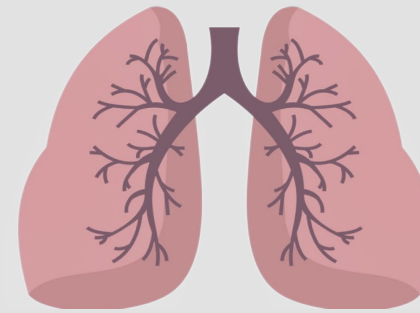


Functions & Organization of The Respiratory System



Respiratory Block

Physiology 439 team work



Editing file



@Physiology_439

- Black: in male / female slides
- Red : important
- Pink: in female slides only
- Blue: in male slides only
- Green: notes
- Gray: extra information
- Textbook: Guyton + Linda

Objectives :

01

Describe the structures and functions conductive and respiratory zones of airways.

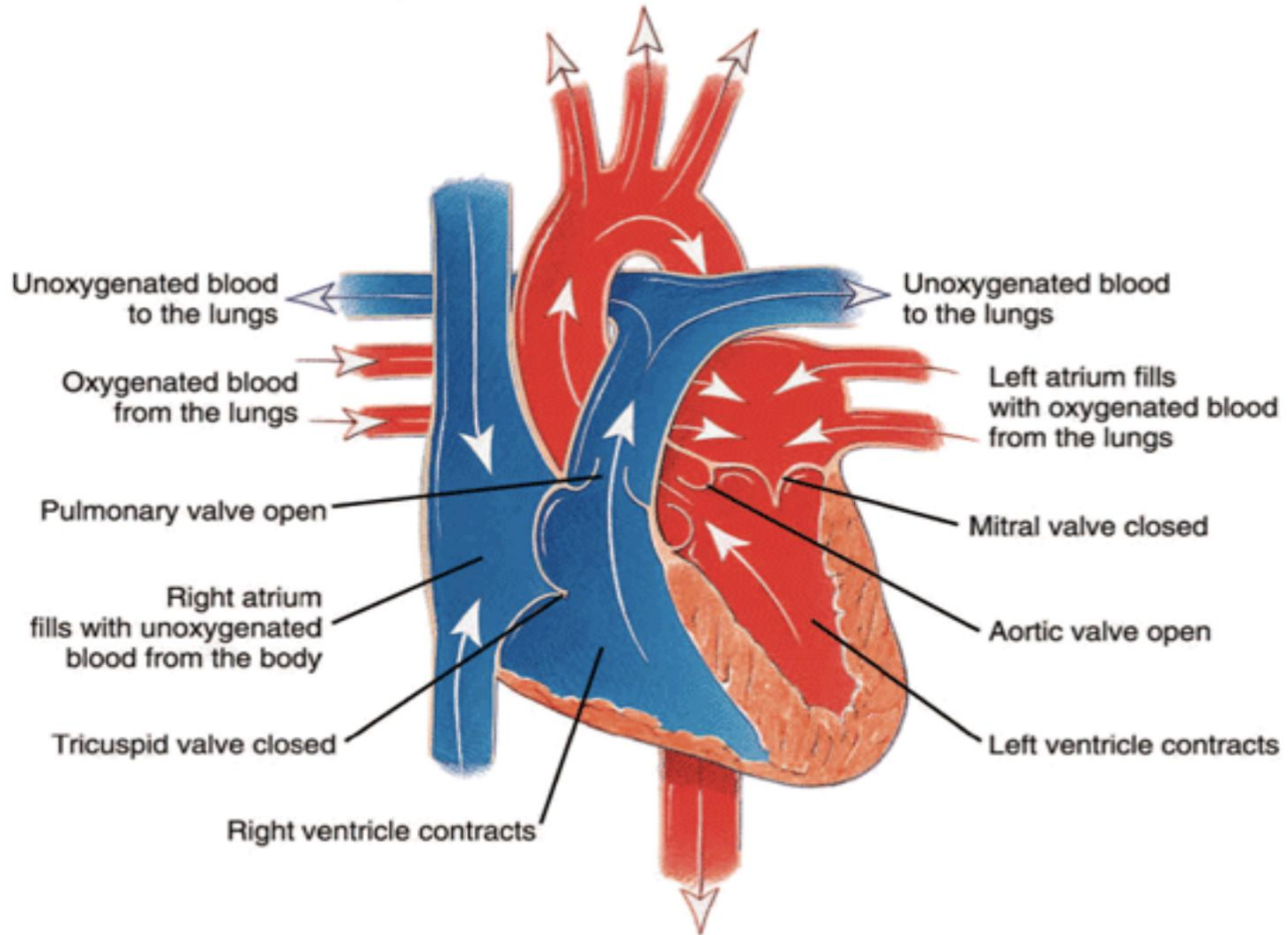
02

Distinguish the difference between internal and external respiration

03

Discuss the functions of the respiratory system, including non-respiratory functions, like clearance mechanism by mucus and cilia, production of surfactant and its physiological significance.

