EXERCISES

Q No. 1: What is glycogen and where is it found?

Ans 1: Glycogen is a readily mobilized storage form of glucose. In humans, glycogen is made and stored primarily in the cells of the liver and the muscles, hydrated with three or four parts of water. Muscle glycogen is converted into glucose by muscle cells, and liver glycogen converts to glucose for use throughout the body including the central nervous system.

Q No. 2: Give the structure of glycogen.

Ans 2: It is a very large, branched polymer of glucose residues that can be broken down to yield glucose molecules when energy is needed. Most of the glucose residues in glycogen are linked by α-1,4-glycosidic bonds. Branches at about every tenth residue are created by α-1,6-glycosidic bonds.

Q No. 3: How is glycogen synthesized?

Ans 3: Synthesis of glycogen from glucose is carried out by the enzyme glycogen synthase (GS). This enzyme utilizes UDP-glucose as one substrate and the non-reducing end of glycogen as another. Glycogen synthesis requires an activated form of glucose, uridine diphosphate glucose (UDP-glucose). The activation of glucose to be used for glycogen synthesis is carried out by the enzyme UDP-glucose pyrophosphorylase 2. This enzyme exchanges the phosphate on C-1 of glucose-1-phosphate for UDP. The energy of the phospho-glycosyl bond of UDP-glucose is utilized by glycogen synthase to catalyze the incorporation of glucose into glycogen. UDP is subsequently released from the enzyme.

Q No. 4: Define hypoglycemia.

Ans 4: Hypoglycemia, caused by excessive insulin is characterized by high liver glycogen levels. High insulin levels prevent the glycogenolysis necessary to maintain normal blood sugar levels.

Q No. 5: What are glycogen storage disorders?

Ans 5: Glycogen storage disorders are a group of inherited diseases that result from a lack of, or abnormal functioning of, one of the proteins (enzymes) involved in the

conversion of glucose to glycogen or the breakdown of glycogen back into glucose. If the enzyme problem is with one of the enzymes involved in glycogen production (synthesis), this causes reduced amounts of normal glycogen to be produced and sometimes abnormal glycogen being produced.

Q No. 6: What is the function of glycogen in liver?

Ans 6: The main role of liver glycogen is to provide a reserve supply of glucose so that blood glucose concentration can be kept at an adequate level to supply the brain during periods of fasting, or when glucose use is increased during physical work and exercise. Thus, after meals, some of the carbohydrate consumed is stored as liver glycogen, and during fasting, this glycogen is broken down and the glucose is released into the blood.

Q No. 7: What functions does glycogen perform in muscles?

Ans 7: The main role of muscle glycogen is to provide fuel for the muscle's own contraction during exercise. Muscle glycogen cannot be broken down to glucose and so cannot be used to raise blood glucose concentration directly. However, in some circumstances, when their metabolism is partly anaerobic, skeletal muscles produce lactic acid from glycogen. When this lactic acid passes into the blood it is taken up by the liver, where it is converted into glucose.

Q No. 8: How is muscle glycogen breakdown linked to muscle activity?

Ans 8: The major stimulus causing the breakdown of muscle glycogen is contraction of the muscles. The initiation of glycogen breakdown, for instance is accompanied by the onset of exercise. The extent to which the muscles continue to use their glycogen store depends on the intensity of the exercise. With low intensity exercise (such as slow walking, cycling, or swimming) the muscles do not use much glycogen as they are able to take up fat from the blood as a source of energy for contraction. However, with higher intensity exercise (jogging, brisk uphill walking, running) the muscles need to use glycogen or glucose from the blood to support the higher rate of energy expenditure.

Q No. 9: Define carbohydrate loading.

Ans 9: Carbohydrate loading also known as glycogen supercomposition is often used

by distance especially, marathon runners before important running events. It involves consumption of a very high carbohydrate diet, especially for at least three days after first depleting muscle glycogen levels, which makes it possible to double the normal glycogen content, ensuring that a longer period of exercise can be sustained before it is used up.

Q No. 10: How does anaerobic respiration take place?

Ans 10: When the muscle is under heavy stress, oxygen is not available in sufficient amounts to maintain mitochondrial function. Under such conditions, the anaerobic glycolytic system then becomes predominant. This is especially likely in white muscles, which are generally involved in heavy activity requiring very large amounts of energy. During anaerobic glycolysis, glycogen is converted through a series of phosphorylated six-carbon and three-carbon intermediates to pyruvate, which is then reduced to lactate. This system requires the cofactor NAD+, and it continually regenerates the NAD+ required. The terminal enzyme of the sequence, lactate dehydrogenase, is principally responsible for regeneration of NAD+.

Q No. 11: In terms of energy generation, how does aerobic and anaerobic respiration differ?

Ans 11: In anaerobic glycolysis, ATP production is much less efficient than it is in aerobic respiration. For example, anaerobic glycolysis yields only 2 or 3 moles ATP per mole of glucose, whereas aerobic respiration yields 36 or 37 moles ATP.

Q No. 12: What is the effect of subjecting animals to stress?

Ans 12: Glycogen is depleted by several stress conditions, and in general, it is desirable to minimize these conditions as much as possible. Stressed animals are likely to have a subnormal content of glycogen in their muscles, whereby, post-mortem, the pH of their flesh fails to attain acidic values and the attributes of eating quality in the meat will be adversely affected.

Q No. 13: What is ultimate pH and what determines it?

Ans 13: The pH of muscle/meat is a measurement of acidity. In a normal living muscle the pH is approximately 7.2. Glycogen is broken down to lactic acid when muscle turns into meat. The pH of meat can range from 5.2 to 7.0. The highest quality products tend to fall in the pH range of 5.7 to 6.0. The ultimate pH is determined by the extent of the pH decline at 24 hours after slaughter. The variation in ultimate pH influences factors such as colour and the ability of the meat to retain water. A low ultimate pH results in meat proteins having decreased water-holding capacity and a lighter colour. Conversely, a higher ultimate pH will give a darker colour and less drip loss.

Q No. 14: What do you understand by DFD?

Ans 14: Due to prolonged antemortem stress that depletes glycogen reserves and limits postmortem glycolysis, a high ultimate pH occurs in muscle tissue. This is fairly common in beef, causing the meat to be dark, firm, and dry (DFD). These “dark-cutting” muscles exhibit excellent water-holding properties but have poor resistance to the growth of microorganisms.

Q No. 15: How does high pH lead to off odor production?

Ans 15: Muscle, which has a high ultimate pH because of a deficiency of glycogen at death, also lacks the glucose which is produced by amylolysis postmortem, albeit in much smaller quantity than lactic acid by glycolysis. In the absence of a readily available carbohydrate substrate, micro-organisms attack amino acids immediately, causing early spoilage including off-odors.