SNS COLLEGE OF ALLIED HEALTH SCIENCES

SNS Kalvi Nagar, Coimbatore - 35

Affiliated to Dr MGR Medical University, Chennai

DEPARTMENT OF CARDIOPULMONARY PERFUSION CARE TECHNOLOGY

COURSE NAME : BIOCHEMISTRY

TOPIC : CARBOHYDRATES – GLYCOGEN METABOLISM

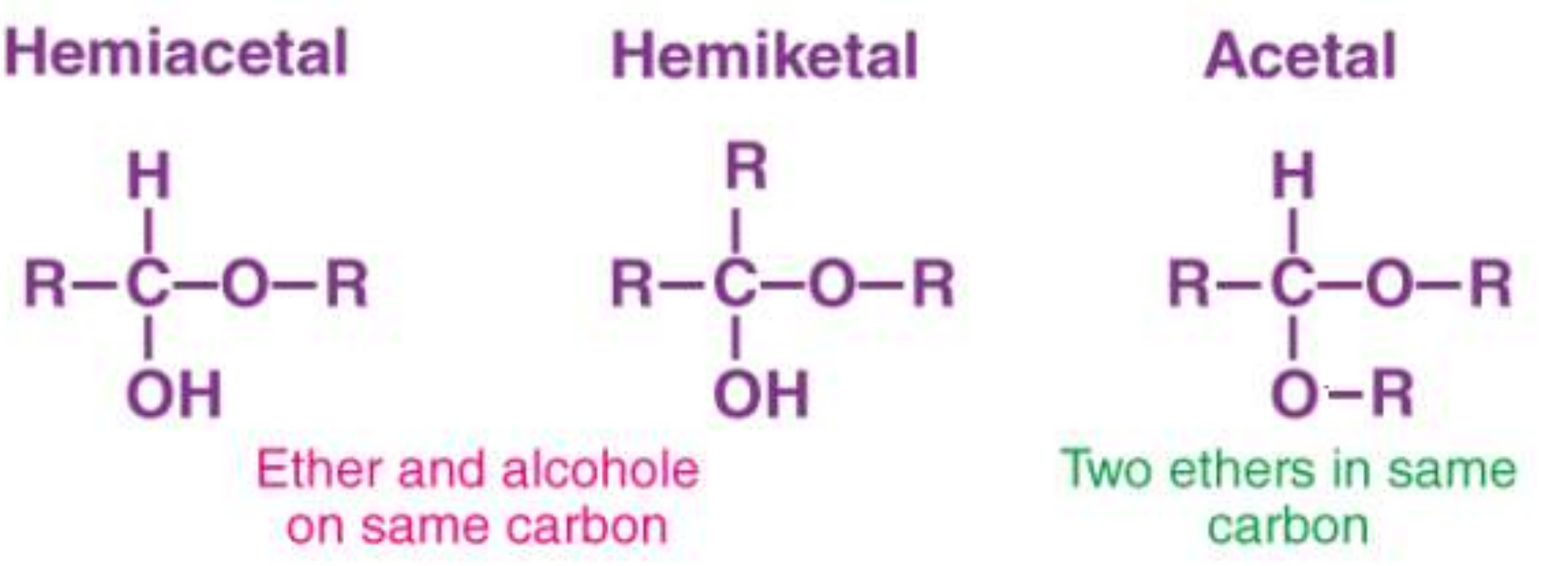
Glycogen

- Glycogen is a polysaccharide of glucose that serves as a form of energy storage in fungi and animals.
- The polysaccharide structure of glucose shows the primary storage form of glucose in the body.
- Glycogen is made and stored in the cells of liver and muscles that are hydrated with the four parts of water.
- It acts as the secondary long-term energy storage.
- Muscle glycogen is quickly converted into glucose by muscle cells and liver glycogen that converts into glucose for use throughout the body which includes the central nervous system.

Structure of Glycogen

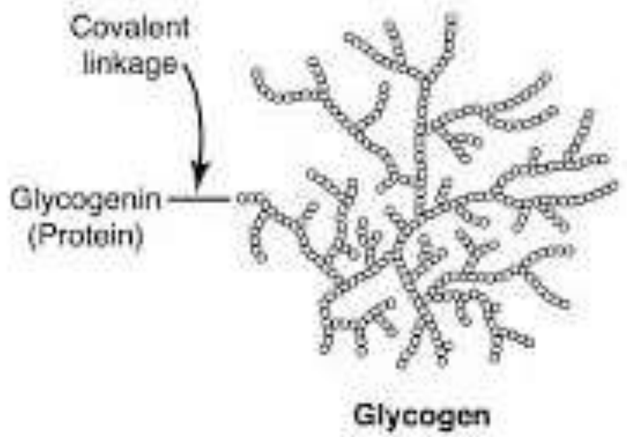
- Glycogen can be formed in a spherical shape, with glucose chains built around a core protein of glycogen with a molecular weight of 38,000 and an appearance similar to the tree branches growing out of a central point.
- Granules 10-40 nm in diameter are generated in the cytoplasm by hydrating glycogen with 3-4 parts water.
- The protein glycogen, which is involved in glycogen synthesis, is found in the granule in the core of glycogen.
- It's a similar substance to starch, which is the most common way for plants to store glucose.
- In addition, starch contains fewer branches than glycogen and will be less compact.

- Glycogen is composed of long polymer chains of glucose units which are bonded with an alpha acetal linkage - Forms by combination of the carbonyl and alcoholic group.
- If the carbonyl group is an aldehyde group i.e (-CHO) also termed as hemiacetal.
- If 2 alkoxy groups are bonded to the same carbon atom, it refers to the acetal group.



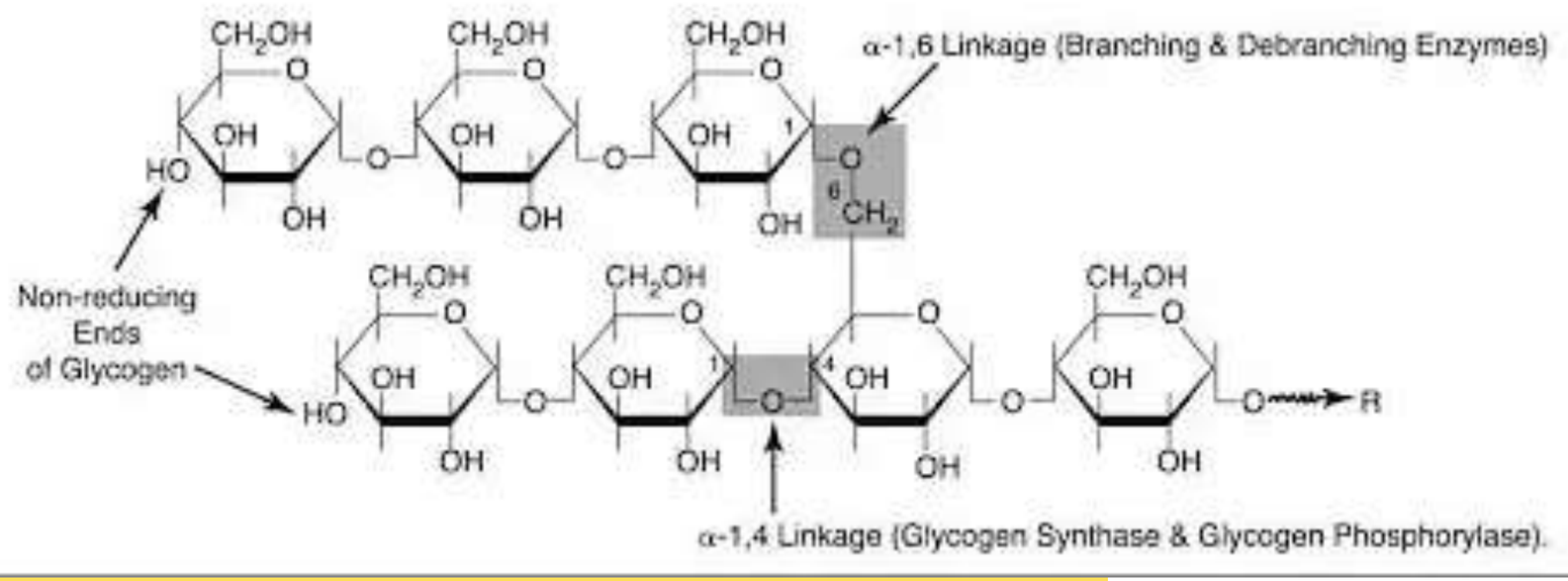
- Glycogen is a branching polymer of glucose.
- Glycogen refers to the analog of starch which is a glucose polymer that functions as energy storage in plants.
- It has a similar structure to amylopectin which is a component of starch, more extensively branched and compact than starch.
- Every glycogen granule has its core a glycogen in protein because of the glycogen is synthesized.
- In muscles, liver and fat cells glycogen is stored in the hydrated form.
- It is composed of three to four parts of water of glycogen that are associated with 0.45 millimoles of potassium for per gram of glycogen.