Oxygenated blood to the head and upper limbs



Oxygenated blood to the abdomen and lower limbs

The main goal of respiration is to:

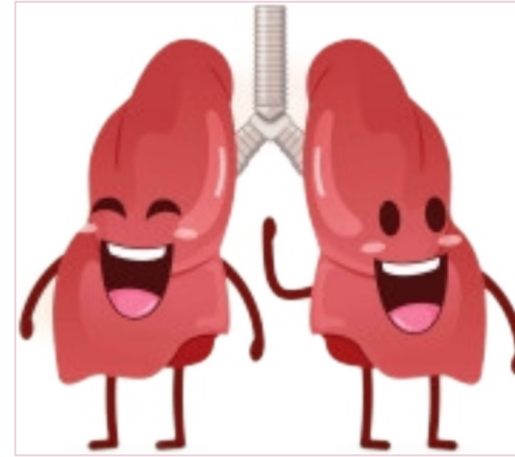
1

Provide oxygen to tissues.

2

Remove CO₂ from the body.

Remove CO₂ more than provide O₂ to maintain the PH

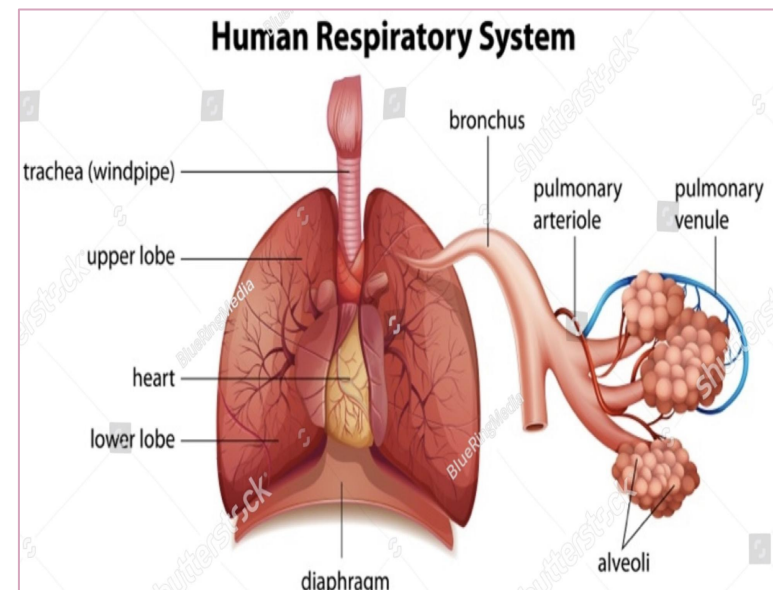


The Respiratory system consist of :

1 Passages (airways)

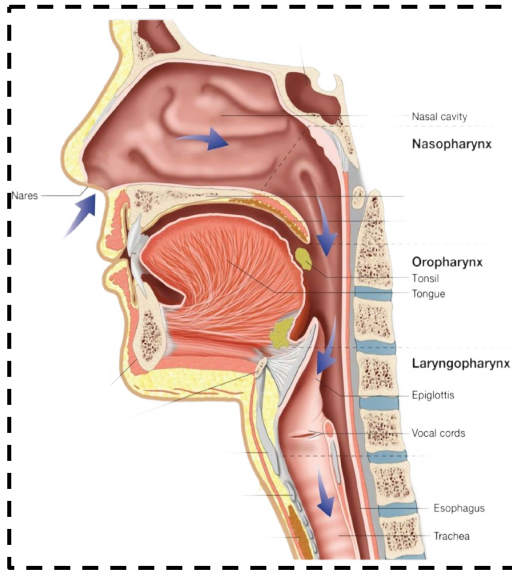
2 Muscles

3 Centers



Organization of The Respiratory System

Respiratory passages (airways)



Upper Tract

Nostrils.

Nasal cavity

Pharynx

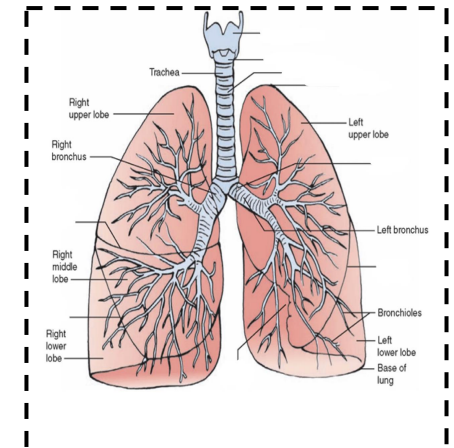
Larynx

Trachea

Primary bronchi

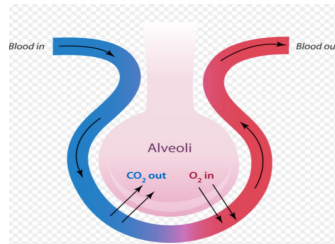
Lungs

Lower Tract



Functions of the Respiratory system

1- Gas exchange (Respiratory function) Main function



2- Phonation (the production of sound by the movement of air through the vocal cords)

3- Pulmonary defense: the respiratory mucus has a muco-ciliary barrier filter and it produces:

1. Immunoglobulin A (IgA)
2. Alpha-1 antitrypsin: protects the lung from the actions of trypsin
3. pulmonary **macrophages**: engulf smaller foreign bodies that pass through the muco-ciliary barrier

