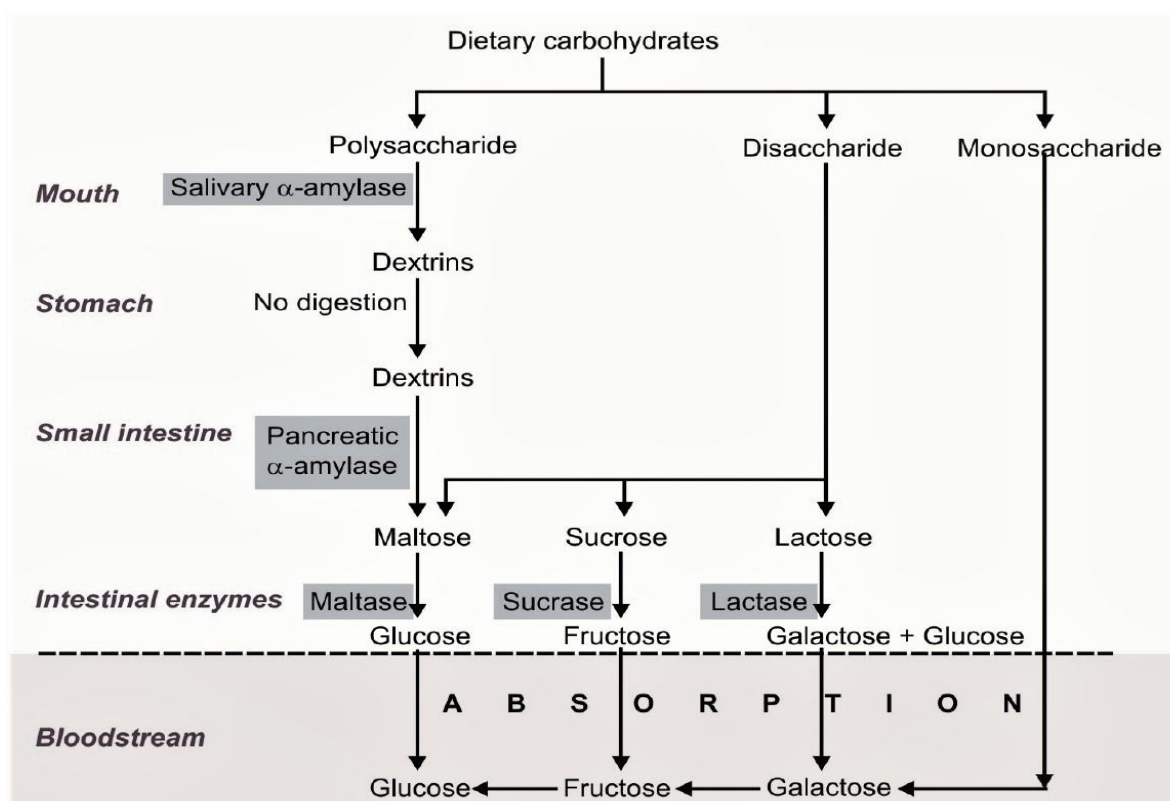


Digestion, absorption and metabolism of carbohydrates

❖ Digestion of Carbohydrates

- The primary goal of carbohydrate digestion is to break down polysaccharides and disaccharides into monosaccharides that can then be converted to glucose.
- The major source of carbohydrates is found in plants.
- Glucose is the universal fuel for human cells. The glucose concentrations in the body are maintained within limits by various metabolic processes.
- The principal sites of carbohydrate digestion are the mouth and small intestine. The dietary carbohydrate consists of:
 - Polysaccharides: Starch, glycogen and cellulose.
 - Disaccharides: Sucrose, maltose and lactose.
 - Monosaccharides: Mainly glucose and fructose.
- Monosaccharides need no digestion prior to absorption, whereas disaccharides and polysaccharides must be hydrolysed to simple sugars before their absorption.



