Date:
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لجان الدُّفعات

Soul Academy

تفريغ فسيولوجي

موضوع المحاضرة : respiratory system

رقم المحاضرة : 16

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THE RATE OF PULMONARY AND SYSTEMIC GAS EXCHANGE DEPENDS ON SEVERAL FACTORS:

- **Partial pressure difference of the gases.** Alveolar PO_2 must be higher than blood PO_2 for oxygen to diffuse from alveolar air into the blood. **The differences between PO_2 and PCO_2 in alveolar air versus pulmonary blood increase during exercise.**

- **Surface area available for gas exchange. The surface area of the alveoli is huge**. In addition, many capillaries surround each alveolus, so many that as much as 900 mL of blood is able to participate in gas exchange at any instant.

• الدم بيطلع من القلب و بيتوزع على جميع انحاء الجسم ، أول اشي بصير انتقال للأكسجين عالخلية والخلية بتستخدمها و بتطلع CO_2 واللي برجع على ال right side of the heart واللي بتوديه عن طريق ال pulmonary artery لل pulmonary capillary واللي بتعمل exchange مع ال alveoli وال alveoli بتعمل exchange مع ال environment فبرجع الدم محمل بالأكسجين و بنتقل عن طريق ال pulmonary vein و بروح left side of the heart

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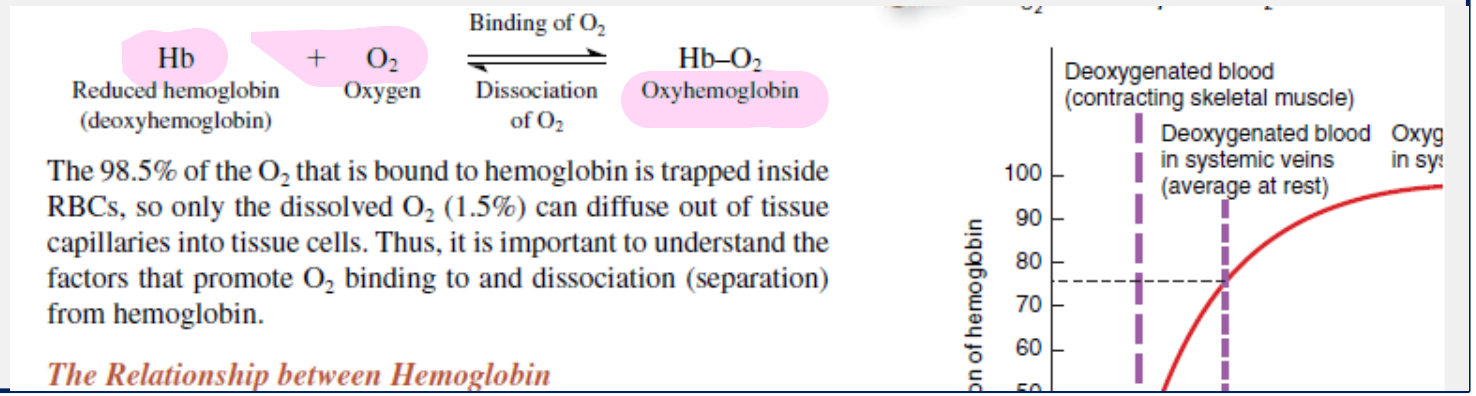
- العوامل اللي بتعتمد عليها الـ rate of breathing
  1. Partial pressure difference of the gas
     كلما كان فرق الضغط اعلى كلما كان الـ rate اسرع
  2. surface area of alveoli
     المساحة تبكون كبيرة فالسرعة بتكون عالية
  3. diffusion distance
     الـ membrane بكون thin فالغاز يعبر بسهولة ولكن واحد عنده تجمع سوائل فالمسافة بتزيد و السرعة بتقل
  4. molecular weight and solubility
     تم دمج الـ molecular weight مع الـ solubility لأنه الـ O_2 الـ molecular weight تاعتها أقل من الـ CO_2 و الذائبية للاكسجين اقل و ذائبية الـ CO_2 اكبر في الرئتين

TRANSPORT OF OXYGEN AND CARBON DIOXIDE: OXYGEN TRANSPORT

- **Oxygen does not dissolve easily in water**, so only about 1.5% of inhaled O2 is dissolved in blood plasma.
- **About 98.5% of blood O_2 is bound to hemoglobin in red blood cells** (the amount dissolved in the plasma is 0.3 mL and the amount bound to hemoglobin is 19.7 mL.).



THE RELATIONSHIP BETWEEN HEMOGLOBIN AND OXYGEN PARTIAL PRESSURE

- The most important factor that determines how much O_2 binds to hemoglobin is the PO_2; **the higher the PO_2, the more O_2 combines with Hb**.