4- Angiotensin I is converted into Angiotensin II with the help of Angiotensin converting enzyme formed by the lungs

Angiotensin II maintain the high level of blood pressure, so patients with hypertension we should give them ACE inhibitor

5- **Regulating the acid-base** status of the body by washing out extra CO₂ from the blood

6- Secretion of important substances like **surfactant**

Trypsin is proteolytic enzyme produce by bacteria to digest the tissue "اللي أصلا عباره عن بروتينات" so when Bacteria enter the respiratory system , the respiratory system produced alpha-1 anti trypsin to protect us

Respiratory passages (airways)

Conductive Zone (No gas exchange)

Non respiratory function (مجرد ناقل للهواء)

- Extends from nose to the end of terminal bronchioles
- Help in warming, humidification and filtration of inspired air.
- Contains the olfactory receptors for smell sensation.
- Conducts the sound during speech.
- Helps in coughing and sneezing reflexes for protection.

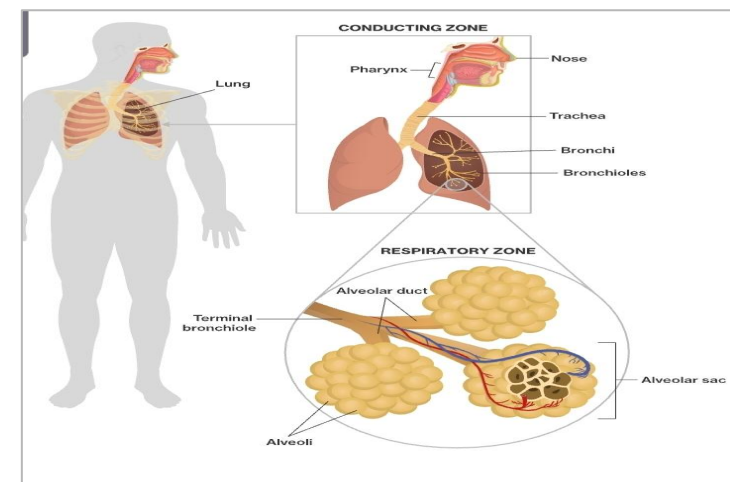
Respiratory Zone (Respiratory unit)

Includes:

- Respiratory bronchioles, alveolar ducts, alveolar sacs and alveoli.
- Function in **gas exchange**.

| | Name of branches | Number of tubes in branch |
|------------------|-------------------------|---------------------------|
| Conducting zone | Trachea | 1 |
| | Bronchi | 2 |
| | | 4 |
| | | 8 |
| | Bronchioles | 16 |
| Respiratory zone | Terminal bronchioles | 32 |
| | | 6×10^4 |
| | Respiratory bronchioles | 5×10^5 |
| | Alveolar ducts | |
| | Alveolar sacs | 8×10^6 |

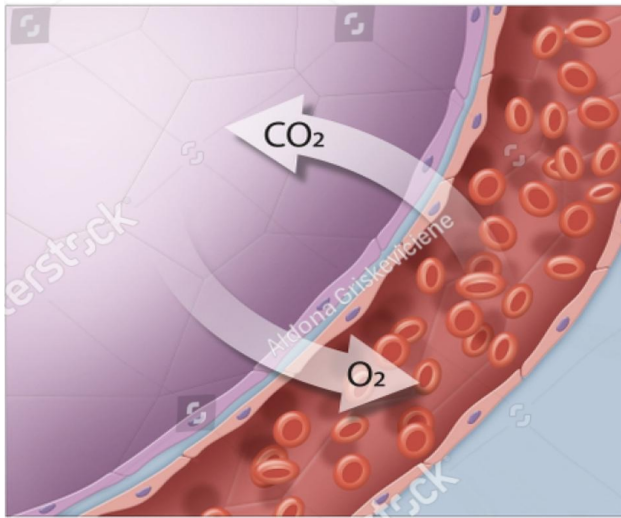
هنا عدد التفرعات التي تساعدنا نحدد وين بتكون المقاومة أكثر



External & Internal respiration

External respiration

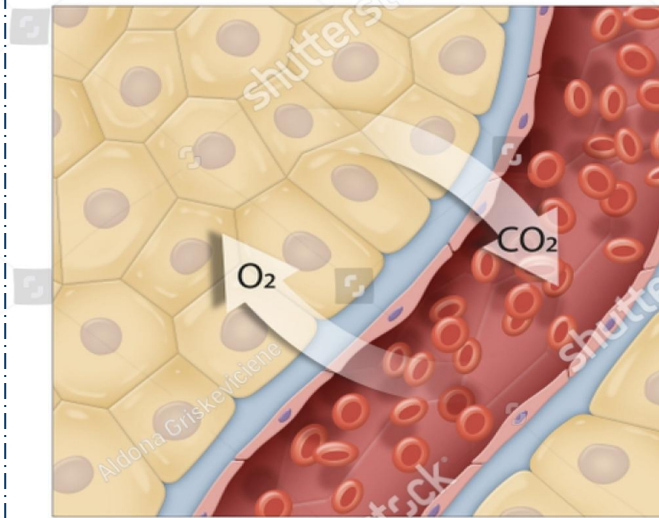
is the process of gas exchange between the alveolar air and the pulmonary capillary blood.