Structure



Glycogen

The α-1,6 glycosidic bonds in glycogen are produced by the non-regulatory brancing enzyme (and broken by debranching enzyme), while α-1,4 glycosidic bonds in glycogen are produced by the regulatory glycogen synthase (and broken by glycogen phosphorylase).



Functions of Glycogen

- Liver glycogen acts as glucose reserve that hepatocyte release when there is a need to maintain a normal blood sugar levels.
- There is about 40 kcal in body fluids while hepatic glycogen can provide about 600 kcal after a fasting night.
- Glucose from glycogen stores remains within the cells in skeletal and cardiac muscles and is used as an energy source from muscle work.
- Brain includes a small amount of glycogen in astrocytes.
- It gets accumulated during sleep and is mobilized upon walking.
- Glycogen reserves also assure a moderate degree of protection against hypoglycemia.
- Glucose from glycogen is stored in the cells of skeletal and cardiac muscles and is used as an energy source during exercise.

- In fetal lung type II pulmonary cells, glycogen has a unique role.
- At around 26 weeks of pregnancy, these cells begin to store glycogen and eventually produce lung surfactants.
- The carefully regulated mechanism of glycogen hemostasis allows the body to release or store glucose depending on its energetic needs.
- Glycogenesis, or glycogen synthesis, and glycogenolysis, or glycogen breakdown, are two processes in glycogen metabolism.
- In addition to muscle and liver cells, glycogen can be found in lower amounts in other tissues such as the kidney, white blood cells, and red blood cells.
- To meet the embryo's energy requirements, glycogen will be used to store glucose in the uterus.
- After being broken down, glycogen will either enter the glycolytic or pentose phosphate pathways or be released into the bloodstream.

