MED437
KING SAUD UNIVERSITY

437
PHYSIOLOGY TEAM

Effects Of Exercise on Respiratory System

➢ Color index:

Red: important
Green: doctor's notes
Grey: extra information
Pink: found only in female's slides
Blue: found only in male's slides
Yellow: numbers

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Physiology 437 team work

Editing file

objectives:

By the end of the lecture you will be able to:

1-Describe the effects of moderate and severe exercise on oxygen consumption, and ventilation volumes.

2- Interpret the effects of exercise on arterial PO_2, PCO_2 and H^+ ions.

3-Define the diffusing capacity of the respiratory membrane, and its typical values at rest, and explain its changes in exercise.

4-Explain causes of hyperventilation in exercise.

The respiratory system and exercise

- During exercise muscles need more O2 and more CO2 must be removed from working muscles
- As a result we increase
  - Breathing rate
  - Depth of breathing increases up to our vital capacity
  - Blood flow through the lungs
  - Oxygen intake and consumption
- Oxygen used during exercise can increase up to 20 times a person's normal oxygen uptake = 250 ml/min

Up to vital capacity:
يعني كمية الهواء اللي يدخل أثناء التمرين ، بتكون مساوية للفايتل كبستي في حالة الريست

Effect of Exercise on the respiratory system:

- The blood gases do not always have to become abnormal for respiration to be stimulated in exercise.
- Instead, respiration is stimulated mainly by neurogenic mechanisms during exercise.
- During exercise the respiration is stimulated by neurogenic mechanisms and in this situation the blood gases do not have to become abnormal.

Regulation of respiration during exercise

- In exhausting “strenuous” exercise O2 consumption and CO2 formation increase 20 times more than normal but alveolar ventilation increases almost exactly in step with the increased levels of metabolism.

- Therefore the arterial PO2, PCO2, PH all remain almost exactly normal.

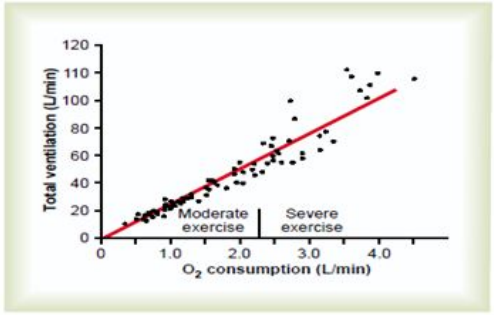


Figure 41–8

Effect of exercise on oxygen consumption and ventilatory rate. (From Gray JS: Pulmonary Ventilation and Its Physiological Regulation. Springfield, Ill: Charles C Thomas, 1950.)

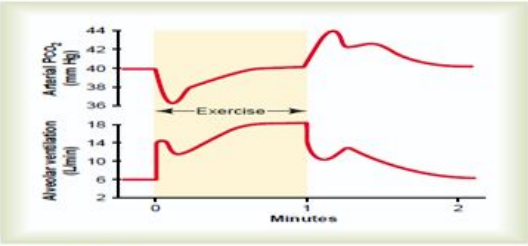


Figure 41–9

Changes in alveolar ventilation *(bottom curve)* and arterial P_{CO_2} *(top curve)* during a 1-minute period of exercise and also after termination of exercise. (Extrapolated to the human being from data in dogs in Bainton CR: Effect of speed vs grade and shivering on ventilation in dogs during active exercise. J Appl Physiol 33:778, 1972.)

مثل مانعرف ان استهلاك الاوكسجين وتكوين ثاني اكسيد الكربون راح يكون عالي عند التمرين
لكن السلايد اللي قبل كان يقول ان الضغوط حقت الغاز ما تتغير حتى خلال التمرين !! ؟
الجواب كالتالي : لأن زيادة استهلاك الاوكسجين يعادلها زيادة تهوية الحويصلات الهوائية فالضغط يصبح متساوي. يعني كأنك تصب في قربة مشقوقة يزيد الاكسجين من هنا ويروح من هنا

-استهلاك الاكسجين ومعدل التنفس يزيدون مع بعض.
-كلما زاد الاحتياج يزيد معدل التنفس.

What causes intense ventilation during exercise?

