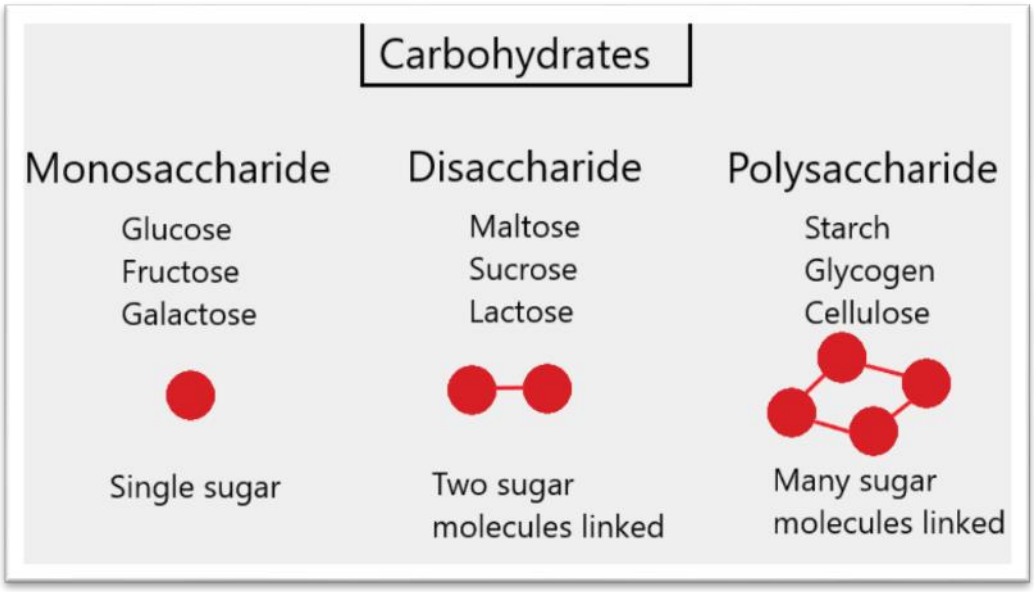
Overview of Carbohydrates

Monosaccharide's ,Disaccharides and Polysaccharides



Background:

- Carbohydrates are the key source of energy used by living things.
- Also serve as extracellular structural elements as in cell wall of bacteria and plant.
- Carbohydrates are defined as the polyhydroxy aldehydes or polyhydroxy ketones.
- Most , but not all carbohydrate have a formula (CH2O) n (hence the name hydrate of carbon)
- In human body, the D-glucose is used.
- Simple sugars ends with –ose.

Several classifications of carbohydrates have proven useful, and are outlined in the following table:

Complexity	**Simple Carbohydrates** monosaccharides		**Complex Carbohydrates** disaccharides, oligosaccharides & polysaccharides		
Size	**Tetrose** C_4 sugars	**Pentose** C_5 sugars	**Hexose** C_6 sugars	**Heptose** C_7 sugars	etc.
C=O Function	**Aldose** sugars having an aldehyde function or an acetal equivalent. **Ketose** sugars having a ketone function or an acetal equivalent.				
Reactivity	**Reducing** sugars oxidized by Tollens' reagent (or Benedict's or Fehling's reagents). **Non-reducing** sugars not oxidized by Tollens' or other reagents.				

Classification :

1-Simple sugar (one unit) :

Monosaccharide's contain one monosaccharide unit.

2-Complex sugar (more than one) :

- Disaccharides contain two monosaccharide units.
- Oligosaccharides contain 3-9 monosaccharide units.
- