Serve Storage Polysaccharides: Starch and Glycogen

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Introduction

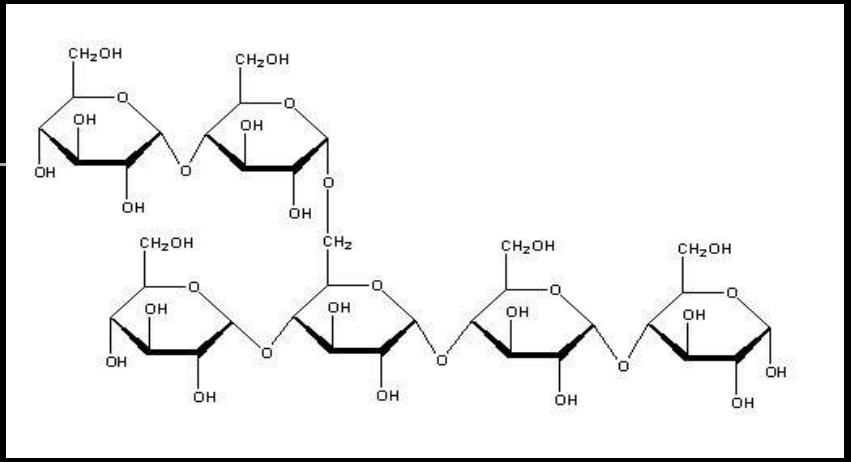
- Starch or amylum is a carbohydrate consisting of a large number of glucose units joined by glycosidic bonds.
- This polysaccharide is produced by most green plants as an energy store.
- It is the most common carbohydrate in human diets.

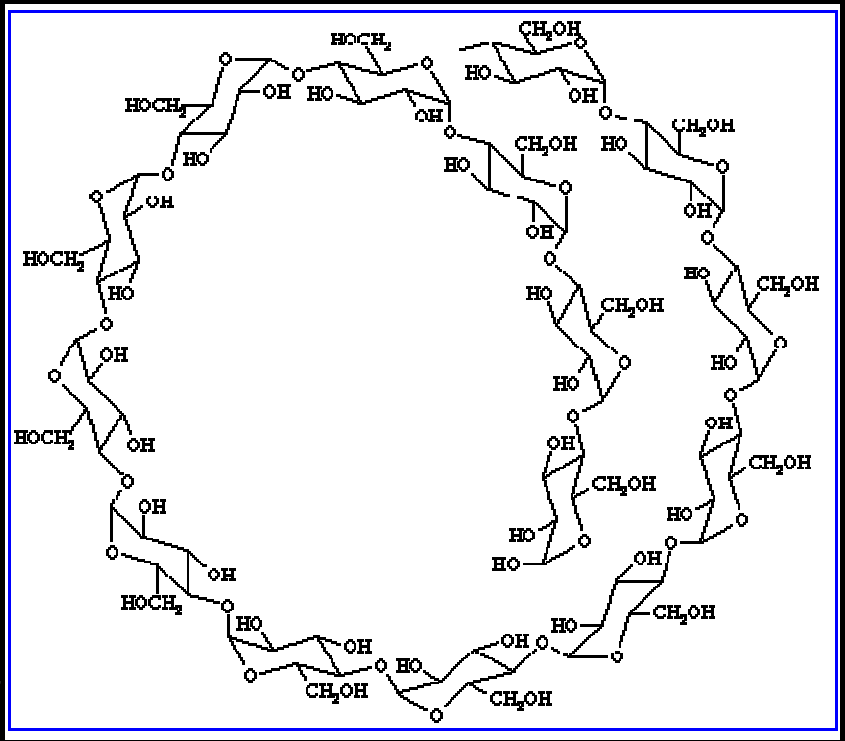
Source

- Is contained in large amounts in such staple foods as potatoes, wheat, maize (corn), rice, and cassava.
- Starch is manufactured in the green leaves of plants from excess glucose produced during photosynthesis and serves the plant as a reserve food supply.
- Starch is stored in chloroplasts in the form of granules and in such organs as the -
- roots of the tapioca plant; the tuber of the potato; the stem pith of sago; and the seeds of corn, wheat, and rice. When required, starch is broken down, in the presence of certain enzymes and water, into its constituent monomer glucose units, which diffuse from the cell to nourish the plant tissues.
- In humans and other animals, starch is broken down into its constituent sugar molecules, which then supply energy to the tissues.