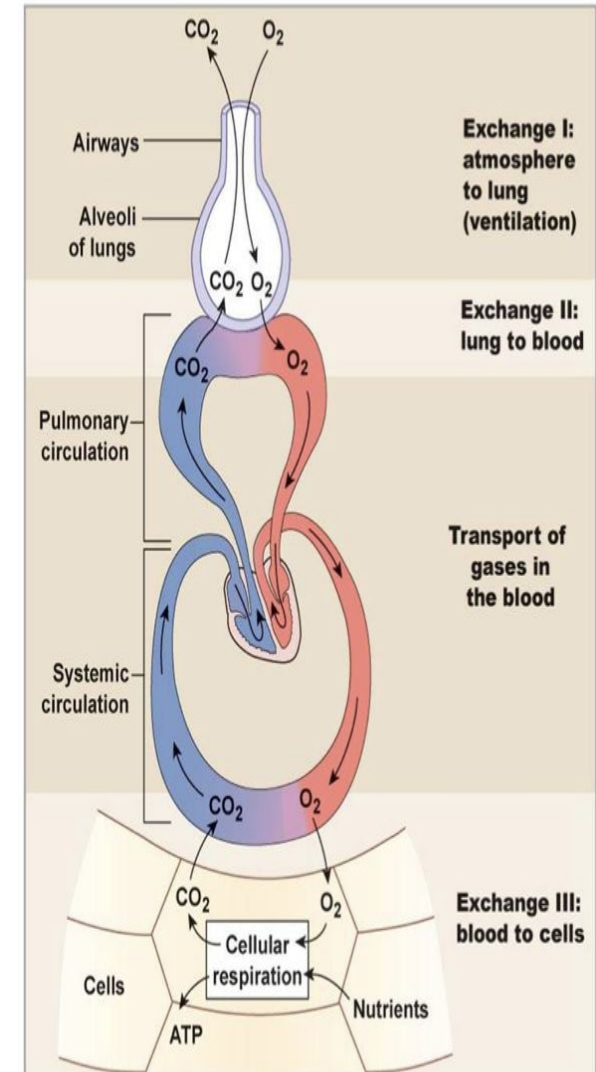
Pulmonary capillary

Internal respiration

is the process of gas exchange between the blood in the systemic capillaries and the tissues.



Systemic capillary



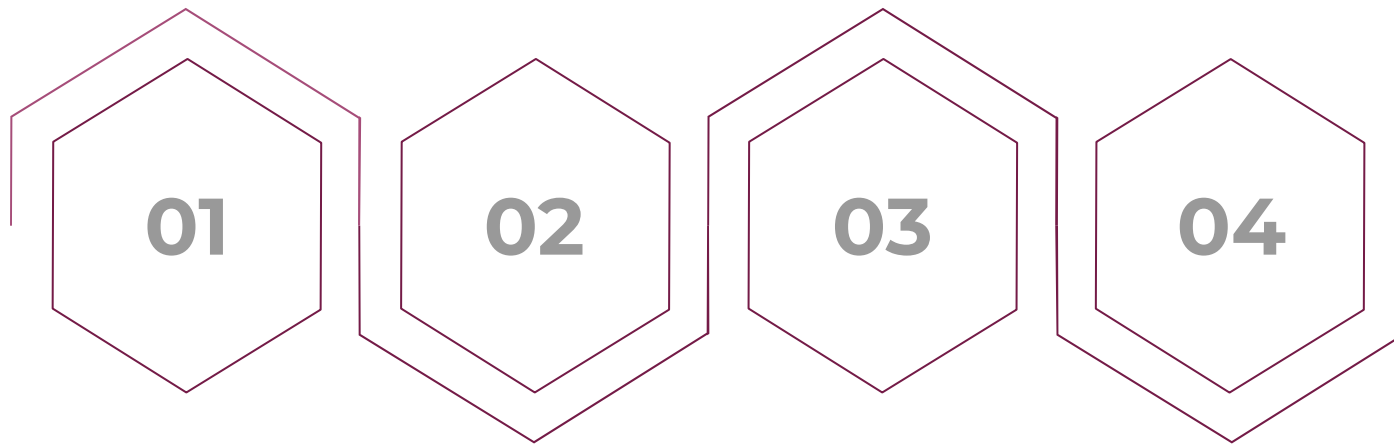
The four major events of respiration are:

Pulmonary ventilation

Inflow & outflow of air from the lung alveoli and the atmosphere
(Is discussed in next lectures)

Transport

Transport of O₂, CO₂ In blood and body Fluids to and from Body's tissue cells (From the lung to the body)



Diffusion

Diffusion of O₂ & CO₂ between the lung alveoli and blood (pulmonary capillaries)

Regulation

Regulate the ventilation and other facets of respiration

Respiration (breathing) could be either:

Resting breathing: normal breathing during resting conditions.

Forced (maximal) breathing: It occurs during exercise and in patients with bronchial asthma, allergy, other pulmonary diseases.

