind the nose and ends at the top of trachea (windpipe) & oesophagus (the tube that goes to stomach).

- The pharynx is about 5 inches long, depending on the body size. Also called throat.
- The pharynx is divided into three regions according to the location i.e. the nasopharynx, the oropharynx and the laryngopharynx or hypopharynx
- pharynx is composed of mucous membrane, submucosal connective tisnue, lymphoid tisnue.
- fun^{n} of pharynx - It carries air, food and fluid down from the nose and mouth.
- The pharynx is the site of common illness, including sore throat and tonsillitis.

(f)

4) Trachea - Trachea is also known as windpipe.
- It is a cartilaginous tube that connects the larynx to the bronchi of the lungs.
- It allows the passage of air and present in almost all breathing animals with lungs.
- The trachea, extends from the larynx and branches into the two primary bronchi.
- At the top of the trachea the cricoid cartilage attaches it to the larynx.
- The trachea is formed by a number of horseshoe-shaped rings joined together vertically by ligaments and by trachealis muscle at their end.

- The trachea is composed of hyaline cartilage on the anterior and lateral walls.
- The tracheal lumen lined by ciliated pseudostratified columnar and goblet cells that create the tracheal mucosa.

(e) Epiglottis - The Epiglottis is a small, movable lid just above the larynx that prevents food and drink from entering the windpipe.
Swelling of the epiglottis can completely block the airway or airpassage. (It is the flap like structure that covers the glottis.)

(g) 5) Bronchi - The trachea divides into left and right bronchi.
- It represents the passage leading into the lungs. The 1st bronchi branch from trachea and they are right and left main bronchi.
- Bronchi enters into the lungs. After entering the lungs, the bronchi continue to branch further into the secondary bronchi known as lobar bronchi, which then branch into tertiary (segmental) bronchi.

(h) 6) Bronchioles - Each bronchus is further divided into Bronchiole
- The Bronchioles or bronchioli are smaller branches of the bronchial airway of the lower respiratory tract
- It carry air to small sacs in your lungs called alveoli.
- Bronchioles are divided into 3 parts i.e. Conducting Bronchiole, Terminal bronchiole & Respiratory Bronchiole.

(7) 7) Alveoli - The bronchiole terminate in ballon like structures known as the alveoli.
- It is the air sacs at the end of the bronchioles.
- The alveoli are where the lungs and the blood exchange O_2 and CO_2 during the process of inhalation and exhalation.
- It is estimated that, there are 300 - 500 million alveoli in the adult lungs.
- It is hollow cup shaped cavity in the lungs where gas exchange takes place.
- Alveolar Sac lined by squamous cell.

(8) 8) Lungs - Humans have a pair of lungs, which are sac like structure and covered by double layered membrane called pleura.
- Lungs plays an important role in respiratory system i.e. They bring oxygen into the bodies called inhalation and send CO_2 out of the body called exhalation.
- Lungs also contain elastic tissues that allow them to inflat and deflate without loosing shape
-
- It is the primary organ of the respiratory system.
- two lungs are located near the backbone on either side of the heart.
- Lungs covered by means of rib cage. Rib cage supports the lungs.

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→ Lungs

- The lungs are located in the chest on the either side of heart in the rib cage.
- The lungs are surrounded by pulmonary pleurae. The pleurae are two serous membrane that is outer parietal pleura and inner visceral pleura.
- They are conical in shape with a narrow rounded apex at the top and broad concave base that rests on the surface of the diaphragm.
- Right lungs having two lobes i.e. Right and the left lobe.
- The right lung has three lobes - upper, middle and lower
- The left lung has two lobes - an upper lobe & lower lobe.
- The primary function of the lungs is to facilitate gaseous exchange. alveoli is the functional unit of the lungs, have thin membranes that allow easy exchange of gase
- The diaphragm and intercostal muscles are two main respiratory muscles that help in inhalation & exhalation.

* function of Respiratory system The function of the respiratory system are as follows -

① Inhalation and Exhalation - The respiratory system helps in breathing.
The air inhaled through the nose moves

through the pharynx, larynx, trachea and into the lungs.
The air is exhaled back through the same pathway.

(2) Exchange of gases between lungs & Bloodstream -

- Inside the lungs, the O_2 and CO_2 enters through alveoli. The inhaled O_2 diffuses into the pulmonary capillary, binds to Haemoglobin & is pumped through the blood stream.
- the CO_2 from the blood diffuses into the alveoli and is expelled through exhalation.

(3) The vibration of the vocal cord.