Stucture

- Starch is the most common carbohydrate in the human diet. The major sources of starch intake worldwide are the cereals (rice, wheat, and maize) and the root vegetables (potatoes and cassava).
- Widely used prepared foods containing starch are bread, pancakes, cereals, noodles, pasta, porridge and tortilla.

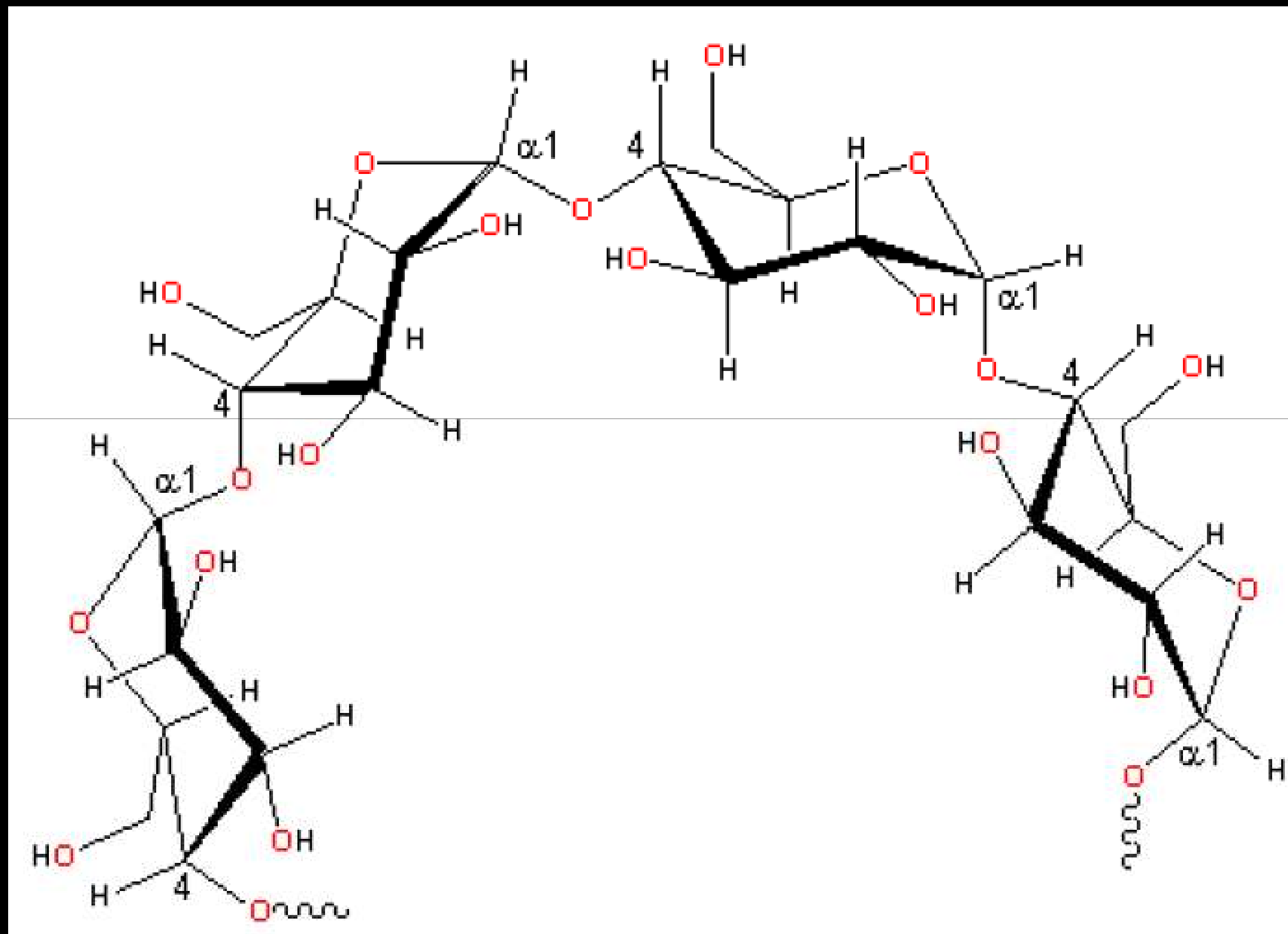




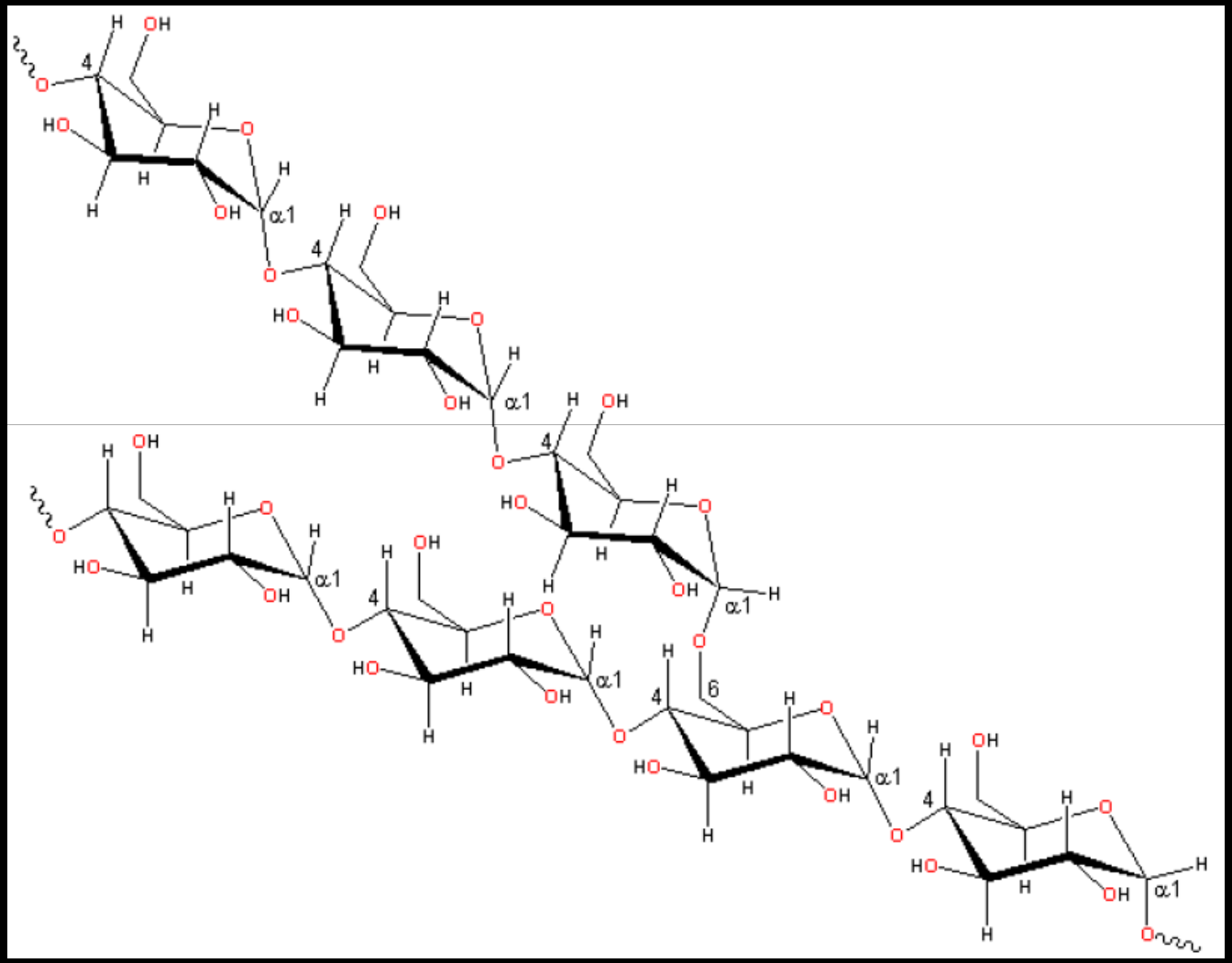
Subunits of Starch

- Starch consists of two types of molecules, amylose (normally 20-30%) and amylopectin (normally 70-80%). Both consist of polymers of α-D-glucose units.
- In amylose these are linked -(1-4)-, with the ring oxygen atoms all on the same side, whereas in amylopectin about one residue in every twenty or so is also linked -(1-6)- forming branch-points.