Lining cells of the alveoli

1- Type I alveolar epithelial cells (type I pneumocytes)

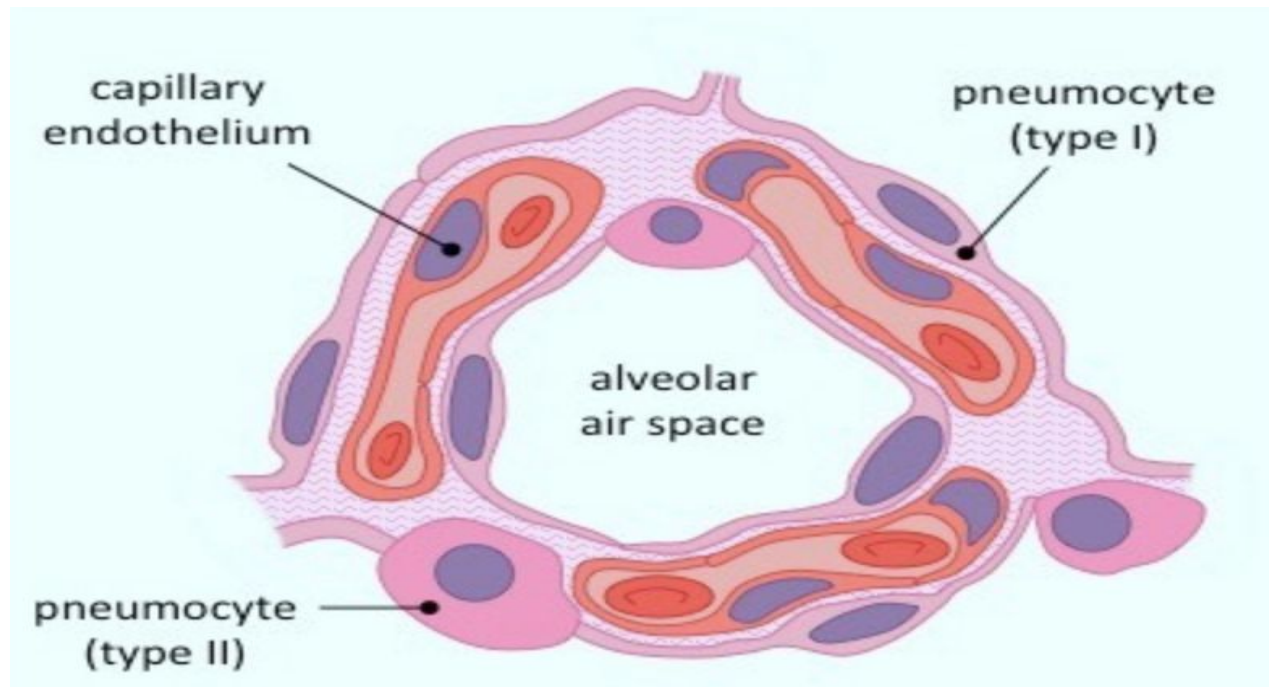
*Participate in the respiratory membrane, across which gas exchange takes place.

2- Type II alveolar epithelial cells (type II pneumocytes)

(10% of the surface area of alveoli) *Secrete surfactant.

3- Alveolar macrophages

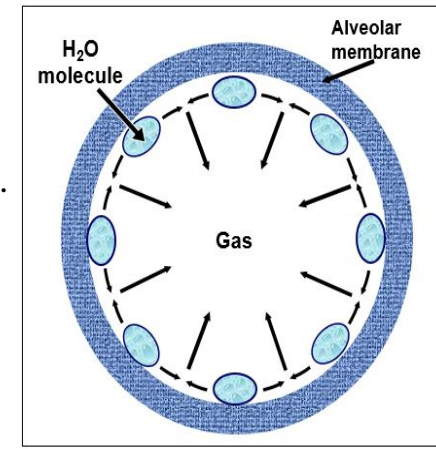
*Engulf the foreign bodies that reach the alveoli.



Surface Tension

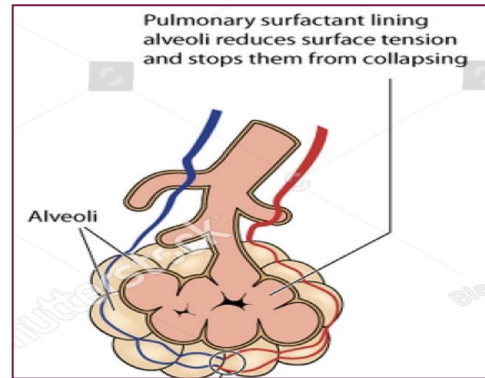
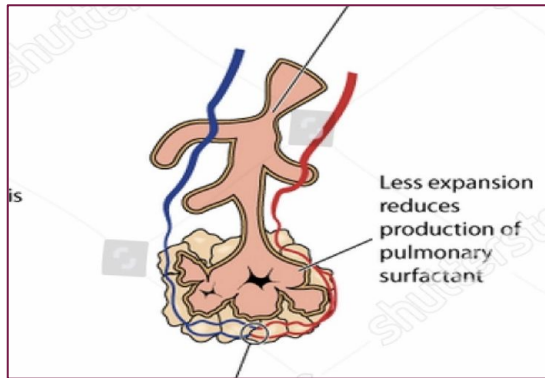
Surface Tension: When H_2O molecules at the surface of alveoli are attracted to each other by attractive forces that resist distension.