- while speaking, the muscle in the larynx move the 'archeoid' cartilage.
These cartilage push the vocal cord together.
- During exhalation, when the air passes through the vocal cord, it makes them vibrates & create sound.

(4) olfaction and Smelling -

During inhalation, when the air enters the nasal cavity, some chemicals present in the air bind to it and activate the receptor of the ~~respiratory system~~. Nervous system on the cilia. The signals are sent to the olfactory bulb via the brain.

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Mechanism of Breathing

* **Breathing -**

- The physical process of taking oxygen into the lungs and leaving CO_2 out from the body is called as breathing.
- Breathing rate is usually 15-18 times/min.
- This is carried out through various respiratory organs.

* Mechanism of Breathing ←

- The mechanism of breathing consist of two simple processes that are inspiration and expiration.
- Inspiration (inhalation) is the process in which air moves into the lungs and during this process contraction of muscles attached to ribs takes place and on the outer side ribs are pulled out.
- This result in the expansion of the chest cavity and produces a partial vacuum that helps to suck the air into the lungs and expand the alveoli.
- Expiration (exhalation) is the process of giving air out of the lungs.

Mechanism of Breathing

Inspiration or Inhalation	Expiration or Exhalation
↓	↓
Mechanism of Inspiration	Mechanism of Expiration

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Mechanism of Inhalation or Inspiration

Musular region of diaphragm contracts

External intercostal muscle contract

Internal intercostal muscles relax

↓

diaphragm flattened

Ribs moves up and out

↓

Volume of thorax increases

↓

Pressure around the lungs decreases

↓

pressure in alveoli descreases

↓

Air enters lungs

Mechanism of Exhalation or Expiration -

Musular region of diaphragm relax

External intercostal muscle relax

Internal intercostal muscle contract

↓

Ribs moves down and in

↓

diaphragm returns to dome shaped

↓

Volume of thorax decreases

↓

pressure around lungs increases

↓

pressure in alveoli increases

↓

air leaves lungs.

① Inspiration -

- In the process of inspiration, there would be a contraction of muscles attached to the ribs on the outer side which pulls out the ribs and results in the expansion of the chest cavity.
- Later, the diaphragm contracts, moves downwards and expands the chest cavity resulting in the contraction of the abdominal muscles.
- The expansion of the chest cavity produces a partial vaccum which sucks air into the lungs and fills the expanded alveoli.

- Mechanism of Inspiration -

- The process of intake of atmospheric air is known as inspiration, it is an active process.
- When the volume of the thoracic cavity increases & the air pressure decreases, inspiration takes place.
- Contraction of external intercostal muscles increases the volume of the thoracic cavity.
- Contraction of the diaphragm further increases the size of the thoracic activity.
  Simultaneously, the lungs expand.
- With the expansion of the lungs, the air pressure inside the lung decreases.
- The pressure equalizes and the atmospheric air rushes inside the lungs.

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② Expiration —

- The expiration process is considered once after the gaseous exchange occurs in the lungs and the air is expelled. The expulsion of air is called expiration.
- During this process, muscles attached to the ribs contract, the muscles of the diaphragm and the abdomen relax which leads to a decrease in the volume of the chest cavity and increases the pressure of the lungs, causing the air in the lungs to be pushed out through the nose.

- Mechanism of Expiration —

- The process of exhaling CO_2 is called expiration. It is a passive process.
- It occurs when the size of the thoracic activity decreases and the air pressure outside increases.
- Now the external intercostal muscles relax and the internal intercostal muscle contract.
- As the result, the ribs are pulled inwards and the size of the thoracic cavity is reduced.
- The diaphragm is relaxed and the lungs get compressed.
- The pressure is then increases and the air is forced outside.

* The diaphragm —

- The diaphragm is the main muscle of inspiration, which is a skeletal muscle.
Inflation of the lungs is caused primarily by contraction of diaphragm.

