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HUMAN PHYSIOLOGY

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I B.Sc., BIOCHEMISTRY

II SEMESTER

CORE COURSE II- HUMAN PHYSIOLOGY-16SCCBC2

DIGESTION AND ABSORPTION OF CARBOHYDRATES

CARBOHYDRATES

Carbohydrates give the body energy to mental and physical tasks. Digesting or metabolizing carbohydrates breaks foods down into sugars, which are also called saccharides. These molecules begin digesting in the mouth and continue through the body to be used for anything from normal cell functioning to cell growth and repair.

There are three main types of carbohydrates. Some carbohydrates are naturally occurring.

Types of carbohydrates

The three types of carbs are:

- Starches or complex carbs
- Sugars or simple carbs
- Fiber

Both simple and complex carbohydrates break down into glucose. A simple sugar is one that's comprised of one or two sugar molecules, while a complex carb contains three or more sugar molecules.

Fiber, on the other hand, is found in healthy carbs, but isn't digested or broken down. Naturally occurring simple sugars are found in fruit and dairy.

Good sources of complex carbohydrates include

- Whole grains
- Legumes
- Beans
- Lentils
- Peas
- Potatoes

TYPE OF CARB	FOOD SOURCES	HEALTH	PERFORMANCE	TAKEAWAY
SIMPLE	Dairy, fruit, candy, gels, sports drinks, soda, honey, juices	Can trigger cravings, insulin resistance, weight gain, mood swings.	Improves performance due to fast absorption and ability to be utilized for energy. Best before and during training.	Consumption of these sources should be limited to before or during activity or in combination with other nutrient sources.
COMPLEX	Whole grains, legumes, starchy vegetables	Provides satiety, improves disease outcomes, provides many other nutrients.	Fiber structures slow breakdown and create more stomach bulk. Best after training.	Most carbs should come from these sources.

Fiber is found in many healthy carbs such as

- Fruits
- Vegetables
- Whole Grains
- Beans
- Legumes

Consuming fibrous, complex and simple carbs from naturally occurring sources like fruit may protect from disease. These carbs include more vitamins and minerals.

Daily intake

For a person eating a standard 2,000 calories a day, this means that carbohydrates might make up 900 to 1,300 of those calories.

How are carbohydrates digested?

All the food eat goes through digestive system so it can be broken down and used by the body. Carbohydrates is starting with the intake at the mouth and ending with elimination from colon.

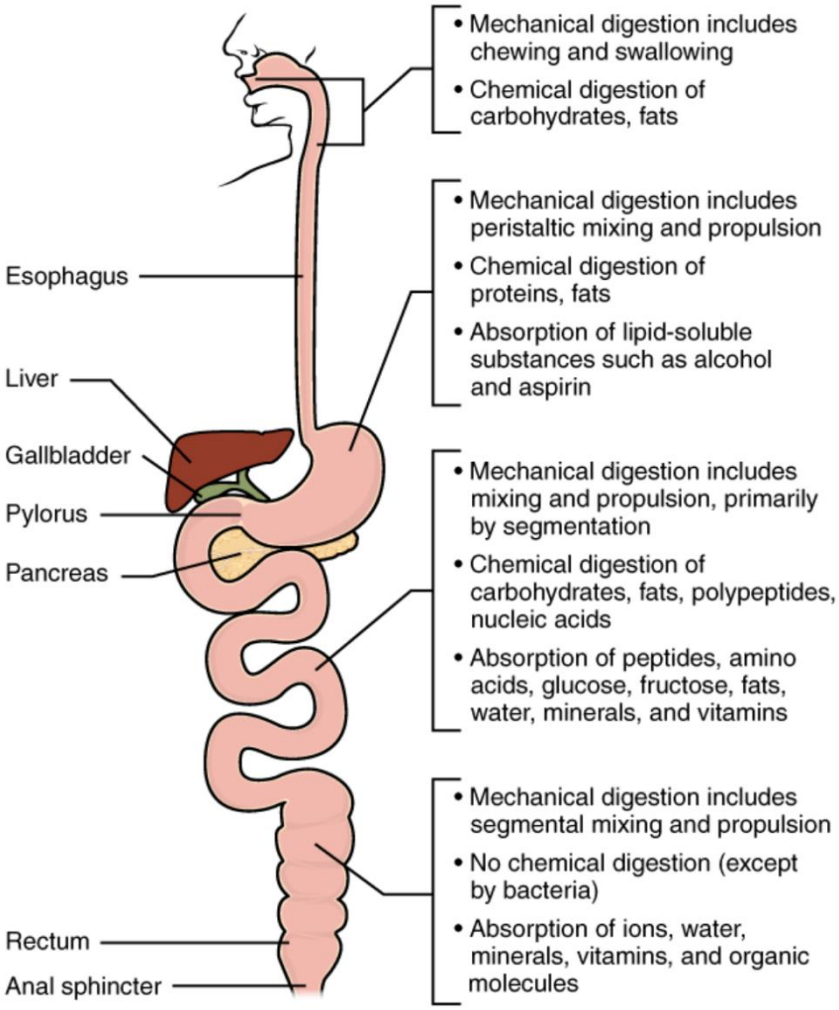
Digestion of food is a form of catabolism, in which the food is broken down into small molecules that the body can absorb and use for energy, growth, and repair. Digestion occurs when food is moved through the digestive system. It begins in the mouth and ends in the small intestine. The final products of digestion are absorbed from the digestive tract, primarily in the small intestine. There are two different types of digestion that occur in the digestive system: mechanical digestion and chemical digestion.

