



RS

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Physiology

Summaries

Lecture : L1

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Respiratory System

Main function of the lung -> Gas exchange -> transport of CO₂&O₂(homeostasis of O₂&CO₂)

There are 2 types of respiration:

1- external respiration -> transport of oxygen from outside the body until it reaches body cells through body circulation (هاي وظيفه RBC)

2- internal respiration -> utilisation of oxygen by cells -> cellular radiation (in mitochondria)

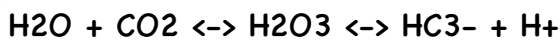
Another function for respiratory system:

A. Acting in acid base balance

Review -> there are three different lines for acid this regulation

1. Buffer system:-

The main buffer system is bicarbonate buffer system



زي ما اخذنا في كيميائ انو زيادة تركيز نواتج او المتفاعلات رح تتحكم في اتجاه تفاعل لليمين او الشمال فمثلا في حالة

1. زيادة نواتج او نقصان متفاعلات.

hyperventilation or respiratory alkalosis (decrease CO₂) / metabolic alkalosis (increase HCO₃⁻) / metabolic acidosis (increase H⁺) رح يسحب التفاعل للييسار

2. في حالة زيادة المتفاعلات او نقصان النواتج.

respiratory acidosis (increase CO₂) / metabolic acidosis (decrease HCO₃⁻) / metabolic alkalosis (decrease H⁺) رح يسحب تفاعل لليمين

2. Respiratory system

In metabolic acidosis -> increase ventilation -> decrease CO₂ as a composition -> decrease H⁺

In metabolic alkalosis -> decrease ventilation -> increase CO₂ as a composition -> increase H⁺

3. Kidneys -> slow, but strong.

In respiratory / metabolic acidosis -> increase HCO₃⁻ reabsorption , increase H⁺ excretion from distal tube-> decrease CO₂

In respiratory / metabolic alkalosis -> decrease HCO₃⁻ reabsorption , decrease H⁺ excretion from distal tube-> increase CO₂



Respiratory System

B. Defence against inhaled particles → through cilia and mucus

C. As a filter to prevent clot from reaching systemic circulation

All cardiac output will reach lungs so any clot formed in the circulation will definitely reach the lungs

If these clots were large enough, they will cause pulmonary embolism (main site is DVT)

Also → settings are brain medicine for malignant secondary metastasis set (why? Metastasis occurs mainly through capillaries or lymphatic channels & as we said all cardiac output will reach lungs)

D. Enabling speech, singing, and other vocalization.

E. Acting as a reservoir for blood.

Lungs are filled with white blood cells those go to circulation when needed

F. Regulating various hormonal and humoral concentrations by means of the pulmonary capillary endothelium.

Angiotensinogen II made by liver as Angiotensinogen I and it is activated and lungs to Angiotensin II by epithelial cells that surround capillaries

G. The respiratory muscles generate the large pressures needed during defecation, vomiting, and childbirth.

Functional anatomy of the lung

^The lungs alone cannot bring air in and out alone

^Respiratory muscles and an airtight chest wall to create a negative pressure within the chest are essential for the proper functioning of the lungs

^The lungs comprise two tree-like structures (two blood supply), the vascular tree (anatomic circulation) and the airway tree (functional circulation)

^There's 2 functional zones of respiratory system

1. Conducting part. (First 16 generations). 2. Respiratory <exchange> part. (17-23 generation)

There is 23 generations in average in all RS start from trachea as generation zero then it is branched into two bronchi as generation one so with each divide leads to a new generation



Respiratory System

1. Conducting part.

From trachea (generation 0) to terminal bronchiole (generation 16)

First 16 generations and Because the conducting airways contain no alveoli, and therefore take **no** part in gas exchange, they constitute the **anatomic dead space**. Its volume is about **150 ml**.

2. Respiratory part

From respiratory bronchiole (generation 17) to alveolar sac (generation 23) → the last 7 generations

The respiratory zone is alveolated and participate in gas exchange and makes up most of the lung, its volume being on about **2.5 to 3 liters** during rest.

Note :

*ti has a constitute of the transitional respiratory bronchioles. (bronchi that start to form alveoli on it)

*Trachea, bronchiol and bronchi are covered with cartilage wh? To prevent constriction and compression by the elastic forces of the lung tissue so parts which aren't covered with Cartilage might be compressed

*Loosing of elastic properties of the lung will lead to asthma (difficulty of expiration and wheezing)

The conducting zone has three important functions:

1. Warming and humidify of air → the air must be in heat of the body
2. Distribute air evenly to all regions of the lungs in same amount
3. Defense system against foreign particles through mucus and Cilia

Note:

1. If the foreign particles escape mucus or removed by Cilia ciliated movement of mucus , a reflex of forceful exhalation occurs through 1. nose → sneezing (عطس) 2. Mouth → coughing
الفكرة هي قبل العطس أو السعال يقوم الجسم بأخذ كمية كبيرة من الهواء وحبسها في الرئتين ثم يقوم بإخراجها دفعة واحدة مما يشكل قوة دافعة لإخراج الجسم الغريب

2. The immunoglobulin that defences against foreign particles is IgA

3. The conducting zone has its own separate circulation, the **bronchial circulation**, which originates from the descending aorta and drains into the pulmonary veins.