Amylose

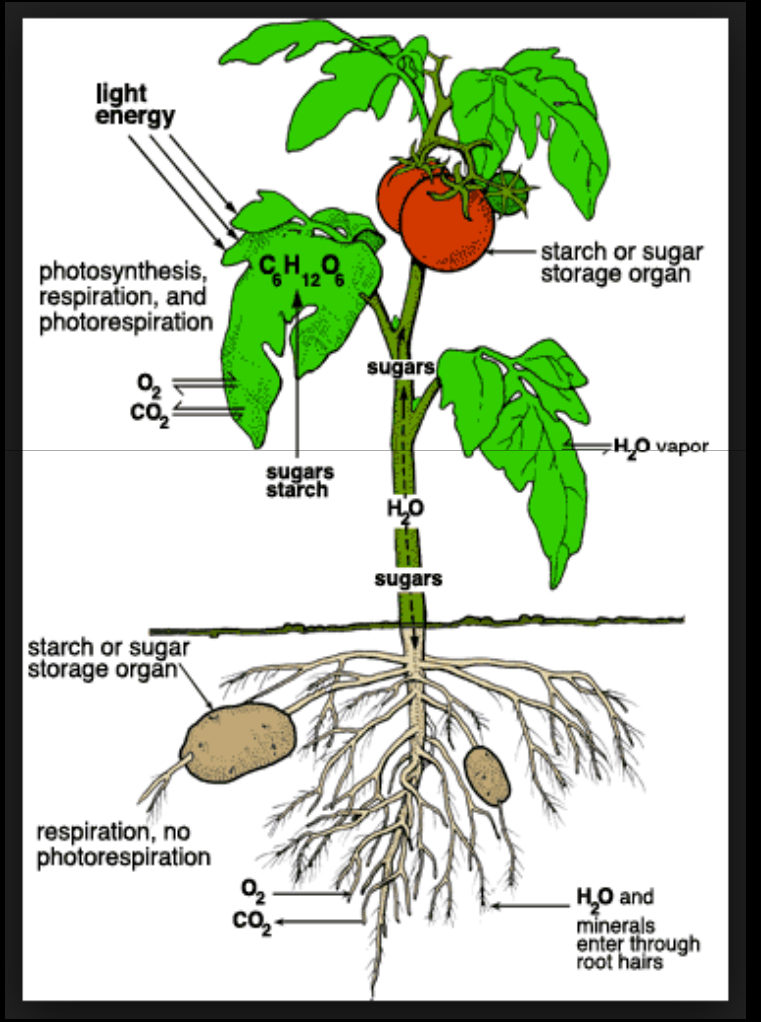


Amylopectin



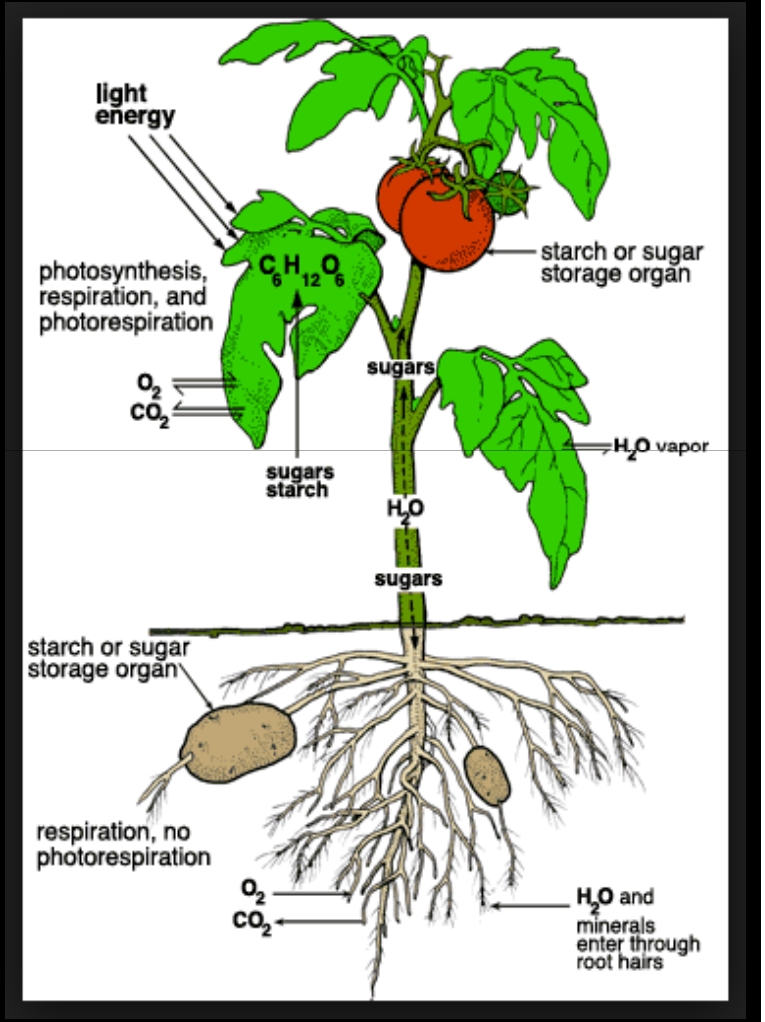
Biosynthesis of Starch

- Plants produce starch by first converting glucose 1-phosphate to ADP-glucose using the enzyme glucose-1-phosphate adenylyltransferase. This step requires energy in the form of ATP.
- The enzyme starch synthase then adds the ADP-glucose via a 1,4-alpha glycosidic bond to a growing chain of glucose residues, liberating ADP and creating amylose.



Biosynthesis of Starch

- Starch branching enzymeintroduces 1,6-alpha glycosidic bonds between these chains, creating the branched amylopectin.
- The starch debranching enzyme isoamylase removes some of these branches.



Glycogen

- Glycogen is a multi branched polysaccharide of glucose that serves as a form of energy storage in animals and fungi.
- The polysaccharide structure represents the main storage form of glucose in the body.

Storage in Different Organs

- In humans, glycogen is made and stored primarily in the cells of the liver and the muscles, and functions as the secondary long-term energy storage (with the primary energy stores being fats held in adipose tissue).
- Muscle glycogen is converted into glucose by muscle cells, and liver glycogen converts to glucose for use throughout the body.

Physiological Importance

- As a meal containing carbohydrates is eaten and digested, blood glucose levels rise, and the pancreas secretes insulin.
- Blood glucose from the portal vein enters liver cells (hepatocytes).
- Insulin acts on the hepatocytes to stimulate the action of several enzymes, including glycogen synthase. Glucose molecules are added to the chains of glycogen as long as both insulin and glucose remain plentiful.