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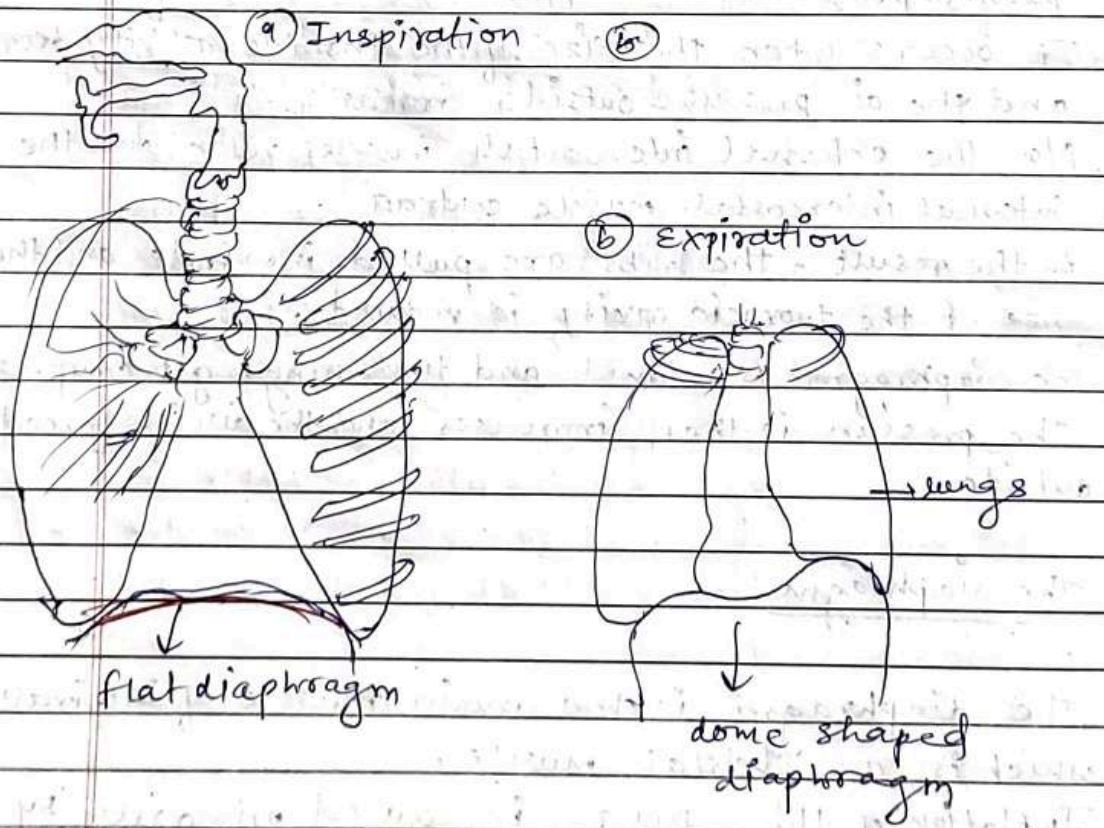
- Contraction of diaphragm expands the thoracic cavity into two ways -

1) The diaphragm is dome shaped and attached to the lower 6 ribs and the xiphoid process of the sternum. Thus when it contracts, the dome is flattened and abdominal content pushed downward so that the thoracic cavity enlarges in its rosto-caudant extent.
Thus the vertical diameter of the thoracic cage increases.

2) Contraction of diaphragm also pushes the rib cage outward that enlarges the thoracic cavity in its anterio-posterior and lateral planes.



- External intercostal muscle -

- External intercostal muscles are present obliquely between ribs in forward and downward direction. Their attachment to lower rib is more forward from the axis of rotation.
- Therefore, contraction of external intercostal muscle raises the lower rib.
- contraction of external intercostal muscle has 2 effect.
  (1) Bucket-handle effect - Increases the transverse diameter of the thoracic cavity.
  (2) Pump-handle effect - Increases the vertical diameter of thoracic cage then antero-posterior diameter also increases to some extent.

* sequence of event in Inspiration -

Inspiratory muscle contract
↓
Volume of thoracic cavity increases
↓
Lungs are stretched; Intrapulmonary volume increases
↓
Intrapulmonary pressure drops (to -1 mm Hg).
↓
Airflows into lungs down

* sequence of events in Expiration -

Inspiratory muscle relax → volume of thoracic cavity decreases → Intrapulmonary volume decreases → Intrapulmonary pressure rise

Air flows out of lungs.

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(8) → Lung volume and capacity

- Lung volumes and lung capacities refers to the volume of air in the lungs at different phases of the respiratory cycle.
- The average total lung capacity of an adult human male is about 6 litre of air.
- Lung volume are also known as respiratory volume.
- Lung capacities are derived from a summation of different lung volume.
- There are four types of lung volume -
  1) Tidal volume
  2) Inspiratory Reserve volume
  3) Expiratory Reserve volume
  4) Residual volume.
- There are three lung capacity -
  1) Inspiratory capacity 4) functional residual capacity.
  2) Total lung capacity
  3) vital capacity.

a Lung Volume -

I] Tidal Volume (TV) -

- Tidal Volume is the amount of air that can be inhaled or exhaled during one respiratory cycle.
- T_V or TV denotes Tidal volume.