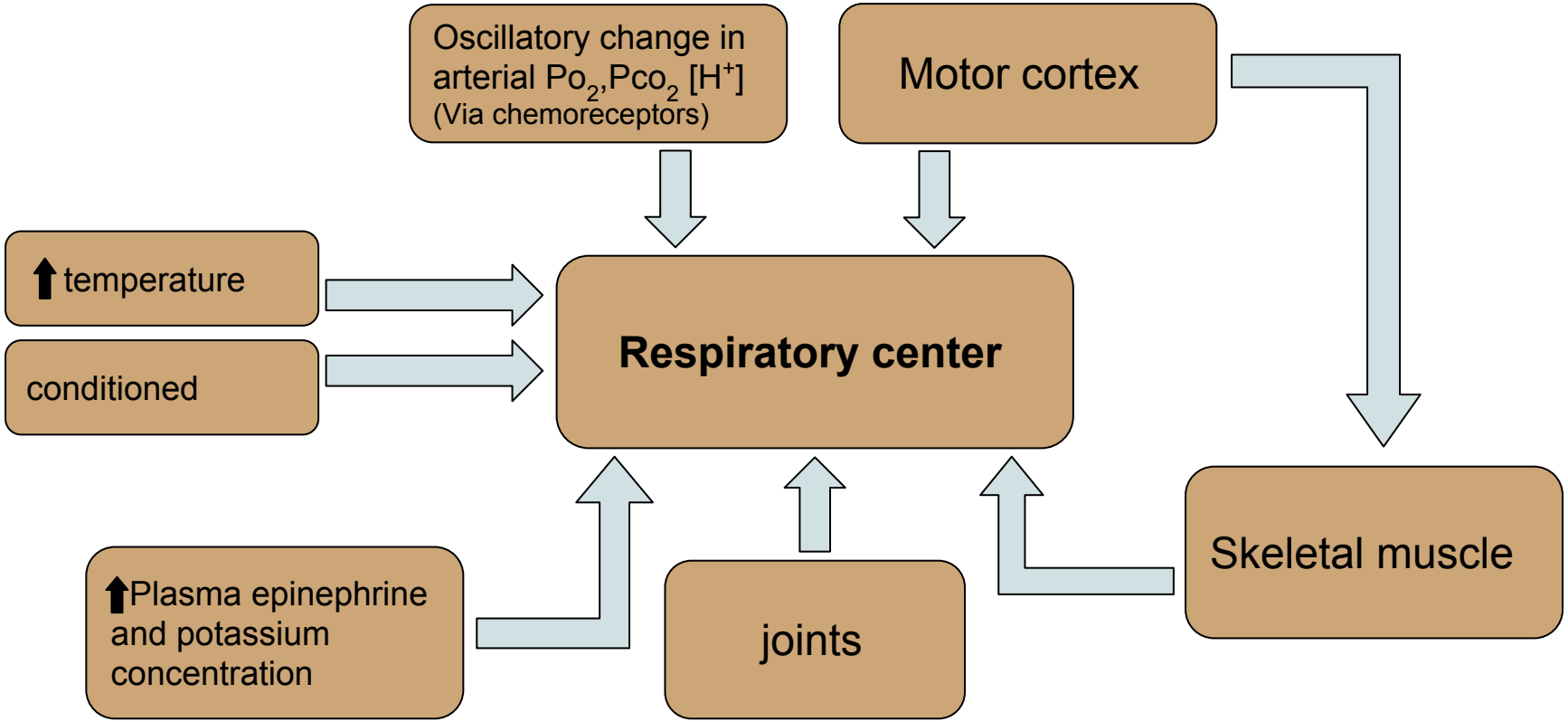
The brain, on transmitting motor impulses to the exercising muscles, transmits at the same time collateral impulses into the brainstem to excite the respiratory center. (when impulses are sent to muscles to contract impulses are also sent to the respiratory system to hyperventilate as well)

