Digestion, Absorption and Assimilation of Carbohydrates

The body uses carbohydrates for energy storage and nutrition. The carbohydrate content of many foods is high, including bread, potatoes, bananas and honey. The main source of carbohydrates in the human diet is polysaccharides, mostly in the form of starch. Humans must metabolise carbohydrates to use them as energy. The body absorbs glucose, which is converted from complex starches into monosaccharides. Carbohydrates begin to be digested in the mouth by salivary amylases. Pancreatic amylase further breaks down the remaining starch in the intestines. A gram of carbohydrate can provide 4 kcal of energy.

Carbohydrates are digested in the mouth by salivary amylase, continue in the small intestine with pancreatic amylase and other enzymes, and are absorbed as monosaccharides (glucose, fructose, galactose) into the bloodstream via the small intestine's villi. Assimilation occurs when the pancreas releases insulin to signal cells to absorb the glucose for immediate energy or storage, and glucagon is released if blood glucose levels drop.

Digestion

Mouth:

- Digestion begins as salivary amylase starts breaking down starches into smaller polysaccharides.

Stomach:

- No significant carbohydrate digestion occurs here as the acidic environment inactivates salivary amylase.

Small Intestine:

- This is where most carbohydrate digestion takes place.
    - Pancreatic amylase continues to break down starch into shorter chains of glucose, called maltose, maltotriose, and alpha-limit dextrins.
    - Enzymes in the intestinal brush border (like sucrase, lactase, and maltase) break down disaccharides and oligosaccharides into monosaccharides (glucose, fructose, and galactose).

Absorption

The small intestine is the main site for absorption, which is facilitated by the villi that increase the surface area. Only monosaccharides can be absorbed.

A portal circulation facilitates the absorption of carbohydrates after digestion. Transportation can either be active, passive or facilitated.

- **Active transport**: The transport of carbohydrates across the plasma membrane occurs through the use of transporter enzymes against the gradient of concentrations.
- **Facilitated Transport**: It is facilitated by transmembrane enzymes that do not require energy to move down concentration gradients.
- **Passive Transport**: Sugars are passively absorbed down concentration gradients without enzymatic activity or energy; this mechanism lasts the longest.

The functions of transporters vary according to their roles: passive, active or facilitated.

SGLT1:

- ✓ Functions to transport glucose through the small intestine
- ✓ Based on an ATPase pump (Na+/K+-ATPase pump) actively generating sodium gradients
- ✓ The transport system transports to sodium, galactose or glucose and water

Glucose transporter 2 (GLUT2)

- ✓ Located on the basolateral membranes of the small intestine and kidney, pancreas and liver
- ✓ Facilitates glucose and fructose diffusion
- ✓ By being bidirectional, the function can be altered based on cellular conditions.

GLUT4

- ✓ Mostly found in adipose tissue
- ✓ Insulin regulates it
- ✓ Depends on cellular conditions to store glucose

GLUT5

- ✓ Facilitates the diffusion of fructose

Passive glucose absorption is rare. The first part of the small intestine (duodenum, jejunum) absorbs most of the glucose.

Assimilation and Metabolism

Insulin Release: As blood glucose levels rise after a meal, the pancreas releases insulin.

Cellular Uptake: Insulin signals the body's cells to absorb glucose from the blood.

Energy or Storage: The body's cells use this glucose for immediate energy or store it. Glucose is stored as glycogen in the liver and muscles, or excess glucose is converted to fat.

Glucagon Release: If blood glucose levels fall, the pancreas releases glucagon, which stimulates the liver to break down its stored glycogen and release glucose into the bloodstream.