• Digestion in Mouth

- Digestion of carbohydrates begins in the mouth. Salivary glands secrete *a-amylase* (**ptyalin**), which initiates the hydrolysis of a **starch**.
- During mastication, salivary *a-amylase* (glucose-polymer cleavage enzyme) acts briefly on dietary starch in random manner breaking some α -**(1 → 4)** bonds, *a-amylase* hydrolysis **starch** into **dextrin's**.

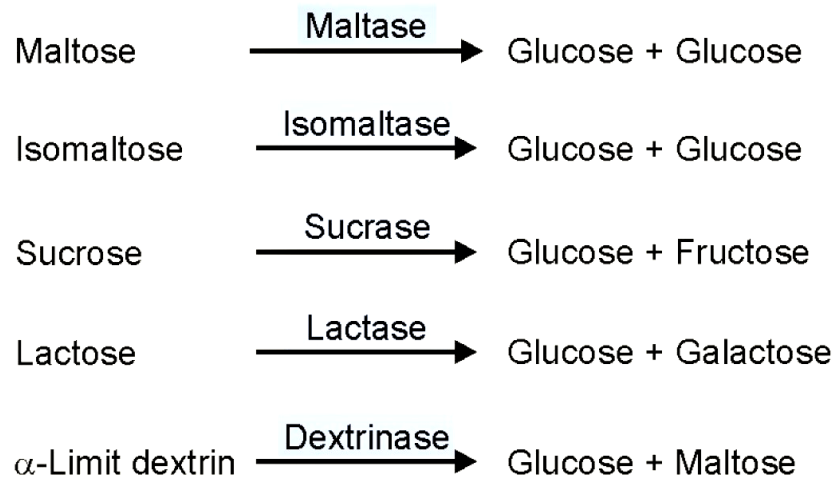
• Digestion in Stomach

- Carbohydrate digestion halts temporarily in the stomach because the high acidity inactivates the salivary *a-amylase*.

• Digestion in Intestine

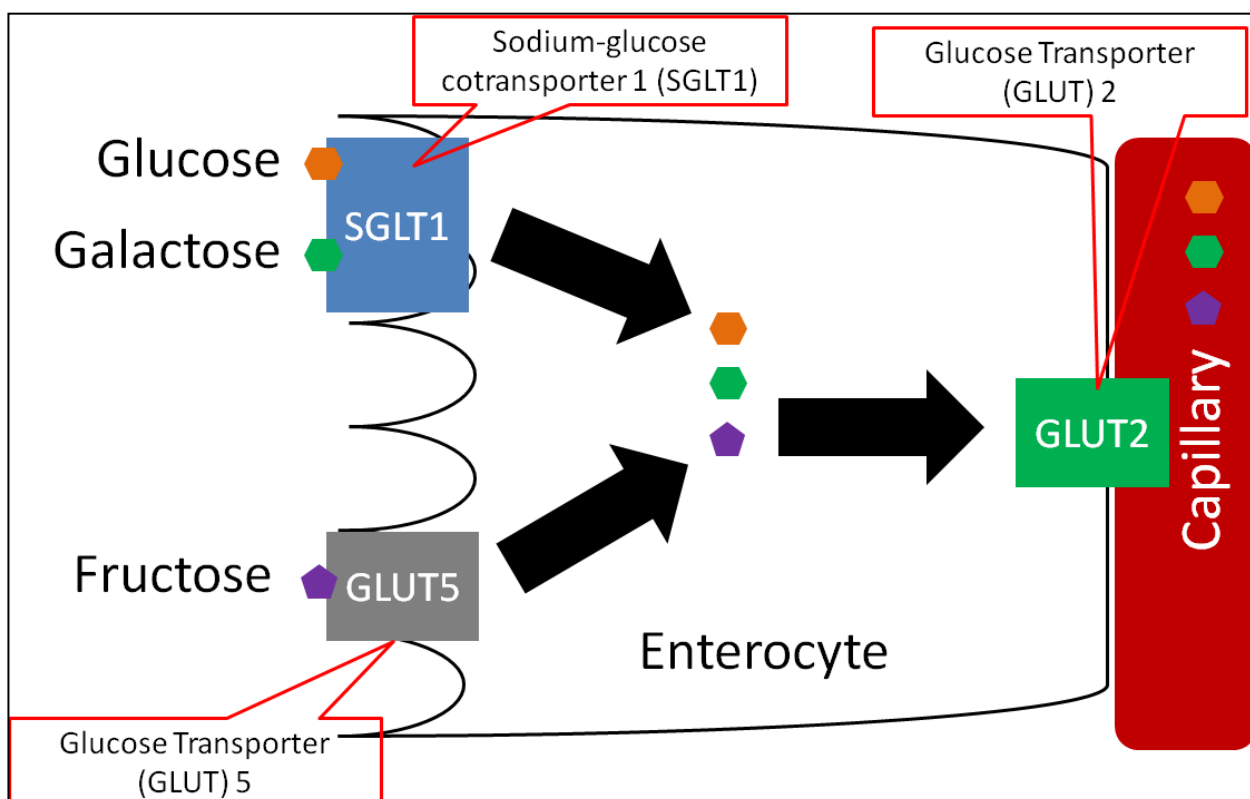
- Further digestion of carbohydrates occurs in the small intestine by pancreatic enzymes.
- There are two phases of intestinal digestion.
 - Digestion due to *pancreatic a-amylase*
 - Digestion due to intestinal enzymes: *sucrase, maltase, lactase, isomaltase*.

