



PHYSIOLOGY

Respiratory system



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إعداد
لجنة التبييضات

Introduction

Revision:

Osmolarity and tonicity: both are the concentration of solute in the solution (tonicity: when the solution is blood plasma)

* **hypotonic solution:** solution contain solutes lesser than plasma

* **hypertonic:** solution contain solute more than the plasma

* **when does the fluid enter the cell?** if the fluid hypotonic

* **when does the fluid get outside of the cell?** if the fluid hypertonic

Introduction

➤ Definition:

Respiration is the transport of O₂ from atmosphere to the cells and CO₂ and water from cells to atmosphere.

➤ Functions of respiration:

- 1) O₂ Supply to tissues and removal of CO₂ from them, as O₂ is used in oxidation of food stuffs in the cells and release of energy. (gas exchange)
- 2) Help venous return. (then to the right atrium)
- 3) Regulation of body temperature through evaporation of water from the respiratory passages: -
 - How do we lose temperature of our body?
 1. **Conduction:** get in contact with something cold
 2. **Convection:** radiation get out of your body with temperature
 3. **Evaporation:** water vapor gets out from respiration and sweating
- 4) Regulation of the pH of the blood through adjusting the amount of CO₂ eliminated from the body. (من المحاضرة السابقة)

Structure of the respiratory system

A) Physiological anatomy of the respiratory system:

The respiratory system consists of:-

- 1- The air passages and lungs.
- 2- Respiratory muscles.
- 3- Nerve centers controlling respiration } Discussed later

* The air passages and lungs:-

They are divided into

- a- Conducting zone.
- b- Respiratory zone.

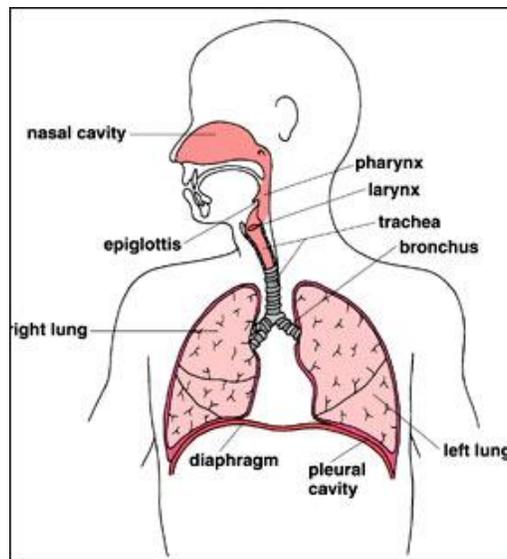


Figure 1: Structure of the respiratory system

a- Conducting zone:-

Includes (Nose, Nasopharynx, trachea, two main bronchi, and the smaller bronchioles till the respiratory bronchioles).

(c- shape cartilage (not complete circle))

Determinates the diameter bronchi either

- Broncho dilation
- Bronchial muscle tone

This c-shape is completed by

- 1- Elastic fiber
- 2- Smooth muscle fiber

Functions of the conducting zone:-

1. **Air conduction** to the respiratory zone.

2. **Air filtration**

i.e. it filters air from particles and bacteria as particles more than 6 microns are trapped by hairs at the entrance of the nose, while smaller particles are trapped by mucous secreted from the goblet cells in the epithelial lining of the air passages.

3. **Air Conditioning**

The mucosa of the nose, mouth, and pharynx has a large surface area and rich blood supply, this adds heat to cold air or remove heat from hot air, thus allow the inspired air to reach the respiratory zone at temperature of 37°C (to prevent alveolar injury), to maintain a constant internal body temperature. (* Why does all this filtration occurs before getting to alveoli ? because alveoli is very delicate (fragile) structure

- Chest = thorax

- Cilia is at the respiratory tract:

 - they move the particle upward

 - there is a genetic disease called “immotile cilia “

So small particle enters which leads to inflammation of lung

- Hyaline membrane disease is very common for children

- If the hot air enters the alveoli, it will destroy it. so that first, the hot air reach to the conduct zone (it removes heat from hot air)

- If cold air enters the alveoli, it will freeze it

4. **Humidification:** (ترطيب) when coughing you feel the dryness

As the air is saturated with water vapor to protect delicate lung tissue. (dry air → injure lung tissue) **mucosa → pseudo stratified squamous epithelium with goblet cells

5. **Phonation** (الصوت) :-

- أما ال articulation هي مخارج الحروف (lips , cheek , tong)

The vibrating element of the larynx (v shape) is the vocal cords which vibrates when air passes through it producing sound.