4. The respiratory zone is the site of gas exchange. The exchange of gases is accomplished by **diffusion** (the only way) in thin-walled air sacs called **alveoli**.

5. Adult lungs contain 300 to 500 million alveoli, with a combined internal surface area of **~75 m²**

6. There are two types of circulation in lung 1. Pulmonary circulation → right ventricle → lung → gas exchange → left Atrium 2. Bronchial circulation (give oxygen and nutrition needed for its tissue to live)



Respiratory System

The velocity of air flow is high and strong in trachea but each time its split the flow will split too so it is become slower and less strong and so on with each generation (splitting) . So when reaching alveoli air flow will be too slow (**Laminar**) -> that allowed appropriate gas exchange

In adults, alveoli, if damaged, have limited ability to repair themselves. Cigarette smoke can destroy alveoli and lead to concomitant decrease in alveolar surface area for gas exchange.

There is extremely rapid increase in total cross-sectional area of the airways in the respiratory zone

ATMOSPHERIC (BAROMETRIC) PRESSURE:

At sea level -> atmospheric pressure = 760mmHg

PO₂ = 160mmHg ----> the percentage of oxygen in air 21% PO₂ = 21% * 760

طبعا كل ما زاد الارتفاع قل PO₂

The total barometric pressure is the sum of the partial pressure of all gases (**Dalton's law**).

Mechanism of PULMONARY VENTILATION

معلومات لازم نعرفها :

1. The chest cavity (between lungs and chest wall) tends to expand as possible

يعني بنحب دائما يكون واسع

& lungs tend to be small as possible due to presence of 2 elastic forces that compress the lung

2. Chest wall has a negative pressure and lungs have a positive pressure.

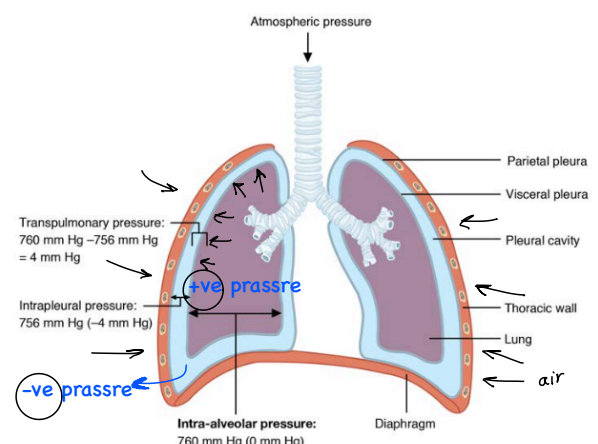
بما ان الرئتين هي المتصلة في الهواء الخارجي عبر القصبة الهوائية وحسب ما اخذنا عن الهواء يتحرك من الضغط العالي الضغط المنخفض

the air will move towards lung to cause their expansion & prevent compression. & these expansion will compress the chest wall to prevent its expansion, also, outside pressure will compress the chest, and prevent its expansion.

So there is an equilibrium

****Downward and upward movement of the diaphragm to increase or decrease the vertical dimension of the thorax.**

Note: Obesity, pregnancy, and tight clothing around the abdominal wall can impede the effectiveness of the diaphragm in enlarging the thoracic cavity.





Respiratory System

Notes:

Damage to the phrenic nerves (C3–C5) can lead to paralysis of the diaphragm. When a phrenic nerve is damaged, that portion of the diaphragm moves up rather than down during inspiration.

** Elevation and **depression of the ribs** to increase and decrease the **anteroposterior diameter** of the chest cavity.

Any change in negative pressure of chest wall will affect the equilibrium and effect ventilation process.