- *Digestion due to pancreatic α -amylase*
- The function of pancreatic α -amylase is to degrade dextrin's further into a mixture of maltose, isomaltose and α -limit dextrin.
- The α -limit dextrin's are smaller oligosaccharides containing 3 to 5 glucose units.
- *Digestion due to intestinal enzymes*
- Enzymes responsible for the final phase of carbohydrate digestion are located in the brush-border membrane.
- The end products of carbohydrate digestion are glucose, fructose and galactose which are readily absorbed through the intestinal mucosal cells into the bloodstream.



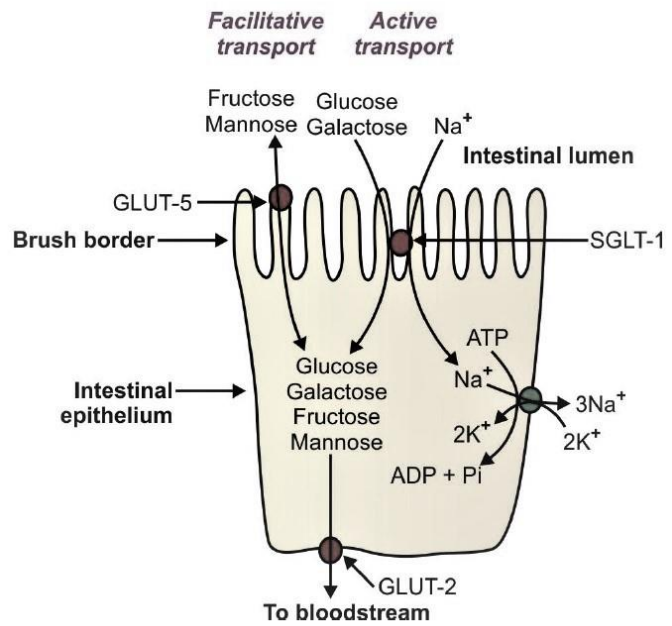
❖ Absorption of Carbohydrates

- Carbohydrates are absorbed as monosaccharides from the intestinal lumen.
- Two mechanisms are responsible for the absorption of monosaccharides:
 - i. **Active transport** against a concentration gradient, i.e., from a low glucose concentration to a higher concentration.
 - ii. **Facilitate transport**, with concentration gradient, i.e., from a higher concentration to a lower one.