الأحبال الصوتية بتفتح و بتسكر عشان الصوت زي الاله

6. **Smell** by olfactory epithelium of the nose:- nasal mucosa has olfactory nerves in its top

7. Protective reflexes

For removal of foreign bodies and irritant substances from the respiratory passage it includes.

A. Sneezing reflex:-

a) **deep inspiration** → forced expiration against open glottis

b) **irritation of nose hair to particles in air** → sneezing

B. Cough reflex :-

• **deep inspiration** → forced expiration against closed glottis

• **it happens when food enters in lung**

• **(foreign bodies) → inflammation of lung**

B-Respiratory zone:-

* Composed of respiratory bronchioles.

* Each of respiratory bronchioles is subdivided into several alveolar ducts, each of which end by clusters of small thin walled air sacs called alveoli.

* Several alveoli open into common chamber called alveolar sac.

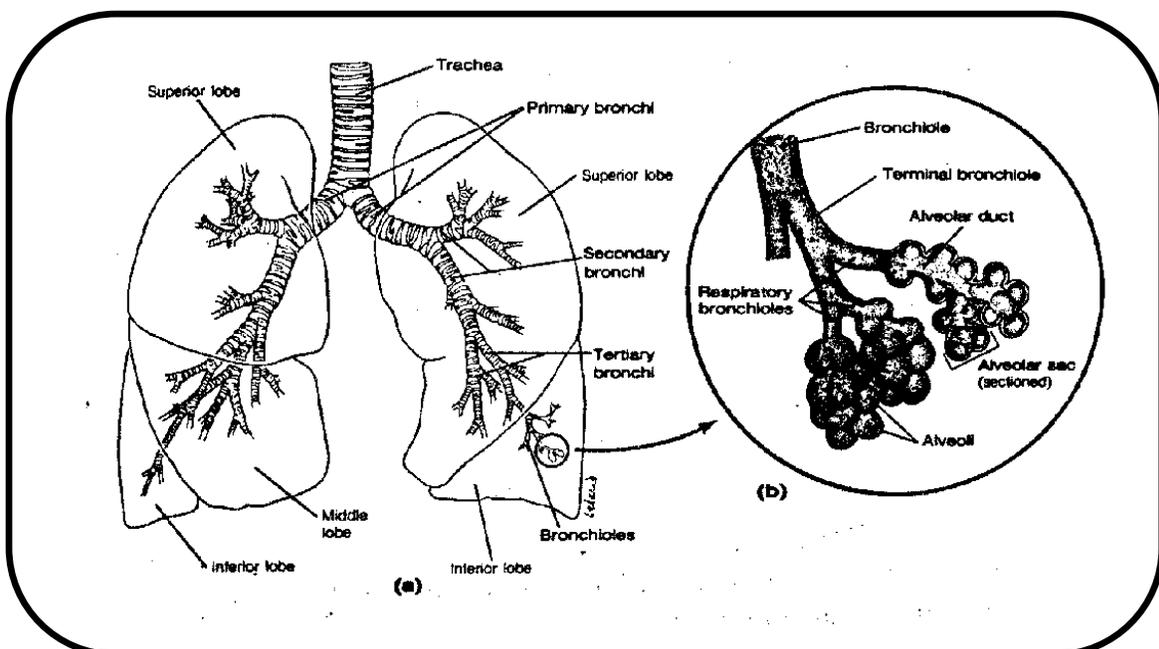
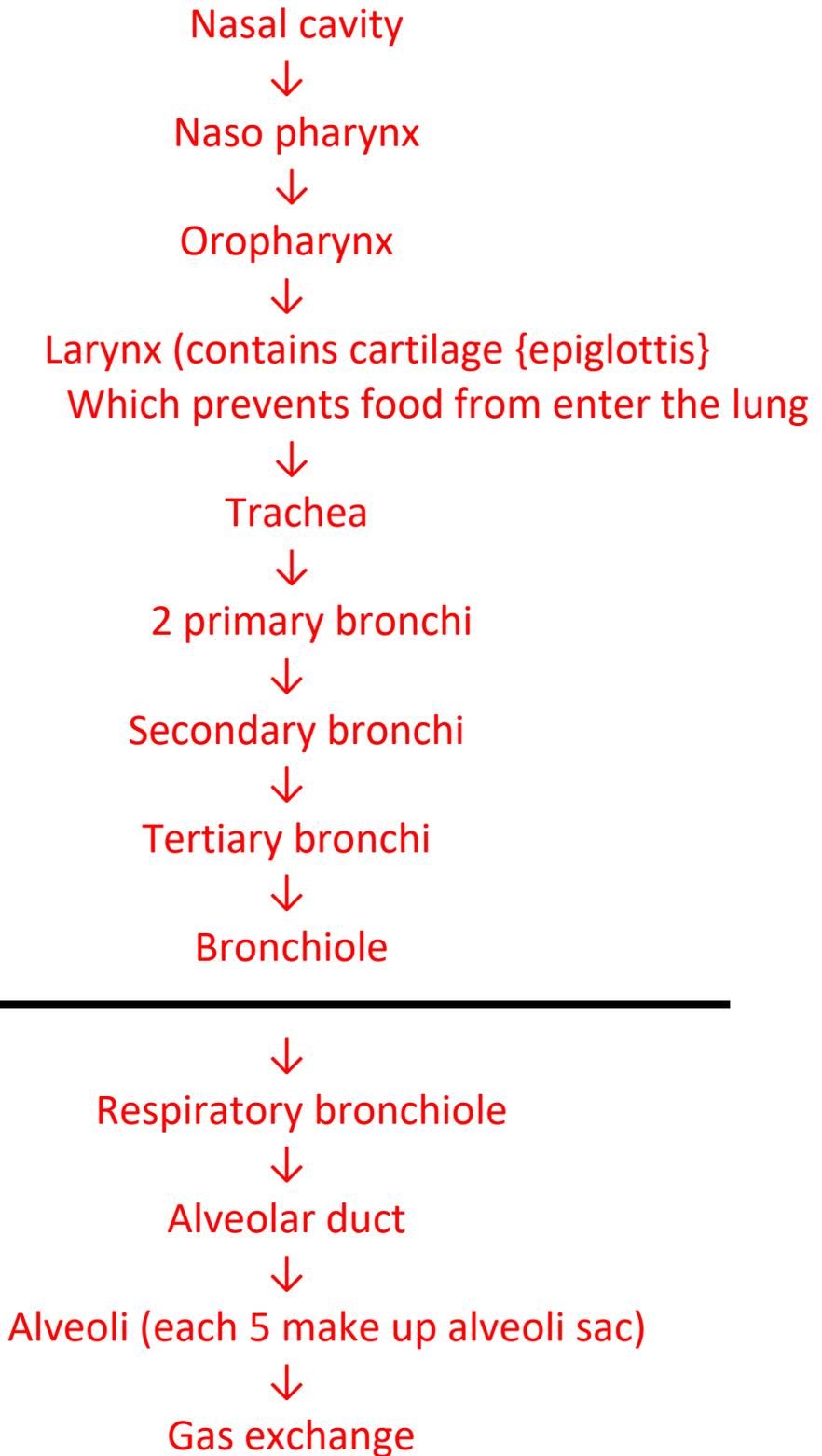


Figure 2: Respiratory zone of the lung

**Conduction zone
(no gas exchanges)**

لغند الخط كلهم بس
بوصلوا الهواء



B) From the physiological Point of view respiration can be divided into:

1) **External respiration**:- (the transport of o₂ from external air to the tissue and transport of co₂ from tissue by lung)

Which includes:-

- a) Pulmonary ventilation for renewal of air in the lungs from atmospheric air. (the pulmonary ventilation or alveolar ventilation happens by doing inspiration or expiration)
- b) Exchange of gases between alveolar air and venous blood in the capillaries around the alveoli.