- **When reduced hemoglobin (Hb) is completely converted to oxyhemoglobin (Hb–O_2), the hemoglobin is said to be fully saturated; when hemoglobin consists of a mixture of Hb and Hb–O_2, it is partially saturated.** The percent saturation of hemoglobin expresses the average saturation of hemoglobin with oxygen. For instance, if each hemoglobin molecule has bound two O_2 molecules, then the hemoglobin is 50% saturated because each Hb can bind a maximum of four O_2.

- اذا ارتبط الهيموغلوبين مع أربعة أكسجين سمي fully saturated
- اذا ارتبط الهيموغلوبين مع 2 أكسجين سمي partially saturated

OTHER FACTORS AFFECTING THE AFFINITY OF HEMOGLOBIN FOR OXYGEN

❖ **1. <u>Acidity</u> (pH):** As acidity increases (pH decreases), the affinity of hemoglobin for O_2 decreases, and O_2 dissociates more readily from hemoglobin. **<u>The Bohr effect</u>** works both ways: An <u>increase in hydrogen ion in blood causes O2 to unload from hemoglobin</u>, and the binding of O_2 to hemoglobin causes unloading of hydrogen ion from hemoglobin (hemoglobin can act as a buffer for hydrogen ions).

- العوامل اللي تبأثر على ارتباط الاكسجين مع الهيموغلوبين
  ← ال ٣ عوامل بتعتمدوا على المعادلة:

$$H_2O + CO_2 \longrightarrow H_2CO_3$$
$$H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

① acidity
- اذا زاد ال CO_2 بزيد ال H^+ و يقل ال O_2 و الارتباط بده يقل

② partial pressure of CO_2
- ال CO_2 اذا كان عالي فال acidity راح يكون عالي وال O_2 قليل فارتباط الاكسجين راح يكون اقل
- ارتباط ال CO_2 مع الهيموغلوبين راح يعتمد على كم هو ارتباط الاكسجين مع الهيموغلوبين انه هل هو fully or partially saturated
- ارتباط ال O_2 مع الهيموغلوبين راح يعتمد على ارتباط ال CO_2 مع الهيموغلوبين او نسبة ال CO_2 في الدم

③ temperature
- hyperthermia ارتفاع الحرارة يؤدي إلى تقليل ارتباط الاكسجين
- hypothermia انخفاض الحرارة يؤدي إلى زيادة ارتباط الاكسجين

CARBON DIOXIDE TRANSPORT

Under normal resting conditions, each 100 mL of deoxygenated blood contains the equivalent of 53 mL of **gaseous CO2, which is transported in the blood in three main forms:**

1. **Dissolved CO_2.** The smallest percentage—about 7%—is dissolved in blood plasma. On reaching the lungs, it diffuses into alveolar air and is exhaled.

2. **Carbamino compounds**. somewhat higher percentage, about 23%, combines with the amino groups of amino acids and proteins in blood to form carbamino compounds. **Because the most prevalent protein in blood is hemoglobin** (inside red blood cells), most of the CO2 transported in this manner is bound to hemoglobin.

- ال CO_2 يتواجد على ٣ أشكال
① dissolved CO2 in plasma 7%
يتواجد لحاله في البلازما
② 23% carbamino compounds
ارتباطه مع الهيموغلوبين
③ 60-70% bicarbonate ions
HCO_3^- شحنته -١ وبالتالي اذا بده يطلع راح يصير اختلال بال electrical gradient حول الخلية ، عشان هيك يصير اشي اسمه chloride shift

CARBON DIOXIDE TRANSPORT

- The amount of CO2 that can be transported in the blood is influenced by the percent saturation of hemoglobin with oxygen. The lower the amount of oxyhemoglobin ($Hb–O_2$), the higher the CO_2-carrying capacity of the blood, **a relationship known as the Haldane effect.**