Metabolism of Glycogen

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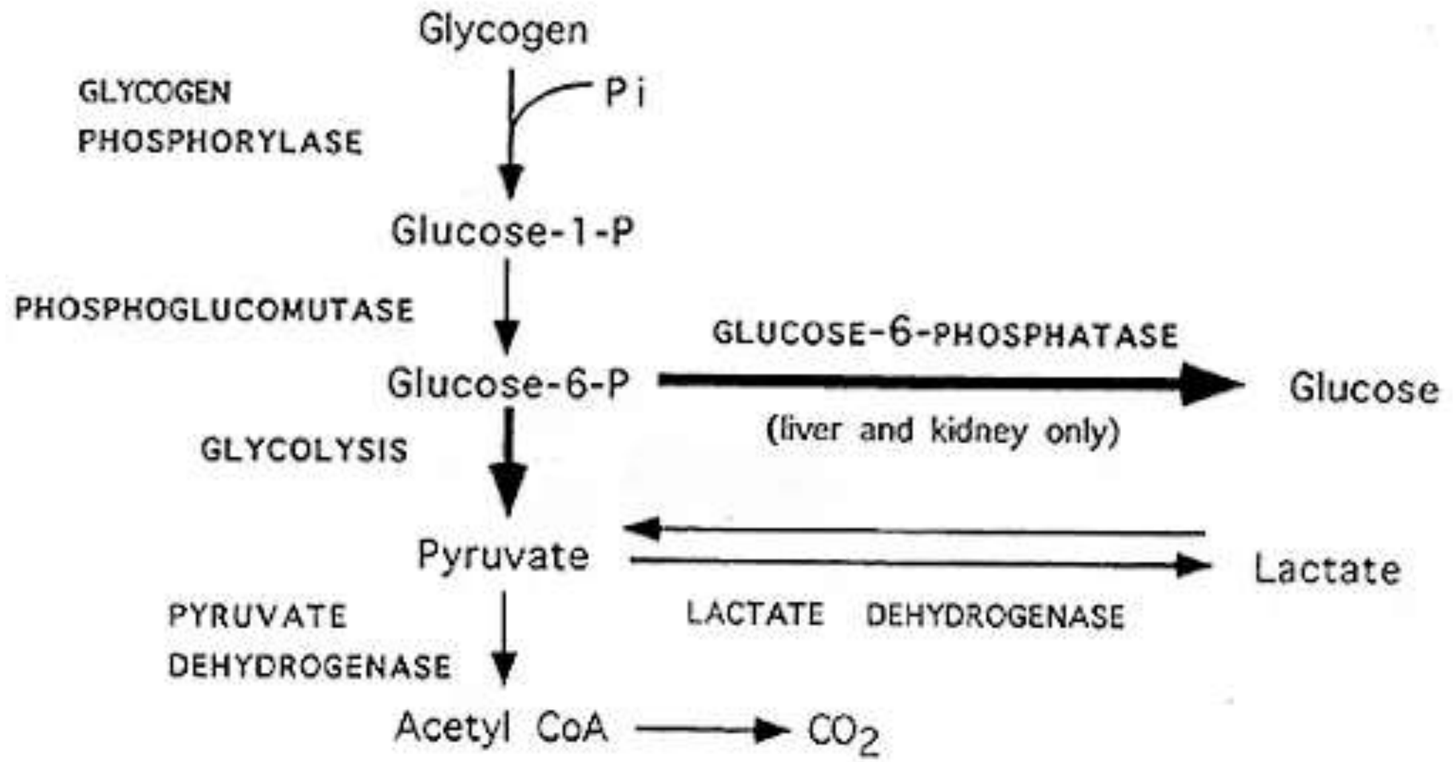