Changing of negative pressure in the chest wall will be achieved by blunting of chest wall (ثقب الصدر)

A. Inspiration.

1. Increasing ventricle, diameter and anteroposterior diameter by:

- Increase ventricle diameter. → contraction of diaphragm skeletal muscles and they are from will move downward
- Increasing Interiorposterior diameter. → why contraction of external intercostal muscles which move ribs anterior. (chest will increase in size to allowed more air Enter)

c. Another inspiration muscles:

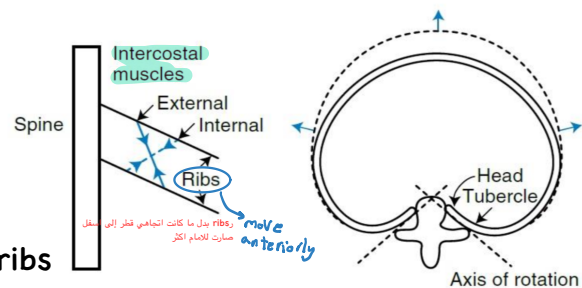
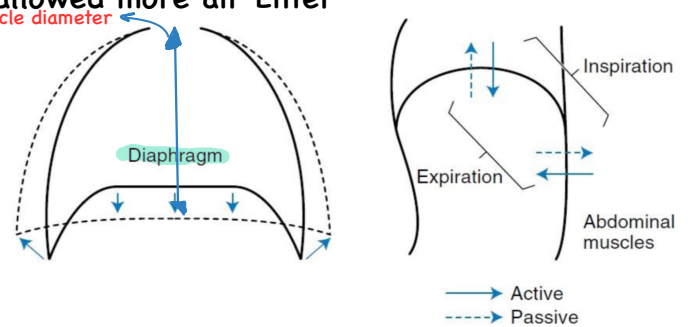
- External intercostals muscles (Bucket handle effect, most important)
- Sternocleidomastoid muscles (lift the sternum)
- Anterior serrati
- Scaleni (lift the first 2 ribs)

2. The previous action will decrease pressure in the chest wall (become more negative)

Why?

هسا تركيز الجزيئات (الغازات) داخل تجويف الصدر بين

Pleura & ribs ثابت لذا عند زيادة حجم الصدر رح يقل الضغط اكثر



3. The air will move from outside to the lungs, causing their expansion and increasing pressure inside them.

So during inspiration →

- Increase pulmonary pressure.
- Increase in chest cavity pressure. (and plural pressure)
- Increase ventricle and anteroposterior diameters of the chest.



Respiratory System

Notes:

1. Because of increasing chest diameters is against normal pressure direction → inspiration is active process. (required energy)
2. Increasing ventricle dimensions of a chest, will decrease ventricle dimensions of abdomen → increasing intra-abdominal pressure → Compression of IVC → increasing Venous return (preload) → increasing CO₂ to the lung

B. Expiration.

1. Relaxation of diaphragm and intercostal muscles. → decreasing in ventricle and anteroposterior diameters → increasing chest wall pressure
2. Lungs will collapse, and air will go outside → decreasing pulmonary pressure

Notes:

1. All movements during expiration is with normal pressure movement so it is **passive process**.
2. During expiration. → increasing ventilation rate (during exercise or in the presence of severe respiratory disease) → decreasing expiration time by contraction of expiration muscles (not needed a normal expiration rate) → so expiration become **active process**

So;

Expiratory muscles are:

1. Abdominal recti (pull downward on the lower ribs and compress the abdominal contents upward against the diaphragm)
2. Internal intercostals
3. Impaired inspiratory force (e.g. muscular dystrophy, poliomyelitis) → respiratory failure. Such patients require mechanical respirators (positive-pressure breathing).

RESPIRATORY CYCLE

Pleural pressure:

Def.: Is the pressure of the fluid in the narrow space between the lung pleura and chest wall pleura (range -5 cm H₂O to -7.5 cm H₂O).

The negative pressure is because of the balanced forces generated by the chest wall (tends to increase lung volume, i.e. inspiratory force) and the lungs (tends to shrink, i.e. elastic recoil of the lung).



Respiratory System

Alveolar pressure:

It is the pressure of the air inside the lung alveoli. It is equal to 0 cm H₂O (atmospheric) when no air is flowing into or out of the lungs.

During the respiratory cycle alveolar pressure ranges between -1 cm H₂O to +1 cm H₂O, but in patients with airway obstruction, it may be many times that.

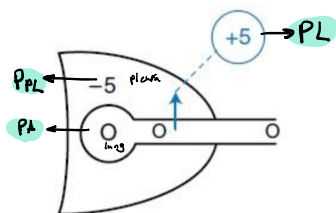
The quiet cycle is made of inspiration (2 seconds) and expiration (2-3 seconds).

Transpulmonary pressure (PL):

Is the pressure difference between the alveolar pressure and the pleural pressure

($PL = PA - PPL$). It is a measure of the elastic force (**elastance**) in the lungs that tend to collapse the

lungs, i.e. the **Recoil Pressure**. Elastance depends on the amount of elastic tissue.



A. Preinspiration

والفرق بين الضغط التاجم عن رغبة lung to collapse
ضغط chest الذي يقوم recording

