**نصف ورقة**

**Second question: (1 hour, 24 marks)**

**A- Complete the following: (4 marks)**

1. Factors that influence airway resistance include airway diameter, lung volume, elastic recoil and muscle tone.
2. Oxygen – hemoglobin dissociation curve is affected by temperature, 2,3 diphosphoglycerate and pH.
3. Right atrium receives blood returning from the systemic circulation; the left atrium receives blood from the lungs.

**B- Give a brief account about two of the followings: (10 marks)**

1. Liver in starvation.

A. Carbohydrate metabolism:

The liver first uses glycogen degradation, then gluconeogenesis to maintain blood glucose levels to sustain energy metabolism of the brain and other glucose requiring tissues.

1. Increased glycogen degradation

Several hours after meal, blood glucose levels decreased and caused increased glucagon secretion and decreased insulin release.

2. Increased gluconeogenesis

It is the process of synthesis of glucose from amino acids, glycerol and lactate. It begins 4 to 6 hours after the last meal and becomes fully active as stores of liver glycogen are depleted.

B. Fat metabolism:

1. Increased fatty acid oxidation.

Oxidation of fatty acids derived from adipose tissue is the major source of energy in hepatic tissue.

2. Increased synthesis of ketone bodies.

It synthesis is favored when the concentration of acetyl CoA exceeds the oxidative capacity of the TCA cycle. It starts during first days of starvation. It is important in starvation because they can be used for fuel by most tissues including brain.

1. Decompression sickness.

If a diver has been beneath the sea long enough that large amounts of nitrogen have dissolved in his or her body and the diver then suddenly comes back to the surface of the sea, signiﬁcant quantities of nitrogen bubbles can develop in the body ﬂuids either intracellularly or extracellularly and can cause minor or serious damage in almost any area of the body, depending on the number and sizes of bubbles formed; this is called decompression sickness.

The symptoms of decompression sickness are caused by gas bubbles blocking many blood vessels in different tissues. At ﬁrst, only the smallest vessels are blocked by minute bubbles, but as the bubbles coalesce, progressively larger vessels are affected. Tissue ischemia and sometimes tissue death are the result. In most people with decompression sickness, the symptoms are pain in the joints and muscles of the legs and arms, affecting 85 to 90 per cent of those persons who develop decompression sickness. The joint pain accounts for the term “bends” that is often applied to this condition. In 5 to 10 per cent of people with decompression sickness, nervous system symptoms occur, ranging from dizziness in about 5 per cent to paralysis or collapse and unconsciousness in as many as 3 per cent. The paralysis may be temporary, but in some instances, damage is permanent. Finally, about 2 per cent of people with decompression sickness develop “the chokes,” caused by massive numbers of microbubbles plugging the capillaries of the lungs; this is characterized by serious shortness of breath, often followed by severe pulmonary edema and, occasionally, death.

1. 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, and (6) death often follows unless the person is removed to a lower altitude.

The causes of this sequence of events are probably threefold: First, the red cell mass becomes so great that the blood viscosity increases severalfold; this increased viscosity tends to decrease tissue blood ﬂow so that oxygen delivery also begins to decrease. Second, the pulmonary arterioles become vasoconstricted because of the lung hypoxia. This results from the hypoxic vascular constrictor effect that normally operates to divert blood ﬂow from low-oxygen to high-oxygen alveoli, as explained in Chapter 38. But because all the alveoli are now in the low-oxygen state, all the arterioles become constricted, the pulmonary arterial pressure rises excessively, and the right side of the heart fails. Third, the alveolar arteriolar spasm diverts much of the blood ﬂow through nonalveolar pulmonary vessels, thus causing an excess of pulmonary shunt blood ﬂow where the blood is poorly oxygenated; this further compounds the problem. Most of these people recover within days or weeks when they are moved to a lower altitude.

**C- Explain the following: (10 marks)**

1) Increased diffusing capacity after acclimatization to low PO2.

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) Natural acclimatization of native human being living at high altitudes.

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 bestacclimatized 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 ventilator 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. Oxygen-hemoglobin dissociation curves for natives who live at sea level and for their counterparts who live at 15,000 feet. Note that the arterial oxygen Po2 in the natives at high altitude is only 40 mm Hg, but because of 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 Po2 in the highaltitude natives is only 15 mm Hg less than the venous Po2 for the lowlanders, despite the very low arterial Po2, indicating that oxygen transport to the tissues is exceedingly effective in the naturally acclimatized high-altitude natives.

3) Using helium instead of nitrogen in very deep dives.

When divers must work at very deep levels—between 250 feet and nearly 1000 feet—they frequently live in a large compression tank for days or weeks level near that at which they will be working. This keeps the tissues and ﬂuids of the body saturated with the gases to which they will be exposed while diving. Then, when they return to the same tank after working, there are no signiﬁcant changes in pressure, so that decompression bubbles do not occur.

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; and (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.

Finally, in very deep dives it is important to reduce the oxygen concentration in the gaseous mixture because otherwise oxygen toxicity would result. For instance, at a depth of 700 feet (22 atmospheres of pressure), a 1 per cent oxygen mixture will provide all the oxygen required by the diver, whereas a 21 per cent mixture of oxygen (the percentage in air) delivers a Po2 to the lungs of more than 4 atmospheres, a level very likely to cause seizures in as little as 30 minutes.

4) Effect of synthesis of ketone bodies during starvation.

After several weeks of starvation gluconeogensis decreased, so the glucose reached to the brain decreased. Therefore, synthesis of ketone bodies is important in starvation because they can be used as a fuel of brain when gluconeogensis decreased.