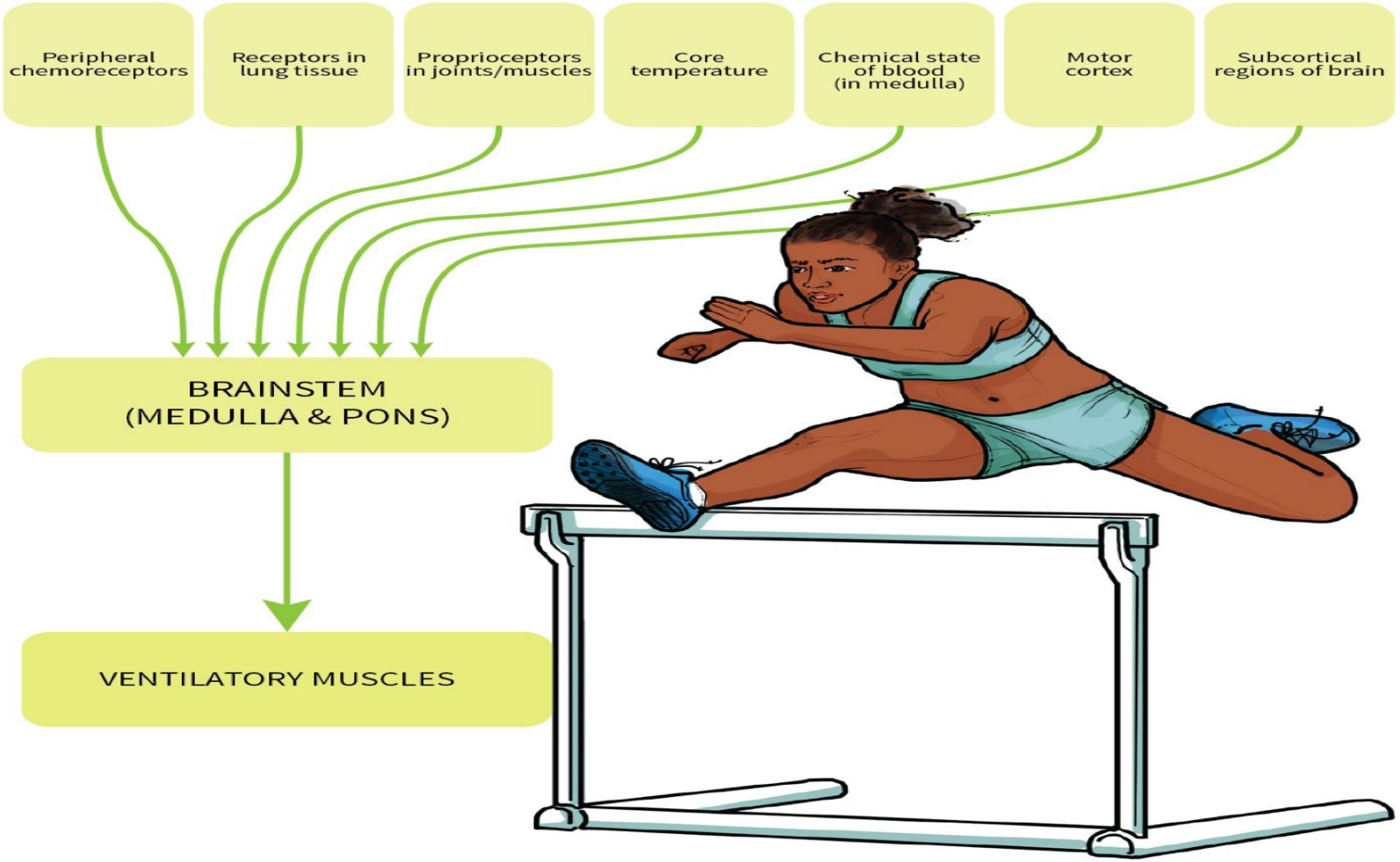
A large share of the total increase in ventilation begins immediately on initiation of the exercise, before any blood chemicals have had time to change. This is mostly due to neurogenic signals.(the blood gases (PO2 + PCO2 levels) do not have to be disturbed to stimulate the hyperventilation, it get stimulated before the blood gases get disturbed so we can maintain within normal levels)

So we can say :

1. Neural signals from the motor areas of the brain to the respiratory center.
2. The joint proprioceptors. في المفاصل لأن لا توجد حركة بدون حركة المفاصل
3. Body temperature (hypothalamus).
4. Possibility that the neurogenic factor for control of ventilation during exercise is a learned response.

Summary of the factors that stimulate ventilation during exercise




Peripheral chemoreceptors
Receptors in lung tissue
Proprioceptors in joints/muscles
Core temperature
Chemical state of blood (in medulla)
Motor cortex
Subcortical regions of brain
BRAINSTEM (MEDULLA & PONS)
VENTILATORY MUSCLES

Relation Between Chemical and Nervous Factors in the Control of Respiration During Exercise

- Direct nervons signal stimulate the respiratory center almost the proper amount to supply the extra oxygen required for exercise and to blow off extra carbon dioxide
- Occasionally, the nervous respiratory control signals are either too strong or too weak.
- Then chemical factors play a significant role in bringing about the final adjustment of respiration required to keep the O2, Co2, and H+ ion concentrations of the body fluids as nearly normal as possible.

The Neurogenic Factor for Control of Ventilation During Exercise Is a Learned Response.

