9th lecture

Effects of Exercise on The Respiratory System

Physiology Team 434
Contact us: physiology434@gmial.com

OBJECTIVES:

- Describe the effects of moderate and severe exercise on oxygen consumption, and ventilation volumes.
- Describe the effects of exercise on arterial PO2, PCO2 and H+ ions.
- Define the diffusing capacity of the respiratory membrane, and its typical values at rest, and explain its changes in exercise.
- Explain causes of hyperventilation in exercise.

CONTENTS

Physiology Team 434
Contact us: physiology434@gmial.com

COLOR INDEX:

- Red = important
- Grey = additional notes

1- EFFECTS OF EXERCISE ON RESPIRATORY SYSTEM

Blood gases do not always have to become abnormal in order to stimulate respiration in exercise , hyperventilation occurs due to compensate gas exchange to prevent hypoxia "O_2 to be consumed by tissues". Instead, respiration is stimulated mainly by neurogenic mechanisms

2- REGULATION OF RESPIRATION DURING EXERCISE

During strenuous exercise although O_2 consumption and CO_2 formation may increase 20 folds , O_2 levels do not decrease and arterial PO2, PCO2, PH all remain almost exactly normal .

alveolar ventilation increases almost exactly in step with the increased levels of metabolism to prevent any change .

3- DIFFUSION CAPACITY OF RESPIRATORY MEMBRANE

✓ Defined as :

The volume of gas that diffuses through the membrane each minute for a pressure difference of 1mmHg

✓ Values :

Diffusion Capacity	At rest	During exercise
Oxygen	***21****ml/min/mmHg* if the oxygen pressure difference across the respiratory membrane is 11mmHg x21= 230ml per min . remember tissues consume 250mlO_2/min	**65**ml/min/mmHg due to increased number of open pulmonary capillaries (was dormant), thereby increasing the surface area for gas exchange **+** increased alveolar ventilation
Carbon dioxide	diffuses 20 times greater than oxygen due to greater diffusion coefficient (20 times that for O_2) . So 21X20 = "around" **400**ml **/**min/mmHg**.**	**1200** to **1300** ml/min/mmHg

N.B

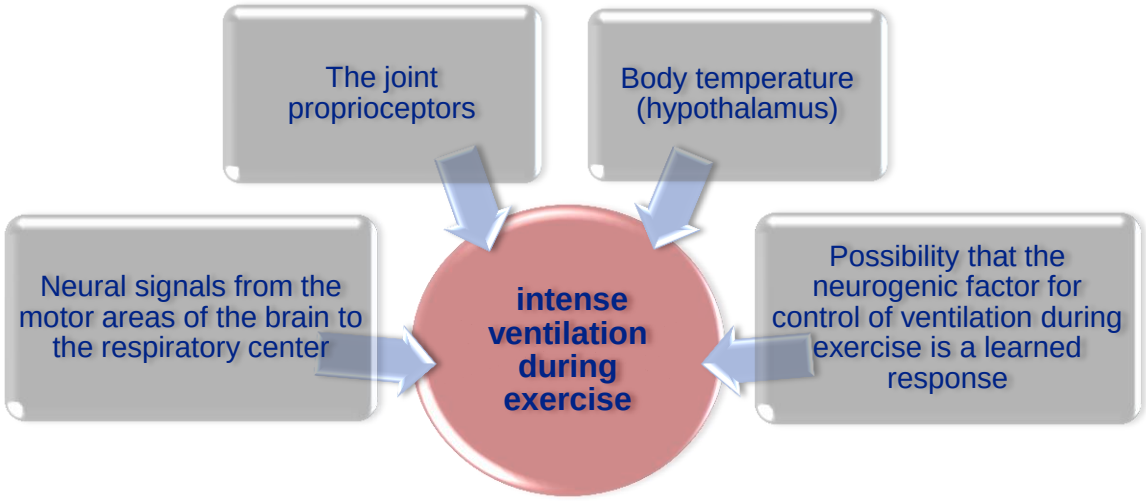
- ✓ During exercise the oxygen requirements increase 20 times + cardiac output increase , and so the time blood remained in the pulmonary capillaries becomes less than half normal despite the fact that additional capillaries open up
- ✓ blood leaving the pulmonary capillaries is almost completely saturated with oxygen .
- ✓ differences between diffusing capacity at resting and of maximal exercise make blood flow through many of the pulmonary capillaries providing greater surface area through which oxygen can diffuse into the pulmonary capillary of blood.

Why ?

1- The diffusing capacity for oxygen increases almost 3folds during exercise, this results mainly from increasing numbers of capillaries participatng in the diffusion + more even V/Q rato 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 (1/2) in exercise, the blood is still fully oxygenated or nearly so .