- Surface tension tends to oppose alveoli expansion.
- Pulmonary surfactant reduces the surface tension of the fluid lining the alveoli.
- Collapsing Pressure is Caused by Surface Tension and is indirectly related to the size of alveoli (law of LaPlace).



$$\text{Pressure} = \frac{2 \times \text{Surface tension}}{\text{Radius of alveolus}}$$

As the surface tension increases, the collapsing pressure increases.



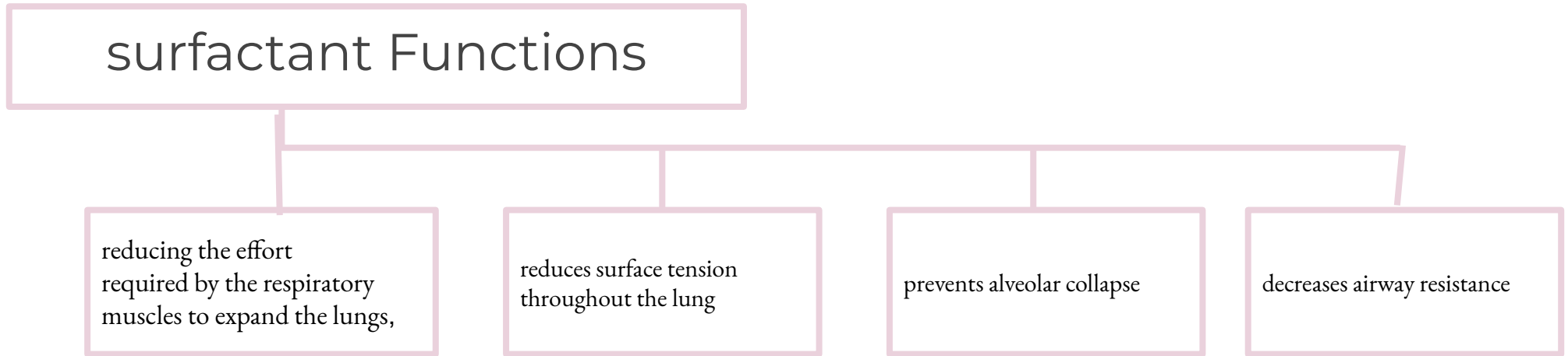
التوتر السطحي يسبب انكماش وتضييق الالفبولاي ودور السيرفكتنت انه يمنع تكون التوتر السطحي وبالتالي يساعد على سهولة زيادة حجم الالفبولاي ويصير التنفس وتبادل الغازات اسهل

[Helpful video](#)



Surfactant

- Surfactant is a complex compound containing phospholipids especially **dipalmitoylphosphatidylcholine** and a number of **Apo proteins**.
- The earliest detection of surfactant from fetal alveoli begins between 6-7th month but this could be delayed in others to **wk 35** of intrauterine life.



أي ممر للتنفس فالجسم لديه مقاومة بسيطة لمرور الهواء عبره، باعتبار ان الهواء جسم غريب والطبيعي تكون هناك مقاومة للاجسام الغريبة. المقاومة تتم عن طريق سموت مسلز شيء طبيعي لكن، لو زادت انقباضات العضلات بالتالي يصير عندي
increase airways resistance
وهذا يجعل السير فاكنتت يقل

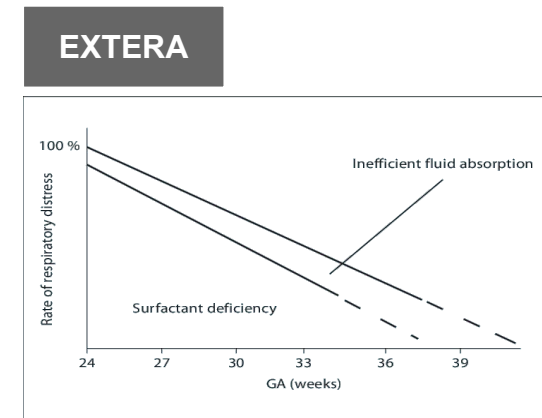
*How is surfactant related to the work of breathing?

More surfactant -> less resistance -> air flows in easily -> with one breath a good amount of air flows in (e.g. 0.5 ml) -> less energy -> less work.

Less surfactant -> more resistance -> air does not flow in easily -> you need more breaths to be able to reach the amount of air taken in by one normal breath (e.g. 0.5 ml)

-> therefore putting in more energy -> more work.