- The ventilatory response during exercise, is at least partly a learned response.
- With repeated periods of exercise, the brain becomes more able to provide the proper signals required to keep the blood PCO2 at its normal level.
- The cerebral cortex is involved in this learning, because experiments that block only the cortex also block the learned response

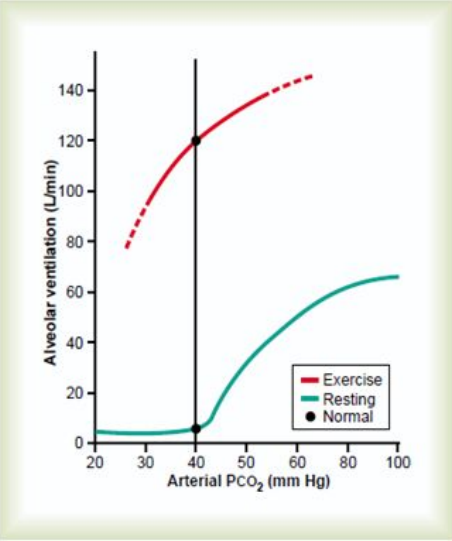
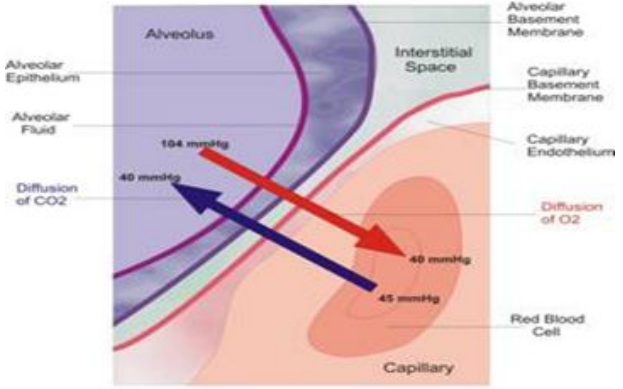


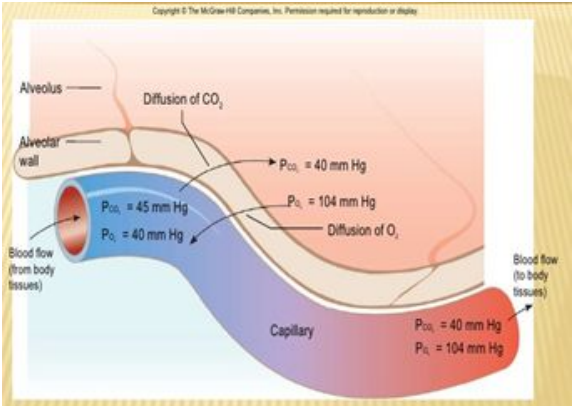
Figure 41–10

Approximate effect of maximum exercise in an athlete to shift the alveolar PCO_2-ventilation response curve to a level much higher than normal. The shift, believed to be caused by neurogenic factors, is almost exactly the right amount to maintain arterial PCO_2 at the normal level of 40 mm Hg both in the resting state and during heavy exercise.

Diffusion capacity of the respiratory membrane

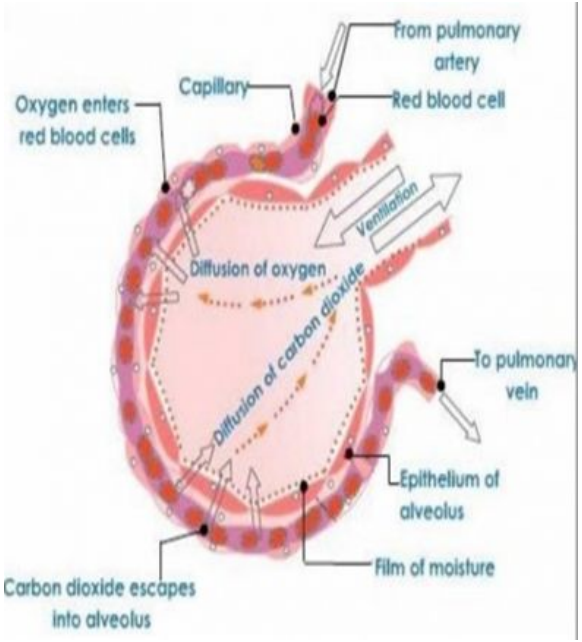
- Is the volume of gas that diffuses through the membrane each minute for a pressure difference of 1mmHg.
- Diffusing capacity for oxygen at rest 21ml/min/mmHg
- Even if the oxygen pressure difference across the respiratory membrane is 11mmHg, >>> 11x21= 230ml oxygen diffusing through the membrane each minute.
- During rest tissues consume 250 ml O2 /min





