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QUESTION 1

Hypoxia refers to a physiological condition in which the body lacks sufficient oxygen for normal cellular functioning. Prolonged hypoxia generally leads to an inhibition of mental capacity and a reduction in the work capacity of muscle. Severe

cases of hypoxia can lead to coma or even death. Depending on the cause, hypoxia can be classified into four general types:

Hypoxic hypoxia is a type of hypoxia that occurs when the partial pressure of oxygen in the blood is too low. For example, climbers at high altitude, where the air contains less oxygen, might experience hypoxic hypoxia because the partial pressure of oxygen in the air inhaled is very low, leading to insufficient partial pressure of oxygen in the blood.

Anemic hypoxia describes a diminished ability of the blood to transport oxygen. Several factors can influence the oxygen-carrying capacity of the blood. Primary causes of anemic hypoxia include a lower than normal number of functional erythrocytes or an insufficient quantity of hemoglobin, the oxygen- carrying molecules of the blood. Abnormal hemoglobin can also decrease the blood\\'s capacity to carry oxygen and lead to anemic hypoxia.

Ischemic hypoxia is caused by a decreased delivery of blood to the tissues. Localized circulatory deficiencies, such as blood clots, and global circulatory deficiencies, such as heart failure, decrease the delivery of blood to the tissues, and can therefore cause ischemic hypoxia.

Histotoxic hypoxia results from the inability of cells to utilize the oxygen available in the blood. Causes of histotoxic hypoxia include the poisoning of cellular enzymes involved in aerobic respiration, as well as the decreased metabolic capacity of the oxidative enzymes due to vitamin deficiency. Cyanide poisoning causes histotoxic hypoxia by blocking the action of cytochrome oxidase in the electron transport chain so that tissues cannot use oxygen even though it is available.

Hypoxia can often be treated by ventilation with pure oxygen. The increased PO2 in the alveoli will lead to an increased PO2 in the blood. Treatment with pure oxygen is LEAST effective in treating which of the following types of hypoxia?

- A. Hypoxic hypoxia caused by hypoventilation
- B. Anemic hypoxia caused by sickle cell anemia
- C. Ischemic hypoxia caused by poor circulation
- D. Histotoxic hypoxia caused by the disease beri beri

Correct Answer: D

Oxygen therapy will help any condition which would be alleviated by an increase in the p of oxygen in the blood. The question stem states that beri beri leads to histotoxic hypoxia. The passage tells us that histoxic hypoxia occurs when the tissues cannot utilize oxygen. So, increasing the amount of oxygen transported in the blood through ventilation with pure oxygen will not serve any purpose. Choice A is incorrect because breathing pure oxygen will greatly help an individual suffering from hypoventilation. If pure oxygen is inhaled, much more oxygen will diffuse into the blood and be carried to the tissues. Choice B is incorrect because, although sickle cell anemia reduces the oxygen carrying capacity of the blood (anemic hypoxia), inhaling pure oxygen will allow more oxygen to dissolve in the plasma, somewhat increasing delivery of oxygen to the tissues. Choice C is incorrect because increasing the concentration of oxygen in the blood will increase delivery of oxygen to the tissues and take full advantage of the carrying capacity of the poor circulation.

QUESTION 2



Many nutrients required by plants exist in soil as basic cations:

A soil\\'s cation-exchange capacity is a measure of its ability to adsorb these basic cations as well as exchangeable hydrogen and aluminum ions. The cation-exchange capacity of soil is derived from two sources: small clay particles called micelles consisting of alternating layers of alumina and silica crystals, and organic colloids.

A13+

Replacement of + and + by other cations of lower valence creates a net negative charge within the inner layers of the micelles. This is called the soil\\'s permanent charge. For example, replacement of an atom of aluminum by calcium within a section where the net charge was previously zero, as shown below, produces a net charge of ?, to which other cations can become adsorbed.



Figure 1

A pH-dependent charge develops when hydrogen dissociates from hydroxyl moieties on the outer surfaces of the clay micelles. This leaves negatively-charged oxygen atoms to which basic cations may adsorb. Likewise, a large pH-

dependent charge develops when hydrogen dissociates from carboxylic acids and phenols in organic matter.

In most clays, permanent charges brought about by substitution account for anywhere from half to nearly all of the total cation-exchange capacity. Soils very high in organic matter contain primarily pH-dependent charges. In a research study,

three samples of soil were leached with a 1 N solution of neutral KCl, and the displaced A13+ and basic cations measured. The sample was then leached again with a buffered solution of BaCl2 and triethanolamine at pH 8.2, and the

displaced H+ measured. Table 1 gives results for three soils tested by this method.