2) **O₂ and Co₂ transport function of the blood** :-

- **Hemoglobin:** a molecule inside RBCs (has carrier site)

Can carry:

- ❖ (1) Molecule of O₂ (25% saturation)
- ❖ (2) Molecule of O₂ (50% saturation)
- ❖ (3) Molecule of O₂ (75% saturation)
- ❖ (4) Molecule of O₂ (100% saturation)

Note: hemoglobin can carry all cases (25%, 50%,75%,100%)

- **Blood circulation:-**

Hb takes O₂ from alveoli $\xrightarrow{\text{transport}}$ left atrium \rightarrow left ventricle \rightarrow aorta \rightarrow body tissue (unload the O₂ there) \rightarrow tissues take O₂ and give away CO₂ \rightarrow Hb carries CO₂ $\xrightarrow{\text{veins}}$ right atrium \rightarrow right ventricle \rightarrow lung where the Hb retakes O₂ from alveoli.... etc.

3) **Internal respiration**

At the level of the cells in which there is utilization of O₂ for oxidation of food stuffs and removal of Co₂ that result from metabolic reactions.

(cellular respiration $\xrightarrow{\text{produce}}$ CO₂ +H₂O)

The respiratory cycle

It consists of:-

A) Inspiration

This is an active process during which:

- * The thoracic cavity increases:-
 - ↓pressure → suction pump → helps the blood return from lower limb vein to inferior vena cava to the right atrium (respiratory pump)
 - Note:- when you move the muscles of lower limb → squeezing of veins → blood return to inferior vena cava .
- * The lungs distend and air rushes into it.
- * Its duration is 1.3 seconds.

B- Expiration

This is a passive process during which:

- * The thoracic cavity decreases.
- * The lungs recoil and air rushes out of the lungs.
- * Its duration is 1.7 seconds.

C- Expiratory pause:-

- * It is a period of rest after expiration.
- * Its duration is about 0.7 second.
- * It is absent in rapid respiration, as in muscular exercise.

