Unit-2

Glycogen: Glycogen is the stored carbohydrate in case of mammals. It is a branched homo – polysaccharide. The monomers of glycogen are glucose. Glycogen acts as energy reserve for short period of time and we can say that it is our currency kept in locker while the fatty acid acts as reserve energy material for a longer period of time and we can say it is our currency kept in bank. For our energy requirements, we are dependent on the amount of glucose running in our blood. If this amount drops, then the breakdown of glycogen takes place and if we have excess energy or after a meal we get too much carbohydrate in our blood, then the synthesis of glycogen takes place. But the breakdown of fat only takes place when the glycogen storage depletes. So we can say that glycogen has an important role to maintain the amount of glucose in our blood or blood glucose homeostasis.Glycogen contains several branches that helps during breakdown of the glycogen as it provides so many number of reducing ends. Hence the process of breakdown of glycogen becomes fast and when needed the synthesis of glycogen also becomes fast fast due to the presence of severalnumber of non - reducing ends. But as the glycogen is a branched carbohydrate, so we can keep fewnumber of glycogen in a large number of spaces. Therefore, with respect to fat molecule, the amount of glycogen that can be stored is low. It also requires water for its storage. The sites of storage of glycogen are liver and muscles. The synthesis of glycogen from glucose molecule is known as glycogenesis, while the breakdown of glycogen into glucose molecules is known as glycogenolysis. This glycogenesis and glycogenolysis are all together known as glycogen metabolism.

Glycogenesis

Glycogenesis or glycogen synthesis is divided into seven steps:
1. First step is the conversion of glucose into glucose 6 phosphate. In glycolysis this process takes place with the help of the enzyme Hexokinase. There are several isozymes of hexokinase. Hexokinase I and II are found in muscle while hexokinase IV is found in liver. This process utilizes ATP. Glucose 6 phosphate may have more than one fates.

2. With the help of enzyme Phospho-glucomutase, the conversion of Glucose 6 phosphate into Glucose 1 phosphate takes place. Now, this Glucose 1 phosphate acts as precursor of glycogen. Hence, the conversion of Glucose 6 phosphate into Glucose 1 phosphate takes it in the direction of glycogenesis. It is committing step of Glycogenesis.

3. Later on Glucose 1 phosphate convert into UDP-Glucose with the help the enzyme UDP Glucose phosphorylase. This uses one UTP per glucose molecule. Hence we can say that, the glycogen synthesis is an expensive process. The formation of nucleotide - glucose makes this process irreversible. During this process Inorganic Pyro-phosphate (PPi) is removed and this is

highly exergonic process. The ΔG_0 of this reaction is -19.2 KJ/mole. This integration of Nucleotide in glucose molecule has several benefits, such as it pulls the reaction in forward direction. The nucleotides sugar associate with the enzymes is an excellent living group hence it facilitates nucleophilic attack on sugar carbon and by tagging some hexose with nucleotidyl group cell can set them aside in a pool for one purpose that is glycogen synthesis.

4. Now, the main enzyme of glycogen synthesis is glycogen synthase but it has a drawback. It cannot synthesize the glycogen De-novo, that is, it cannot synthesize from the starting point. It needs a primer and here the function of the primer and the initial extension of the chain is done by another enzyme. This enzyme is Glycogenin. This glycogenin act both as primer and as a base on which the initial synthesis of glycogen starts and its extension takes place. It adds glucose from one UDP-Glucose to its Tyrosine Residue (at number 194). In next step it transfer glucose molecule from UDP - Glucose to the first glucose molecule and so on, up to 8 residues.

5. When the initial glycogen chain forms of eight glucose residues, then this chain is transfered to another enzyme, that is, the main enzyme of glycogen synthesis Glycogen Synthase. Now, the glycogen synthase transfer several glucose molecules from UDP-Glucose to the non - reducing end of the glycogen molecule.

6. One more enzyme is involved in the process that is Glycogen Branching Enzyme. This is also known as Amylo α (1→4) to α (1→6) transglycosylase or Glycosyl (4→ 6) transferase. This enzyme transfers terminal fragment of 6 to 7 glucose residues from the non - reducing end on a glycogen having at least 11 residues. It breaks α (1→4) Bond and transfer it at α (1→6) hydroxyl group of a glucose residue and does it creates a new branch.

7. Now, again glycogen synthase adds up glucose residue at both non reducing ends that is one at the main chain and another at the branched chain. After sometime another branch can be created either in the main chain or the pre-existing branch. The biological cause of branching is to make the glycogen molecule more soluble and to increase the number of nonreducing ends, so that the rate of its synthesis and breakdown process maybe enhanced