Mechanical digestion is a physical process in which food is broken into smaller pieces without becoming changed chemically. It begins with first bite of food and continues as chew food with teeth into smaller pieces. The process of mechanical digestion continues in the stomach.

Chemical digestion is the biochemical process in which macromolecules in food are changed into smaller molecules that can be absorbed into body fluids and transported to cells throughout the body. Carbohydrates must be broken down into simple sugars, proteins into amino acids, lipids into fatty acids and glycerol, and nucleic acids into nitrogen bases and sugars. Some chemical digestion takes place in the mouth and stomach, but most of it occurs in the first part of the small intestine (duodenum).

Absorption

When digestion is finished, it results in many simple nutrient molecules that must go through the process of absorption from the GI tract by blood or lymph so they can be used by cells throughout the body. A few substances are absorbed in the stomach and large intestine. Absorption of the majority of these molecules takes place in the second part of the small intestine, called the jejunum. After being absorbed in the small intestine, nutrient molecules are transported to other parts of the body for storage or further chemical modification. The epithelial tissue lining the small intestine is specialized for absorption. It has many wrinkles and is covered with villi and microvilli, creating an enormous surface area for absorption. The thin surface layer of epithelial cells of the villi transports nutrients from the lumen of the small intestine into these capillaries and lacteals.



Absorption and Digestion

1. The mouth

The carbohydrate digestion begins in the mouth. The saliva secreted from the salivary glands moistens food as it's chewed. Saliva releases an enzyme called amylase, which begins the breakdown process of the sugars in the carbohydrates.

2. The stomach

From there, swallow the food, it's chewed into smaller pieces. The carbohydrates travel through the esophagus to the stomach. At this stage, the food is referred to as chyme. Stomach makes acid to kill bacteria in the chyme before it makes its next step in the digestion journey.

3. The small intestine, pancreas, and liver

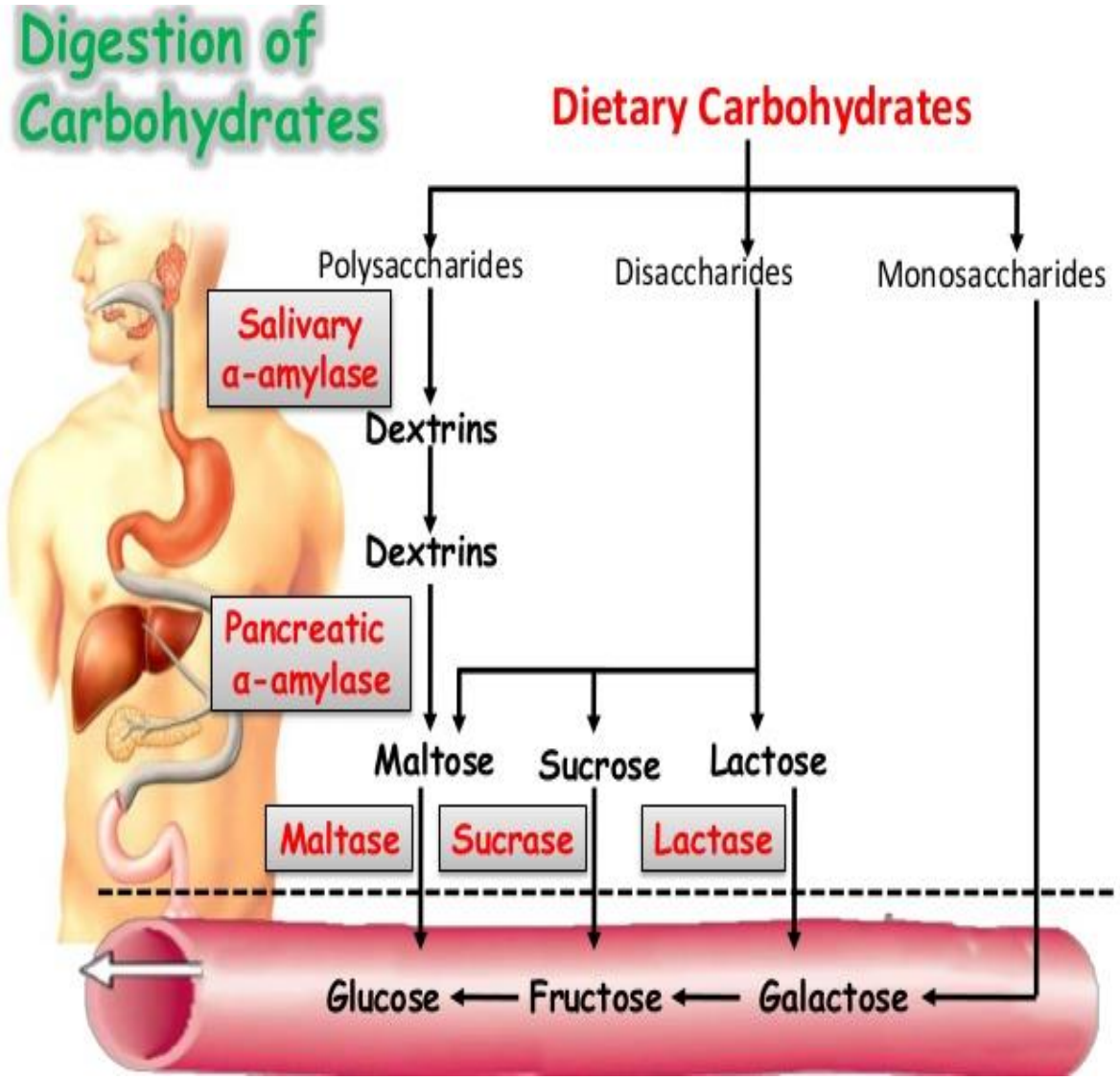
The chyme then goes from the stomach into the first part of the small intestine, called the duodenum. This causes the pancreas to release pancreatic amylase. This enzyme breaks down the chyme into dextrin and maltose.