In an healthy young human adult, tidal volume is approximately 500 ml per inspiration or 7 ml / kg of body mass.

II) Inspiratory reserve volume — An Inspiratory reserve volume is a supplementry volume, approx. ranging between 2500 to 3100 ml of air which could be effectively inhaled after the inspiration of standard tidal volume.

- It is the amount of extra air inhaled above tidal volume during forceful breathin or inhalation.
- Average inspiratory reserve volume is about 3000 ml in males and 2100 ml in females.
- It is denoted by IRV.

III) Expiratory reserve volume.

- The extra volume of air that can be expired with maximum effort beyond the level reached at the end of a normal, quiet expiration.
- It is denoted by ERV.
- The additional capacity of air which is about 1200 ml are that could be forcefully exhaled out after the expiration of a standard tidal volume.
- The average Expiratory reserve volume is about 1100ml in male and 800 ml in females.

IV) Residual volume — It is denoted by RV.

- It is the volume of air remaining in the lungs after maximum forceful expiration or Breathout.

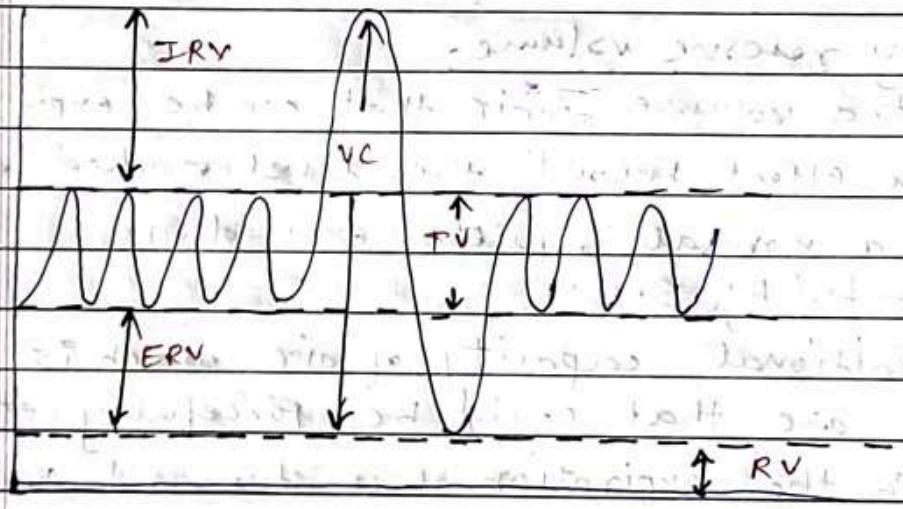
- It is the volume of air that cannot be expelled from the lungs, thus causing the alveoli to remain open at all times.
- Residual volume is calculated by subtracting the expiratory reserve volume from the functional residual capacity.

RV = FRC - ERV. OR RV = TLC - IVC.

- Normal adult value is 1200 ml or 20-25 ml/kg

Lung capacities -

1] Inspiratory capacity -



* Lung volume Graph * where, IRV - Inspiratory reserve volume
ERV - Expiratory reserve volume
VC - Vital capacity
TV - Tidal volume
RV - residual volume.

lung capacities of an healthy man is estimated to be 6000 ml.

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* Lung capacity - Lungs capacity are of 3 types are as follows:-

(1) Inspiratory Capacity -

It is also known as Normal inspiratory capacities. It is about 3 litre or 3,000 ml Inspiratory capacity is the total volume of air that can be inspired. which is about 3600 ml.

$IC = TV + IRV$.

(2) Total lung capacity - The total lung capacities appies to the total volume of air filled in the lungs after a forfull inspiration.
The total lung capacity (TLC) of healthy man is estimated to be 6000 ml.

$TLC = TV + ERV + IRV + RV$.

(3) Vital capacity - Vital capacity is the total volume of air that can be expired or exhaled after a maximum inhalation or maximum air that a person can breath in after forced expiration.

- It is an important measure of a person's respiratory health.
- A decreased vital capacity is an indication of restrictive lung disease where the lungs can not expand completely.
- In the case of Normal vital capacity, the improper functioning of lungs indicates obstructive lung disease, where the lungs are blocked in the airway.

$VC = TV + ERV + IRV$.

- vital capacity of normal adult ranges betw 3 to 5 litre.

(4) functional residual capacity -

- The functional residual capacity is the total volume of air residing within the lungs after an exhalation process.
- It is about 2400 ml.
- The residing air present within the lungs which does not participating in gas exchange is located in the portion of the airways inside the bronchi and bronchiole and outside the alveoli.