Since the surfactant begins to form in the 7th month most likely that the infant will die if delivered before that period and as time passes by, the rate of respiratory distress decreases (because surfactant is starting to gradually form)



Surfactant Deficiency

RDS Disease

(respiratory distress syndrome)

Deficiency of surfactant in premature babies causes this disease
Also called hyaline membrane disease

Prevention

Corticosteroid injections to mothers who are expected to deliver prematurely (reaches infant through placenta)

Postnatal treatment

After delivery infants are given inhaled surfactant (derived from animal lungs)

Risk factors

In Adults:Smoking, hypoxia & hypoxemia decrease the secretion of surfactant (causes adult RDS)

In infants: Preterm birth

Respiratory Distress Syndrome (RDS)

Also known as **Hyaline Membrane Disease (HMD)**
RDS occurs primarily in premature infants, its Incidence is inversely related to gestational age and birthweight

| Gestational age | Percentages |
|-----------------|-------------|
| <28 wks | 60-80% |
| 32-36 wks | 15-30% |
| 37-39 wk | 5% |

Learn more about surfactant [here](#)



Innervations of Lungs & Bronchi

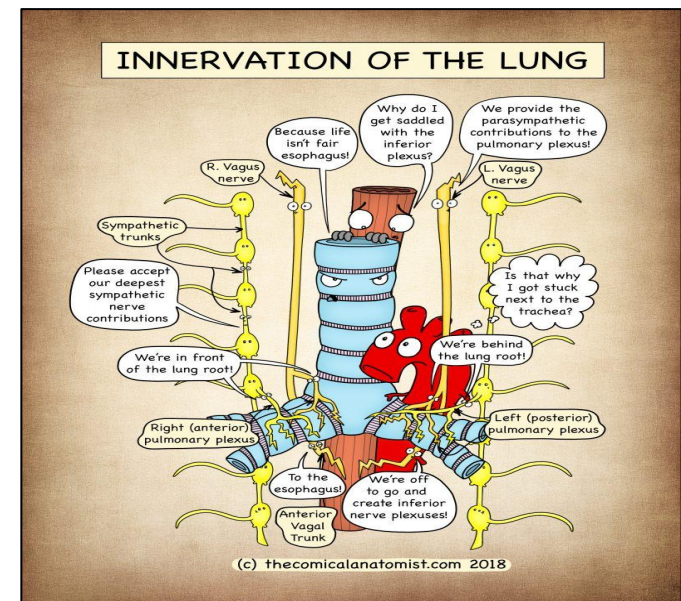
Innervated by autonomic nerves

Constrictors

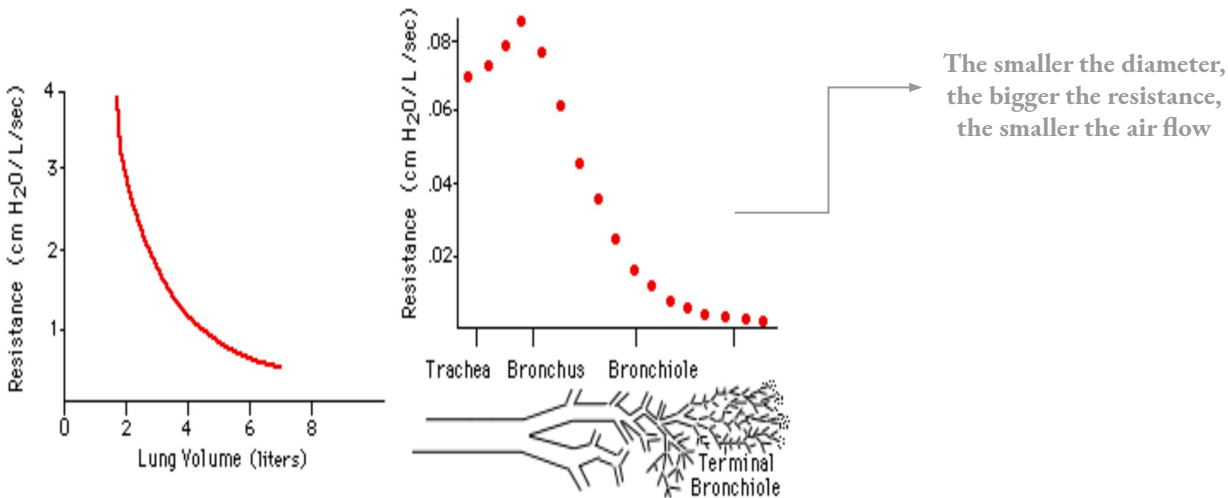
- **Histamine & SRSA** “slow reacting substances of anaphylaxis like bradykinin” are secreted by mast cells due to allergy like patients with asthma, often cause bronchiolar constriction and increase airway resistance leading to forced breathing.
- **Smoking, dust and sulfur dioxide & some acidic elements** in smog inhalation may act directly on the lung and causes obstructive constrictions of the airways
- Parasympathetic stimulation releases **Ach** which causes constriction of bronchi.
- Constrictors causes increased airway resistance as well as forced breathing and coughing

Dilators

- Sympathetic stimulation releases **epinephrine (adrenaline)** which causes dilatation of bronchi



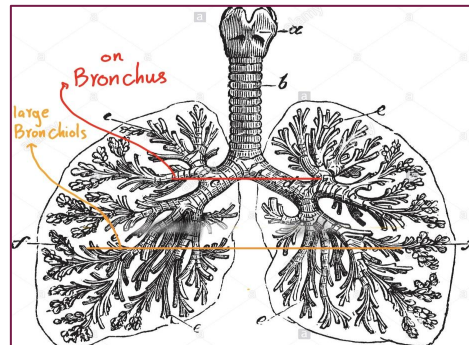
Resistance to Airflow in The Bronchial Tree