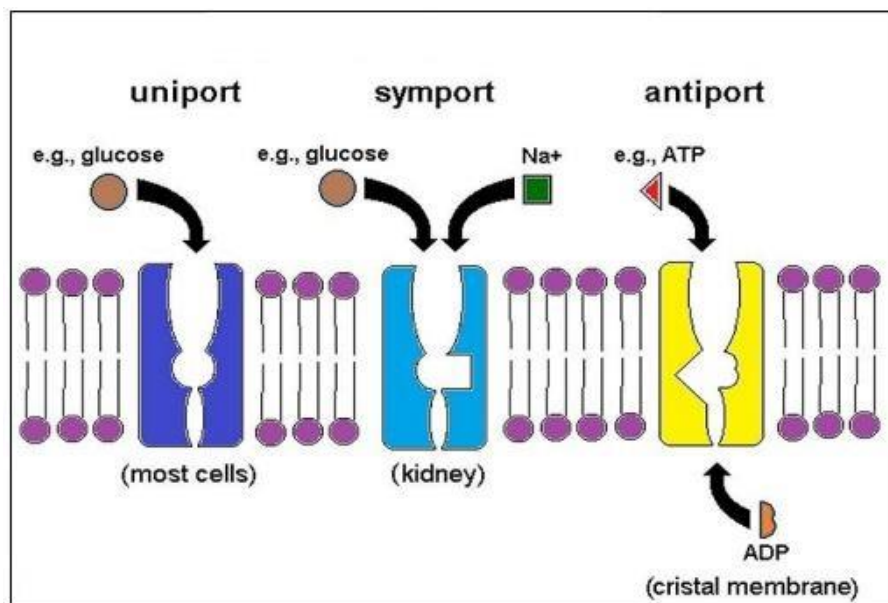
✓ *Active Transport*

- A sodium dependent glucose transporter (SGLT-1) binds both glucose and Na⁺ at separate sites and transports them both through the plasma membrane of the intestinal cell.
- The Na⁺ is transported down its concentration gradient (higher concentration to lower concentration) and at the same time glucose is transported against its concentration gradient.
- The free energy required for this active transport is obtained from the hydrolysis of ATP linked to a sodium pump that expels Na⁺ from the cell in exchange of K⁺.