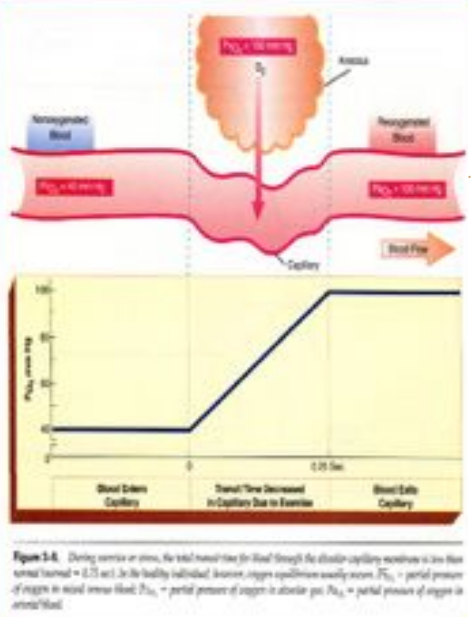
Changes in the oxygen- diffusing capacity during exercise

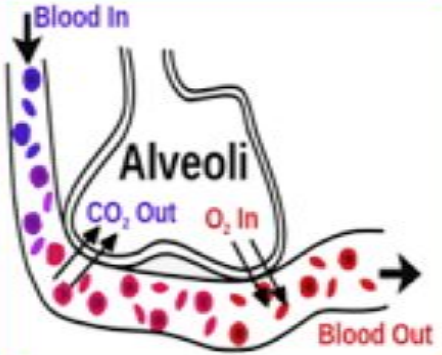
- Diffusing capacity for oxygen during exercise = 65ml/min/mmHg
- This is due to increased number of open pulmonary capillaries which was dormant(في سبات), thereby increasing the surface area for gas exchange.
- In addition to increased alveolar ventilation.



Diffusing capacity for carbon dioxide

- Diffusion capacity for carbon dioxide 400ml/min/mmH, which diffuses 20 times greater than oxygen (in O2 ***21ml/min/mmHg***) because it's 20 times greater in diffusion coefficient for oxygen.
- Diffusion capacity for carbon dioxide During exercise 1200 to 1300ml/min/mmH.
- During exercise the oxygen requirement increased 20 times, cardiac output increased and the time blood remained in the pulmonary capillaries becomes less than half normal despite the fact that additional capillaries open up.
- When the blood leaves the pulmonary capillaries it almost saturated with oxygen.

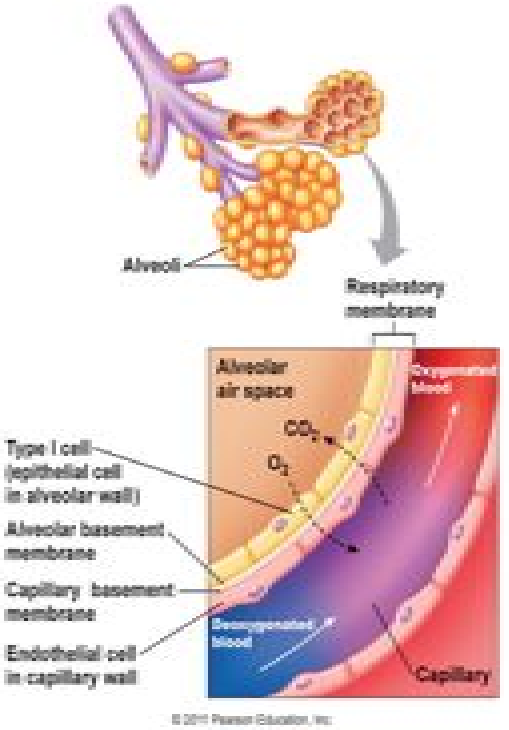




Reasons for this are as follow:

1- The diffusing capacity for oxygen increases almost three folds during exercise, this results mainly from increasing numbers of capillaries participating in the diffusion, and a more even V/Q ratio all over the lung.

2- At rest the blood normally stays in the lung capillaries about three times as long as necessary to cause full oxygenation. Therefore, even with shortened time of exposure in exercise, the blood is still fully oxygenated or nearly so.



Oxygen Consumption and Pulmonary Ventilation in Exercise.

- Normal oxygen consumption for a young man at rest is about 250 ml/min.
- However, Under maximal conditions, this can be increased to approximately the following average levels:

  - Untrained average male ---------- 3600 ml/min
  - Athletically trained average male --- 4000 ml/min
  - Male marathon runner---------- 5100 ml/min

Runners at the end of a race are often left gasping for air

Gasping for air after a hard race, to repay the oxygen debt.

Female’s team:

Leader: Alanoud Salman Alotaiby

Members:

Male’s team:

Leader: Abdulhakim AlOnaiq

Members:

Anas Abdullah Alsaif

Saud alatawi

Fahad alhussain

Khaled showail