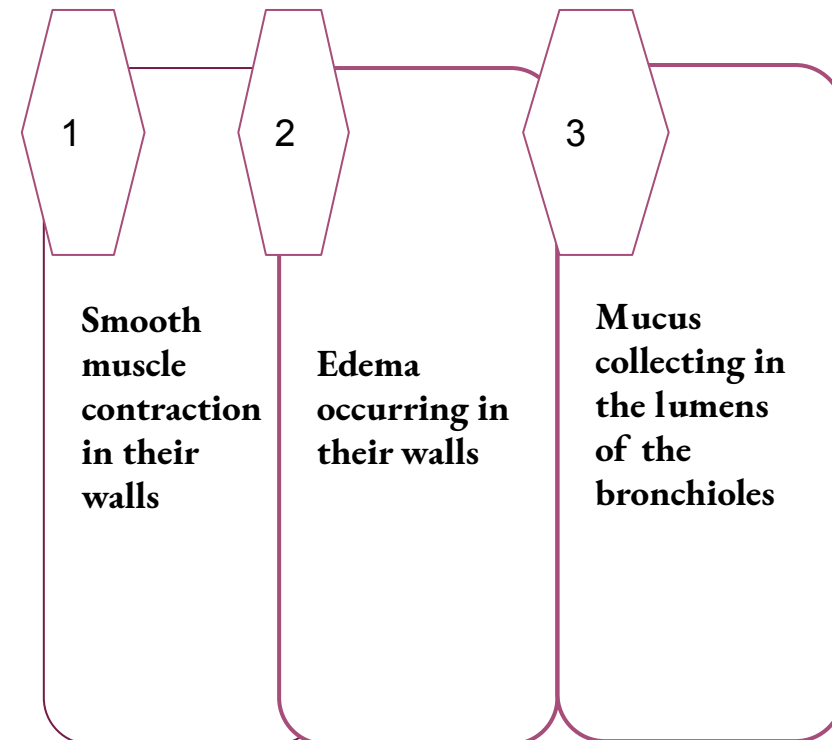
Resistance/Volume
 - The greatest amount of resistance occurs in the larger bronchioles and bronchi near the trachea, The reason for this high resistance is that there are relatively few of these larger bronchi in comparison with the approximately 65,000 parallel terminal bronchioles,

(This is why we call it bronchial asthma not bronchioles asthma, because the problem is in the bronchi)

كل ما زاد ت التفرعات كل ما زاد ال cross section كل ما قل resistance ال
 بمعنى في bronchi التفرعات قليلة لذلك ال cross section area ال
 قليل لذلك المقاومة عالية جدا ونفس الكلام في ال large terminal bronchioles
 لكن لو نلاحظ ال bronchiole التفرعات اللي طالعه منها مره كثير لذلك ال cross section area ال
 كبير لذلك المقاومة منخفضة



In some diseases, the smaller bronchioles play a greater role in determining airflow resistance because of their small size and because they are easily occluded or obstructed in different ways



If I didn't clarify this well to you. Ninji will do!



[Click here](#)

Summary

The respiratory system has many functions, the most important is gas exchange (provide O₂ and remove CO₂).

Respiratory passages (airways) are divided into Conductive Zone (No gas exchange) and Respiratory Zone (Respiratory unit)

Lung is Innervated by autonomic nerves (constrictor: Histamine, SRSA, Smoking, dust and sulfur dioxide & some acidic elements and Ach) , (dilator: epinephrine (adrenaline)

Surfactants are composed of dipalmitoylphosphatidylcholine and Apo proteins. They reduce surface tension preventing alveolar collapse. Deficiency of them causes RDS Disease .

Quiz



| | | | |
|---|----------------------------|-------------------------|----------------------|
| Q1: which of the following participate in pulmonary defense? | | | |
| A) IgA | B) IgG | C) IgD | D) IgE |
| Q2: washing out extra CO₂ from the blood helps in: | | | |
| A) Angiotensin converting | B) secretion of surfactant | C) pH regulation | D) phonation |
| Q3: which of the following is a compartments undergoes lower respiratory tract | | | |
| A) nostrils | B) larynx | C) pharynx | D) lungs |
| Q4: which of the following secretes surfactants : | | | |
| A) pneumocyte type I | B) pneumocytes type II | C) alveolar macrophages | D) endothelial cells |
| Q5: The earliest detection of surfactant from fetal alveoli begins between..... months | | | |
| A) 6-7 | B) 1-3 | C) 5-6 | D) 7-8 |

Key Answers :

5: A
4: B
3: D
2: C
1: A

SAQs

What are the defense factors in the pulmonary system?

Immunoglobulin A (IgA) , Alpha-1 antitrypsin: pulmonary macrophage

What is the opposite force of surface tension?

alveoli expansion

how does the autonomic system affect The bronchi ?

Sympathetic system causes dilation by epinephrine

Parasympathetic causes constriction by Ach

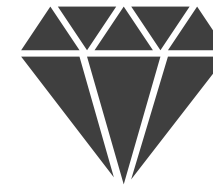
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