4- WHAT CAUSES INTENSE VENTILATION DURING EXERCISE

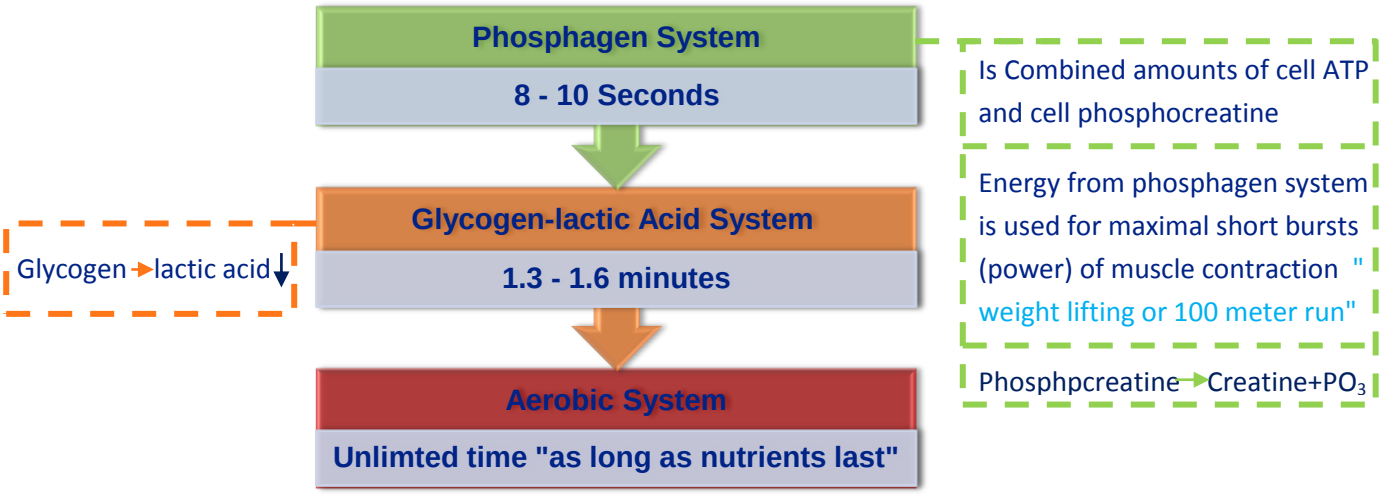


Physiology Team 434
Contact us: physiology434@gmial.com

5- ENERGY SOURCES FOR MUSCLE CONTRACTION "ATP→ADP+AMP"

A- ANEROBIC SYSTEM

Relation between exercise duration & energy :



B- AEROBIC SYSTEM

7-OXYGEN CONSUMPTION AND PULMONARY VENTILATION IN EXERCISE

increase about 20-fold between the resting state and maximal intensity of exercise in the well-trained athlete. (Linear relationship)

Normal oxygen consumption for a young man at rest is about 250 ml/min. HOWEVER, under maximal conditions, this can be increased .

Eg :

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

8-OXYGEN DEBT

- ✓ Defined as the Extra Consumption of Oxygen After Completion of Strenuous Exercise (about 11.5 liters)
- ✓ Developed after about 5 minutes or more of constant exercise (when exercise is ANAEROBIC–without O_2-) and hence If the exercise is just AEROBIC–with O_2-there will be no oxygen debt.

This page is mentioned in the boys slides only, go through it just in case ..

1-CAUSES OF HYPERVENTILATION IN EXERCISE

Notice : maximal breathing capacity is about 50 % greater than the actual pulmonary ventilation during maximal exercise

During maximal effort :

Pulmonary ventilation at maximal exercise 100-110L/min

Maximal breathing capacity :

150-170L/min

**** to give athletes extra ventilation E.g** - exercise at high altitudes,

- exercise under very hot conditions
- abnormalities in the respiratory system

Remember Respiration is stimulated mainly by neurogenic mechanisms during exercise !

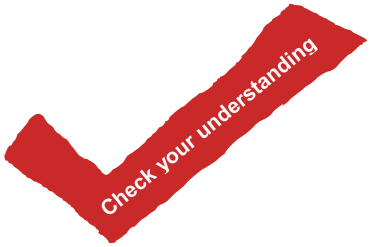
direct stimulation of the respiratory center by the same nervous signals that are transmitted from the brain to the muscles

sensory signals transmitted into the respiratory center from the contracting muscles and moving joints

2- EFFECTS OF EXERCISE ON ARTERIAL PO_2, PCO_2 AND H^+ IONS.

Many studies have reported that the lactate threshold (LT) is strongly correlated with ventilatory anaerobic threshold (VAT) - which refers to the onset of exercise induced hyperventilation during effort-. This increase as a homeostatic response to deal with the consequences of the excess lactate production which can dissociate to release H^+ ions into the blood stream. The H^+ ions are buffered by bicarbonate and release CO_2 and this buffering will result in extra CO_2 production over that produced by aerobic metabolism and hence increases the arterial (PCO_2) which stimulates excess ventilation that follows on from the lactate threshold .

Physiology Team 434
Contact us: physiology434@gmial.com



Respiratory system effects of exercise

Physiology Team 434
Contact us: physiology434@gmial.com

Done by:

- Amal Afrah
- Amerah Mansour
- Moath Aleisa
- Wajda Alhothali