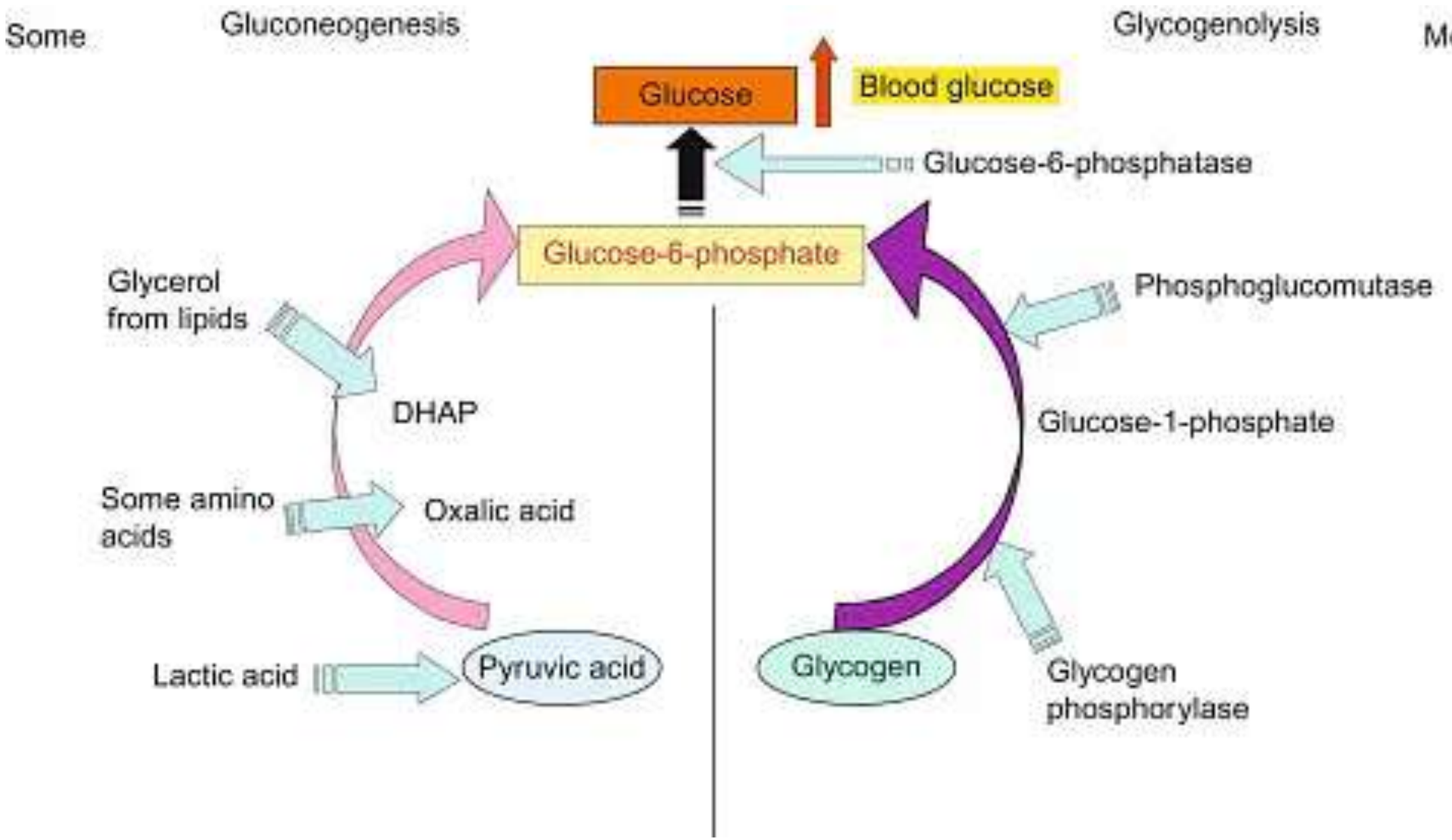
Glycogen Synthesis or Glycogenesis

- Uridine Tri-Phosphate provides the energy required for glycogenesis (UTP).
- The enzymes glucokinase and hexokinase phosphorylate the free glucose to produce glucose-6 phosphate, which is then transformed to glucose-1 phosphate by the enzyme phosphoglucomutase.
- The activation of glucose is catalyzed by the UTP glucose-1 phosphate, which reacts with UTP to generate UDP glucose.
- Glycogen is a protein that catalyzes the attachment of UDP glucose during glycogen formation.
- Each subunit of glycogenin has a tyrosine residue that will function as a point of attachment for the glucose.
- To construct a chain of nearly eight glucose molecules, more glucose molecules will be added to the reducing end of the previous glucose molecule.

Glycogen Synthesis or Glycogenesis

- The glycogen synthase expands when glucose is added by α-1, 4 glycosidic connections.
- The glycogen branching enzyme catalyzes the branching mediated by amyloid 1- 4 to 1- 6 transglucosidases.
- The glycogen branching enzyme hence transfers a certain segment of approximately 6-7 glucose molecules from the end of a chain to the C6 of a glucose molecule that is located farther inside the glucose molecule, forming α-1, 6 glycosidic connections.

Glycogenesis and Glycogenolysis



Glycogen Breakdown or Glycogenolysis

- The glucose will be released from glycogen by the glycogen phosphorylase, which will produce glucose-1 phosphate by removing one molecule of glucose from the non-reducing end.
- The enzyme phosphoglucomutase is required for the conversion of glucose-1 phosphate to glucose-6 phosphates, which occurs during glycogen degradation.
- Phosphoglucomutase transfers a phosphate group from a phosphorylated serine residue within the active site to the C6 of glucose-1 phosphate, attaching it to the serine within the phosphoglucomutase, and subsequently releasing the glucose-6 phosphates.
- Because glycogen phosphorylase is unable to cut glucose from branch sites, debranching will require 1-6 glucosidase, glycogen debranching enzyme (GDE), or 4-α glucanotransferase, which will have both glucosidase and glucosyltransferase activities.

Glycogen Breakdown or Glycogenolysis

- The glycogen phosphorylase will be unable to remove the glucose residues nearly four residues from a branch point.
- The GDE will remove the branch's final three residues and attach them to C4 of a glucose molecule at the end of another branch, before removing the branch's final α-1- 6 linked glucose deposit.

THANK YOU