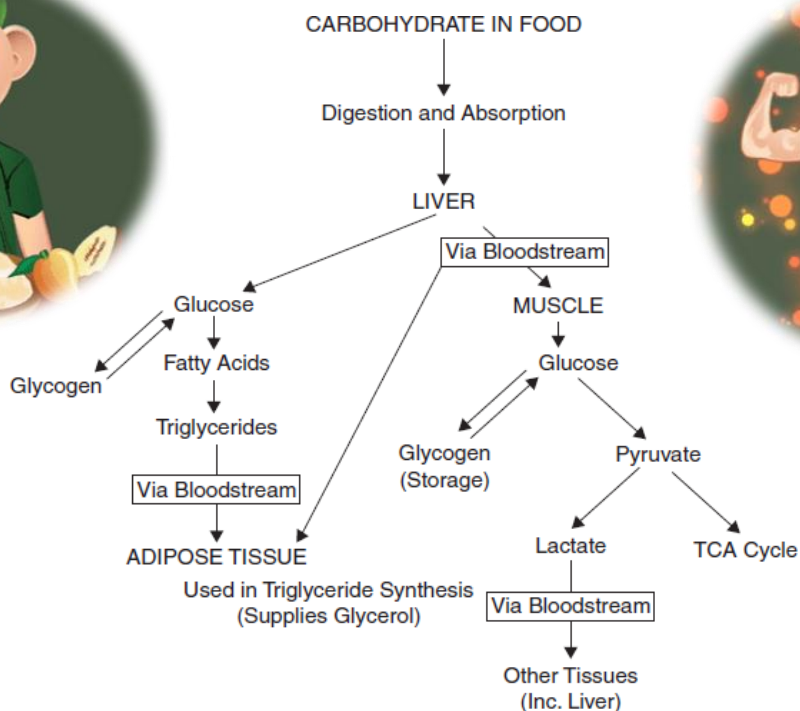
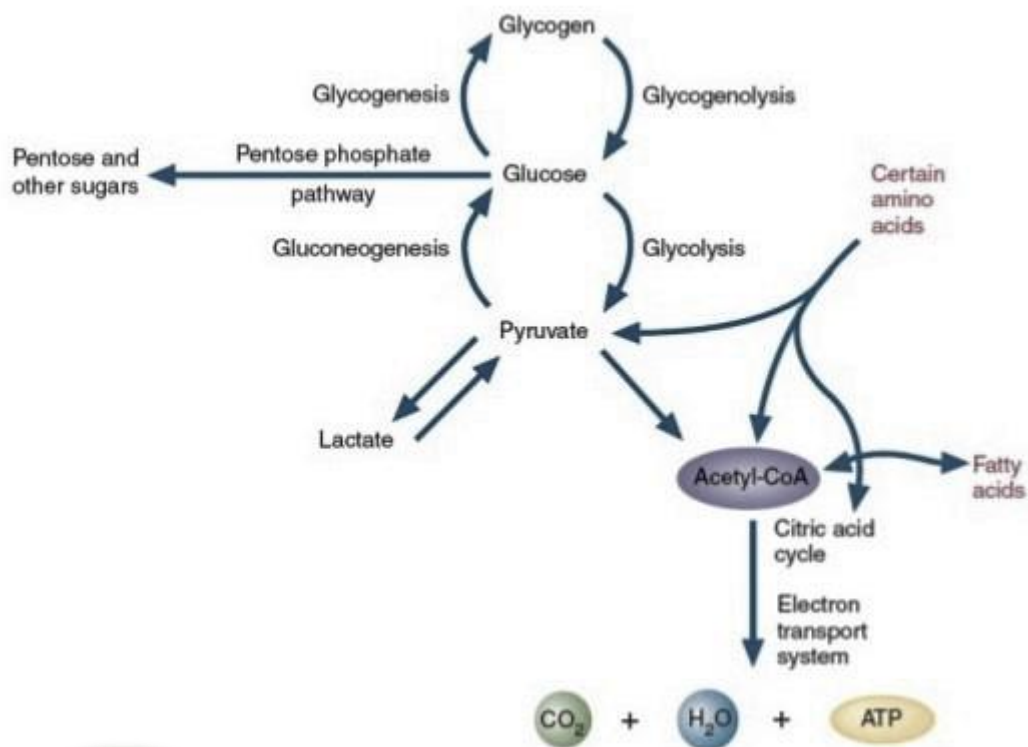
✓ *Facilitate Transport*

- Fructose and mannose are transported across the brush border by a Na⁺ independent facilitative diffusion process, requiring specific glucose transporter, GLUT-5.
- The same transport can also be used by glucose and galactose if the concentration gradient is favourable.
- The sodium independent transporter, GLUT-2 that facilitates transport of sugars out of the mucosal cells, thereby entering the portal circulation and being transported to the liver.



❖ **Metabolism of Carbohydrates**

- Metabolism of carbohydrates includes the process where in complex carbohydrates with 3 or more sugar units in a chain are broken down into simple mono- and disaccharides like glucose and sucrose which are important components of several metabolic pathways.
- Glycolysis is an important pathway which occurs in almost every living cell, both in prokaryotes and eukaryotes. In this pathway glucose is broken down into 2-3 carbon unit molecules like pyruvate and the energy generated in this pathway is stored in the form of **ATP** and **NADH**.
- Depending on whether the subsequent steps are aerobic or anaerobic several end products like **acetyl CoA** and **lactic acid, ethanol, acetic acid** may be generated.



Overall Carbohydrate Metabolism