



Benha University
Faculty of Science
Department of Zoology

Adaptation Physiology (318 Z)

Semester / year: first
2014/2015

Exam time: 1:00 hours
Dr. Doaa S. Ibrahim

Level: third level

Sepec: Zoology

Second question: (1 hour, 24 marks)

A- Explain the following: (15 marks)

- 1) Increasing lung diffusing capacity after acclimatization to low po_2 .

It will be recalled that the normal diffusing capacity for oxygen through the pulmonary membrane is about 21 ml/mm Hg/min, and this diffusing capacity can increase as much as threefold during exercise. A similar increase in diffusing capacity occurs at high altitude. Part of the increase results from increased pulmonary capillary blood volume, which expands the capillaries and increases the surface area through which oxygen can diffuse into the blood. Another part results from an increase in lung air volume, which expands the surface area of the alveolar-capillary interface still more. A final part results from an increase in pulmonary arterial blood pressure; this forces blood into greater numbers of alveolar capillaries than normally—especially in the upper parts of the lungs, which are poorly perfused under usual conditions.

- 2) Acclimatization of the natives at high altitudes begins in infancy.

Many native human beings in the Andes and in the Himalayas live at altitudes above 13,000 feet—one group in the Peruvian Andes lives at an altitude of 17,500 feet and works a mine at an altitude of 19,000 feet. Many of these natives are born at these altitudes and live there all their lives. In all aspects of acclimatization, the natives are superior to even the best acclimatized lowlanders, even though the lowlanders might also have lived at high altitudes for 10 or more years. Acclimatization of the natives begins in infancy. The chest size, especially, is greatly increased, whereas the body size is somewhat decreased, giving a high ratio of ventilatory capacity to body mass. In addition, their hearts, which from birth onward pump extra amount of cardiac output, are considerably larger than the hearts of lowlanders. Delivery of oxygen by the blood to the tissues is also highly facilitated in these natives and the greater quantity of hemoglobin, the quantity of oxygen in their arterial blood is greater than that in the blood of the natives at the lower altitude. Note also that the venous Po_2 in the highaltitude natives is only 15 mm Hg less than the venous Po_2 for the lowlanders, despite the very low arterial Po_2 ,

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indicating that oxygen transport to the tissues is exceedingly effective in the naturally acclimatized high-altitude natives.

- 3) Helium is usually used in the gas mixture instead of nitrogen in deep dives.

In very deep dives, especially during saturation diving, helium is usually used in the gas mixture instead of nitrogen for three reasons:

- (1) It has only about one fifth the narcotic effect of nitrogen.
- (2) Only about one half as much volume of helium dissolves in the body tissues as nitrogen, and the volume that does dissolve diffuses out of the tissues during decompression several times as rapidly as does nitrogen, thus reducing the problem of decompression sickness.
- (3) The low density of helium (one seventh the density of nitrogen) keeps the airway resistance for breathing at a minimum, which is very important because highly compressed nitrogen is so dense that airway resistance can become extreme, sometimes making the work of breathing beyond endurance.

B- Compare between the followings: (5 marks)

- 1) Acute and chronic mountain sickness.

Acute mountain sickness:

A small percentage of people who ascend rapidly to high altitudes become acutely sick and can die if not given oxygen or removed to a low altitude. Tness begins from a few hours up to about 2 days after ascent.

Two events frequently occur:

1. Acute cerebral edema. This is believed to result from local vasodilation of the cerebral blood vessels, caused by the hypoxia. Dilation of the arterioles increases blood flow into the capillariesthus increasing capillary pressure, which in turn causes fluid to leak into the cerebral tissues.
2. Acute pulmonary edema. The severe hypoxia causes the pulmonary arterioles to constrict potently, but the constriction is much greater in some parts of the lungs than in other parts, so that more and more of the pulmonary blood flow is forced through fewer and fewer still uncontracted pulmonary vessels. The postulated result is that the

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capillary pressure in these areas of the lungs becomes especially high and local edema occurs.

Chronic mountain sickness

Occasionally, a person who remains at high altitude too long develops chronic mountain sickness, in which the following effects occur:

- (1) The red cell mass and hematocrit become exceptionally high.
- (2) The pulmonary arterial pressure becomes elevated even more than the normal elevation that occurs during acclimatization.
- (3) The right side of the heart becomes greatly enlarged.
- (4) The peripheral arterial pressure begins to fall.
- (5) Congestive heart failure ensues.
- (6) Death often follows unless the person is removed to a lower altitude.

2) Oxygen and carbon dioxide toxicity at high pressure.

Oxygen toxicity at high pressure:

Above a critical alveolar P_{O_2} , the hemoglobin-oxygen buffering mechanism fails, and the tissue P_{O_2} can then rise to hundreds or thousands of millimeters of mercury. At these high levels, the amounts of oxidizing free radicals literally swamp the enzyme systems designed to remove them, and now they can have serious destructive and even lethal effects on the cells. One of the principal effects is to oxidize the polyunsaturated fatty acids that are essential components of many of the cell membranes. Another effect is to oxidize some of the cellular enzymes, thus damaging severely the cellular metabolic systems. The nervous tissues are especially susceptible because of their high lipid content. Chronic oxygen poisoning causes pulmonary disability also.

Carbon dioxide toxicity at high pressure:

In certain types of diving gear, however, such as the diving helmet and some types of rebreathing apparatuses, carbon dioxide can build up in the dead space air of the apparatus and be rebreathed by the diver. Up to an alveolar carbon dioxide pressure (P_{CO_2}) of about 80 mm Hg, twice that in normal alveoli, the diver usually tolerates this buildup by increasing the minute respiratory volume a maximum of 8- to 11-fold to compensate for the increased carbon dioxide. Beyond 80-mm Hg alveolar P_{CO_2} , the situation becomes intolerable, and eventually the respiratory center begins to be depressed, rather than excited, because of the negative tissue

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metabolic effects of high P_{CO_2} . The diver's respiration then begins to fail rather than to compensate. In addition, the diver develops severe respiratory acidosis, and varying degrees of lethargy, narcosis, and finally even anesthesia.

C- Write short notes on brain in starvation? (4 marks)

Normally, glucose serves as the primary fuel for the brain. During starvation, ketone bodies play a significant role as a fuel for brain, reducing its dependence on glucose.

A. Carbohydrate metabolism

In the fed state, the brain uses glucose exclusively as a fuel. The brain contains no significant stores of glycogen and is, therefore, completely dependent on the availability of blood glucose.

B. Fat metabolism

The brain has no significant stores of triglycerides, and the fatty acids circulating in the blood make little contribution to energy production because fatty acids bound to albumin do not efficiently cross the blood-brain barrier.

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