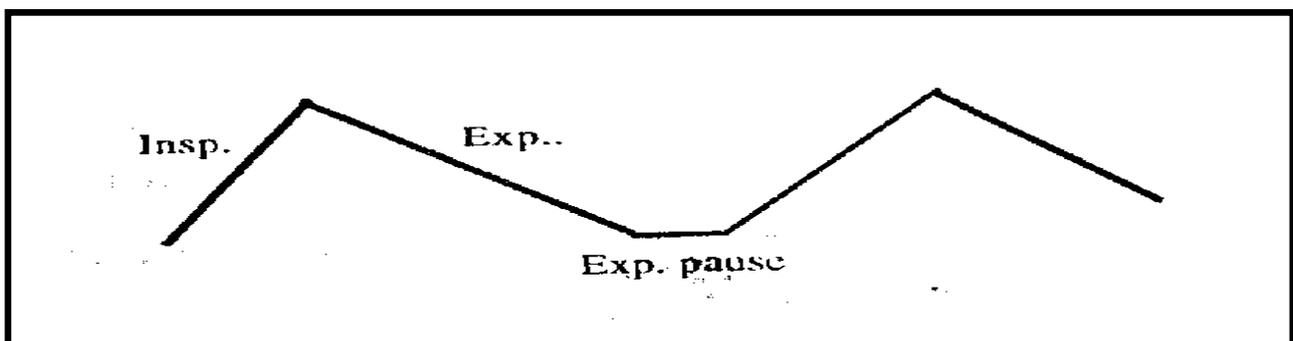


Figure 3: Respiratory cycle

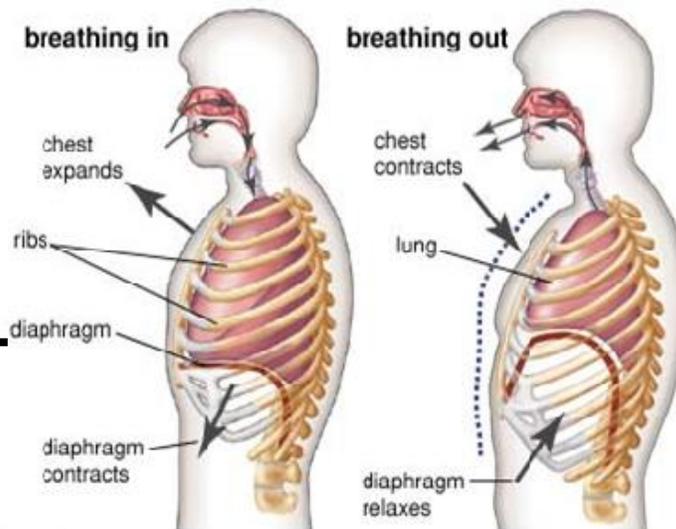
Total duration of respiratory cycle

Inspiration + Expiration + Expiratory pause

1.3 + 1.7 + 0.7 = 3.7 sec.

So respiratory rate/ min = $60/3.7 = 17$ cycles/min.

Mechanics of respiration



حاجز بين ال
Chest and Abdomen

Note: respiration is
an voluntary
The respiratory
center is located in
the brain stem

Figure 4: Mechanics of respiration

Breathing in = inspiration

breathing out = expiration

(A) Mechanics of inspiration:-

Inspiration is an active process during which there is an increase in the length and diameter of the thorax.

1- The increase of length is due to contraction of the diaphragm.

The increase in the length of the thorax is produced by contraction of the **diaphragm** which is dome shaped during rest, but with inspiration it contracts and flatten leading to increased length of the thorax (the transverse diameter), the **diaphragm** accounts to about 75% of the increase of the chest size. The **diaphragm** is supplied by the phrenic nerves which arise from the third to fifth cervical segments.

2- The increase in diameter (transverse and anteroposterior diameter) is due to contraction of external intercostal muscles.
(between ribs)

Contraction of the **external intercostal muscles** leads to elevation (and eversion) of ribs, as they are at rest inclined downward and forward, during inspiration and due to contraction of the external intercostal muscles, the ribs are elevated and the transverse and anteroposterior diameters of the thorax are increased. **The external intercostal muscles** are supplied by anterior horn cells of all thoracic segments. (supplied by intercostal nerves)

(B) Mechanics of expiration:- (the only mechanic that occur passively)

It is a **PASSIVE PROCESS**, that occurs by relaxation of the diaphragm and external intercostal muscles so all dimensions of the chest are decreased, leading to increased intrapulmonary pressure to about 1 mm Hg leading to air pumping out.

(C) Forced inspiration:- (exercise)

During forced inspiration, other thoracic muscles are involved, to increase the thoracic volume; these muscles are called accessory muscles of respiration which includes.

- * Sternocleidomastoid.
- * Serratus anterior.
- * Scaleni muscles.
- * Pectoralis minor.
- * latismusdorssi muscle.

The above muscles contract in addition to the contraction of the diaphragm and external intercostal muscles.

* passive process: process that doesn't require contraction of muscle but relaxation

* active process:- vice versa

(D) Forced expiration:- (تثاؤب) (blowing a balloon exercise)

It is an active process, and occurs by contraction of.

* **Abdominal muscles** to increase the intra-abdominal pressure leading to elevation of the diaphragm upward so decreasing the vertical diameter of the chest.

* **Internal-intercostal muscles** which pulls the ribs downward and inward so reducing the transverse and antero-posterior diameters of the chest leading to more reduction in the thoracic cavity removing more air out of the lungs.

* It occurs during straining as during defecation and labor.

Summary of normal quiet ventilation and forced ventilation is shown in the following table:-

	Inspiration	Expiration
1	Active process	Passive process
2	Caused by contraction of diaphragm and external intercostal muscular.	Caused by relaxation of the diaphragm and external intercostal muscles.
3	The intra pulmonary pressure decrease to -1mm Hg.	The intrapulmonary pressure increase to about +1 mmHg.
4	The thoracic cavity is increased in all dimensions Air rush inside the lungs.	The thoracic cavity is decreased in all dimensions. Air rush outside the lungs.
5		
	Forced inspiration	Forced expiration
1	Contraction of accessory muscles.	Contraction of abdominal and internal intercostal muscles.
2	The intrapulmonary pressure decreases to about -20 mmHg.	The intrapulmonary pressure increases to about + 30 mmHg.
3	Active process	Active process

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لا تنسونا من صالح دعائكم ...♥♥♥♥