From there, the wall of the small intestine begins to make lactase, sucrase and maltase. These enzymes break down the sugars even further into monosaccharaides or single sugars. These sugars are the ones that are finally absorbed into the small intestine. Once they're absorbed, they're processed even more by the liver and stored as glycogen.

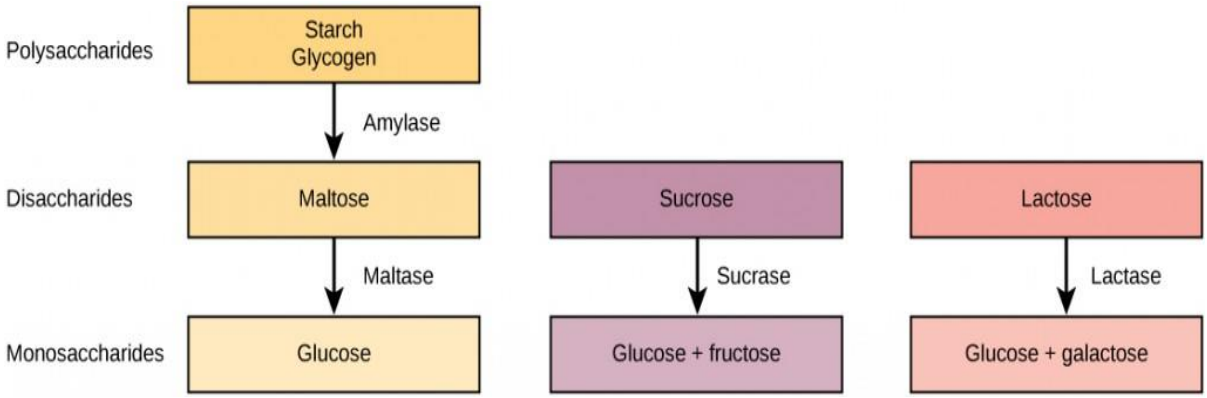
Other glucose is moved through the body by the bloodstream. The hormone insulin is released from the pancreas and allows the glucose to be used as energy.

4. Colon

Anything that's left over after these digestive processes goes to the colon. It's then broken down by intestinal bacteria. Fiber is contained in many carbohydrates and cannot be digested by the body. It reaches the colon and is then eliminated with stools.



The steps in carbohydrate digestion are



Digestion of carbohydrates is performed by several enzymes. Starch and glycogen are broken down into glucose by amylase and maltase. Sucrose (table sugar) and lactose (milk sugar) are broken down by sucrase and lactase, respectively.

Enzyme	Produced By	Site of Action	Substrate Acting On	End Products
Salivary amylase	Salivary glands	Mouth	Polysaccharides (Starch)	Disaccharides (Maltose), oligosaccharides
Pancreatic amylase	Pancreas	Small intestine	Polysaccharides (Starch)	Disaccharides (Maltose), monosaccharides
Oligosaccharidases	Lining of the intestine; brush border membrane	Small intestine	Disaccharides	Monosaccharides (e.g., Glucose, Fructose, Galactose)

SUMMARY OF CARBOHYDRATE DIGESTION:

The primary goal of carbohydrate digestion is to break polysaccharides and disaccharides into monosaccharides, which can be absorbed into the bloodstream.

- After eating, nothing needs to happen in the digestive tract to the monosaccharides in a food like grapes, because they are already small enough to be absorbed as is.
- Disaccharides in that grape or in a food like milk are broken down (enzymatically digested) in the digestive tract to monosaccharides (glucose, galactose, and fructose).
- Starch in food is broken down (enzymatically digested) in the digestive tract to glucose molecules.
- Fiber in food is not enzymatically digested in the digestive tract, because humans don't have enzymes to do this. However, some dietary fiber is fermented in the large intestine by gut microbes.