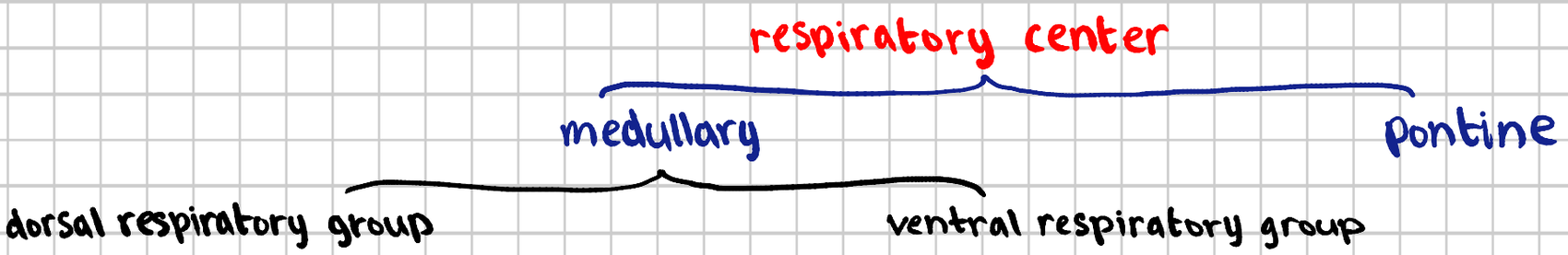
- ارتباط ال O_2 مع الهيموغلوبين يعتمد على ارتباط ال CO_2 مع الهيموغلوبين والعكس صحيح

CONTROL OF BREATHING

- ✓ **Respiratory Center**:

- These nerve impulses are sent from clusters of neurons located bilaterally in the brain stem. This widely dispersed group of neurons, collectively called the respiratory center, can be divided into two principal areas on the basis of location and function: (1) the medullary respiratory center in the medulla oblongata and (2) the pontine respiratory group in the pons.

- ال respiratory center الموجود في ال brain بقسم إلى قسمين
  1. medullary respiratory center موجود بال medulla oblongata
  2. pontine respiratory center موجود بال pons



- لما بصير انتقال لل action potential اما عن طريق ال sympathetic accelerator nerve او عن طريق ال vagus nerve و بصير activation لل chemoreceptors , اذا بدي ازيد ال respiratory rate بتم تحفيز ال sympathetic و اذا بدي اقلله بدي احفز ال parasympathetic و صدول ال nerves بدهم يوصلوا لل respiratory center و بمر منه ال action potential و بوصل عند ال medullary بعديها ممكن ال action potential يوصل للجزئين تاع ال pontine و ممكن يوصل ال medullary

normal inhalation and normal exhalation → dorsal respiraty center .
forceful inhalation and exhalation → ventral respiratory center .

- ال chemoreceptors بتكون موجودة على ال arch تبع ال aorta وال carotid و بجانب ال Baroreceptors , تسميهم peripheral لأنه ال chemoreceptors موجودة بال Brain اسمها central (معلومة مهمة بالامتحان)

THE INFLATION REFLEX

- ✓ Similar to those in the blood vessels, **stretch-sensitive receptors called baroreceptors or stretch receptors** are located in the walls of bronchi and bronchioles.
- ✓ **When these receptors become stretched during overinflation of the lungs,** nerve impulses are sent along the vagus (X) nerves to the dorsal respiratory group (DRG) in the medullary respiratory center. In response, the DRG is inhibited and the diaphragm and external intercostals relax. As a result, further inhalation is stopped and exhalation begins.

OTHER INFLUENCES ON BREATHING

- **Limbic system stimulation:** Anticipation of activity or emotional anxiety may stimulate the limbic system, which then sends excitatory input to the DRG, increasing the rate and depth of breathing.

- **Temperature**
- **Pain**
- **Stretching the anal sphincter muscle**
- **Irritation of airways:** Physical or chemical irritation of the pharynx or larynx brings about an immediate cessation of breathing followed by coughing or sneezing.
- **Blood pressure**

- limbic activity system المفروض تكون normal ولكن اذا زادت ال activity تاعتها بصير sympathetic nervous system activation

TABLE 23.3

Summary of Stimuli That Affect Breathing Rate and Depth

STIMULI THAT INCREASE BREATHING RATE AND DEPTH	STIMULI THAT DECREASE BREATHING RATE AND DEPTH
Voluntary hyperventilation controlled by cerebral cortex and anticipation of activity by stimulation of limbic system.	Voluntary hypoventilation controlled by cerebral cortex.
Increase in arterial blood P_{CO_2} above 40 mmHg (causes an increase in H^+) detected by peripheral and central chemoreceptors.	Decrease in arterial blood P_{CO_2} below 40 mmHg (causes a decrease in H^+) detected by peripheral and central chemoreceptors.
Decrease in arterial blood P_{O_2} from 105 mmHg to 50 mmHg.	Decrease in arterial blood P_{O_2} below 50 mmHg.
Increased activity of proprioceptors.	Decreased activity of proprioceptors.
Increase in body temperature.	Decrease in body temperature (decreases respiration rate), sudden cold stimulus (causes apnea).
Prolonged pain.	Severe pain (causes apnea).
Decrease in blood pressure.	Increase in blood pressure.
Stretching of anal sphincter.	Irritation of pharynx or larynx by touch or chemicals (causes brief apnea followed by coughing or sneezing).