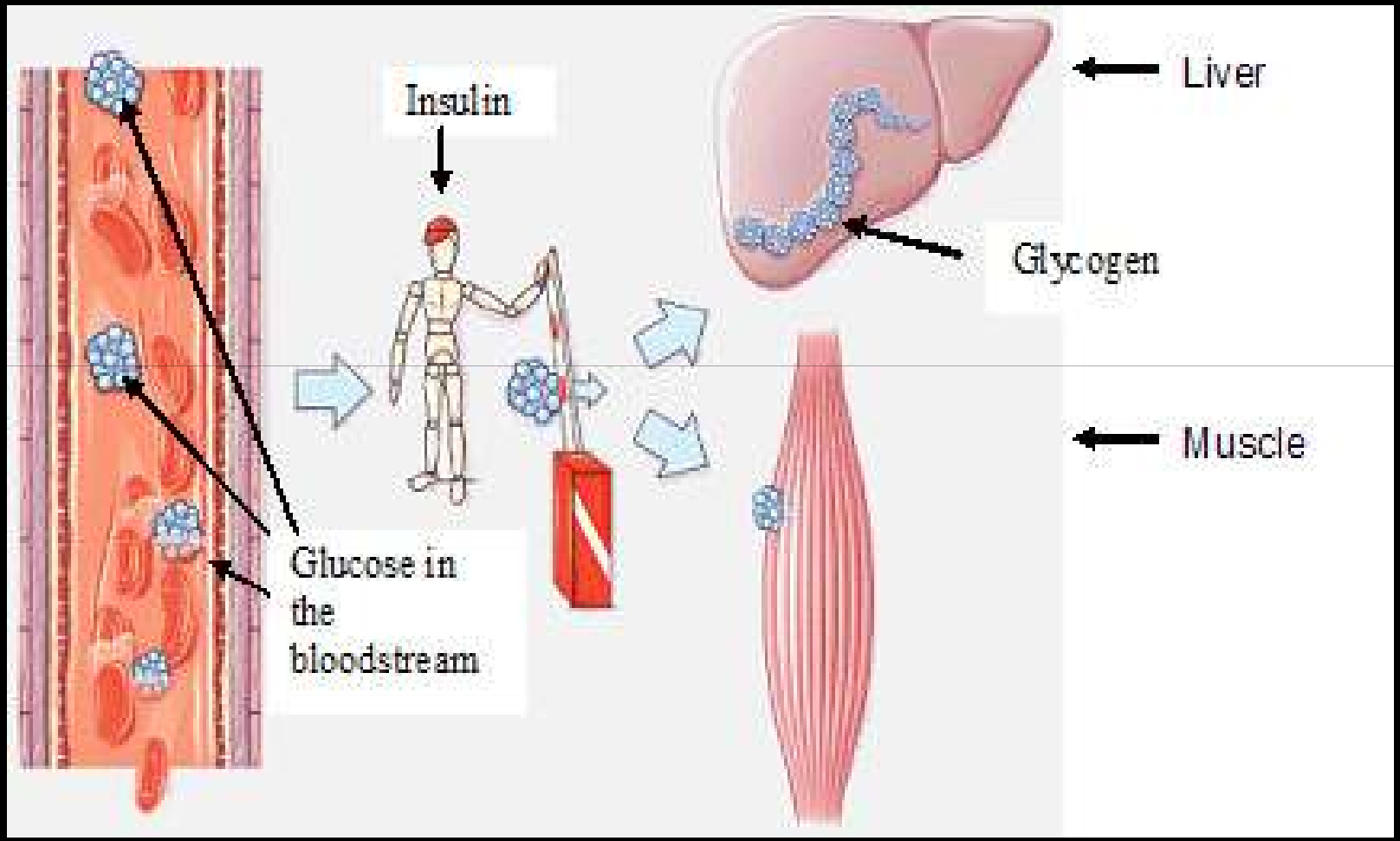
Physiological Importance

- In this postprandial or "fed" state, the liver takes in more glucose from the blood than it releases.
- After a meal has been digested and glucose levels begin to fall, insulin secretion is reduced, and glycogen synthesis stops.
- When it is needed for energy, glycogen is broken down and converted again to glucose. Glycogen phosphorylase is the primary enzyme of glycogen breakdown.