Table 1



	(meq/100 g)				Total
	pН	Al ³⁺	Basic Cations	H+	Exchange Capacity
Sample I	4.5	11.7	1.9	34.0	47.6
Sample II	5.3	1.6	16.3	19.5	37.4
Sample III	6.0	0.5	9.8	7.8	18.1

Due to the buffering effect of the soil\\'s cationexchange capacity, just measuring the soil solution\\'s pH will not indicate how much base is needed to change the soil pH. In another experiment, measured amounts of acid and base were added to 10-gram samples of well-mixed soil that had been collected from various locations in a field. The volumes of the samples were equalized by adding water. The results were recorded in Figure 2.

Figure 2.



A13

Which of the following would probably NOT displace + in soil micelles?



- A. A1³⁺
 B. H⁺
 C. A1³⁺ and Basic Cations
 D. A1³⁺ and H+
- A. Option A
- B. Option B
- C. Option C
- D. Option D
- Correct Answer: C

The passage tells you that in soil micelles, cations like A13 and Si4+ are replaced by cations with lower valences. That is what gives the micelles their negative charge. When an A13 cation is displaced by a cation with a +2 charge, the micelle gains a ? charge. So the leaching of these actions as depicted in Table 1 gives an indication of the permanent charge as we saw in the earlier questions. Knowing this, it is easy to see that Si4+, with a valence of +4, is the cation that could not displace the A13+, since Na+, Mg2+, and Cr2+ all have lower valences than the aluminum\\'s +3 and would give a net negative charge to the micelle.

QUESTION 3

What happens if a reaction is at equilibrium state and some more reactants are added in container?

- A. The equilibrium will not be affected.
- B. The reverse reaction rate will increase.
- C. The forward reaction rate will increase.
- D. The forward reaction rate will decrease.

Correct Answer: C

QUESTION 4

When glucose is heated with Fehling\\'s solution, the colour of the precipitate obtained is:

A. black.

- B. yellow.
- C. red.
- D. white.



Correct Answer: C

QUESTION 5

A biochemist grows two cultures of yeast -- one aerobically and the other anaerobically -- and measures the amount of ATP produced by each culture. He finds that the aerobically-grown yeast produce about 18 times as much ATP as the anaerobically-grown yeast. These observations are consistent with the fact that in the aerobically grown yeast:

A. oxygen is converted into ATP.

- B. oxygen is necessary to convert glucose into pyruvate.
- C. oxygen is the final electron acceptor of the respiratory chain.

D. oxygen is necessary for the reduction of pyruvate into lactate.

Correct Answer: C

Aerobic respiration cannot occur without oxygen. Why? Because oxygen is necessary for the final step of aerobic respiration, which is the electron transport chain. Here\\'s a brief summary of glycolysis, the tricarboxylic acid cycle, also known as the Krebs cycle of the citric acid cycle, and the electron transport chain -- which are the three stages of aerobic respiration. Glycolysis is a series of reactions that lead to the oxidative breakdown of glucose into pyruvate. These reactions occur in the cytoplasm and result in the production of two NADH and a net gain of two ATP. Oxygen is not required for glycolysis, therefore, choice B is wrong. In the absence of oxygen -- that is, under anaerobic conditions -- the pyruvate is reduced to lactate; it undergoes this fermentation step so that NAD+ can be generated. Hence, choice D is wrong. In the presence of oxygen -- that is, under aerobic conditions -- the pyruvate is oxidized to release the considerable energy still stored in its chemical bonds. The pyruvate is transported from the cytoplasm into the mitochondrial matrix. The oxidative decarboxylation of pyruvate into Acetyl CoA is catalyzed by pyruvate dehydrogenase complex; one NADH is generated during the formation of acetyl CoA. Next, the acetyl group from the acetyl CoA combines with oxaloacetate, forming citrate. Through a complicated series of reactions, the citrate is completely oxidized, two molecules of carbon dioxide are released, and NADH, FADH2, and ATP are generated. Next, all of the molecules of NADH and FADH2 generated during glycolysis, pyruvate decarboxylation, and the TCA cycle, transfer their high potential electrons to a series of carrier molecules located in the inner mitochondrial membrane. A series of redox reactions is coupled with the phosphorylation of ADP; this is known as oxidative phosphorylation. As the electrons are transferred from carrier to carrier, free energy is released, which is then used to produce ATP. So, choice A is also wrong. The final carrier of the electron transport chain, cytochrome a3, passes its electrons to the final electron acceptor, molecular oxygen. Oxygen picks up a pair of hydrogen ions, forming water. The final ATP tally for aerobic respiration is net gain of 36 ATP. This is eighteen times as much ATP as produced during anaerobic respiration. So, choices A, B, and D are all wrong, and choice C is true and consistent with the observations made by the biochemist in the question.

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