Glycogen of Muscle Cell

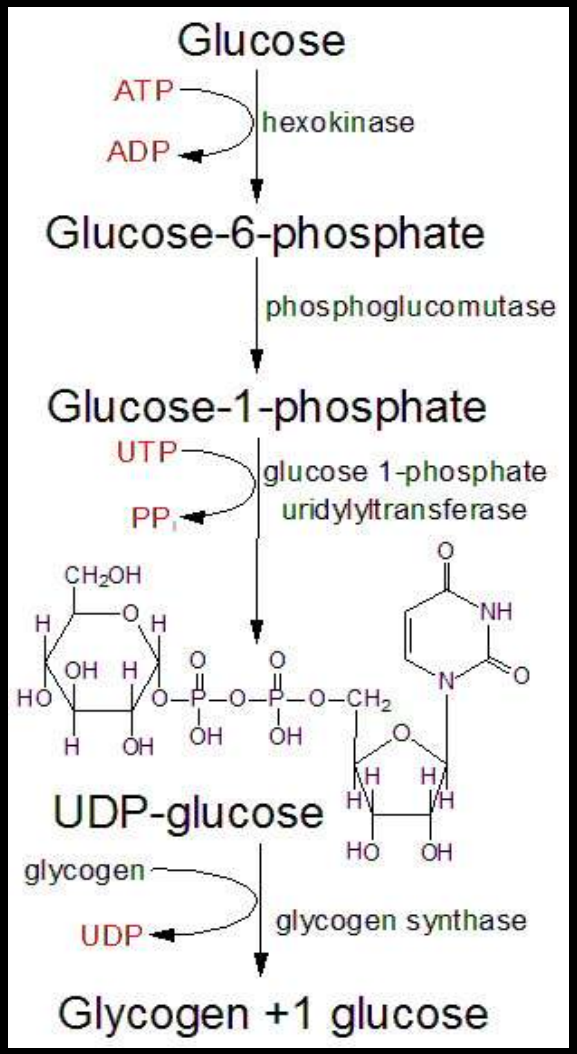
- Muscle cell glycogen appears to function as an immediate reserve source of available glucose for muscle cells.
- Other cells that contain small amounts use it locally, as well.
- As muscle cells lack glucose-6-phosphatase, which is required to pass glucose into the blood, the glycogen they store is available solely for internal use and is not shared with other cells. (This is in contrast to liver cells, which, on demand, readily do break down their stored glycogen into glucose and send it through the blood stream as fuel for the brain or muscles).

Physiological Importance



Synthesis of Glycogen

- The activation of glucose to be used for glycogen synthesis is carried out by the enzyme UDP-glucose pyrophosphorylase.
- 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.



Glycogen Storage Disease (GSD)

- When a person has GSD The liver cannot control the use of glycogen and glucose.
- Certain enzymes are missing that control the change of sugar (glucose) into its storage form (glycogen) or release of glucose from glycogen.
- There are at least 10 different types of GSDs.
- The most common forms of GSD are types I (one), III (three) and IV (four).

Glycogen Storage Disease (GSD)

- GSD I, also known as von Gierke disease: Results from a lack of the enzyme Glucose-6-Phosphatase.
- GSD III, also known as Cori disease: Results from a lack of the debrancher enzyme.
- This causes the body to form glycogen molecules that have an abnormal structure. This abnormal structure also prevents the glycogen from being broken down into free glucose.

Glycogen Storage Disease (GSD)

- GSD IV, also known as amylopectinosis: There is not an increased amount of glycogen in the tissues.
- Instead, the glycogen that does build up in the tissues has very long outer branches.
- With this type of GSD, there is lack of the branching enzyme. This abnormal glycogen is thought to stimulate the immune system.
- The result is a great deal of scarring (cirrhosis) of the liver as well as other organs, such as muscle and heart.


Thankyou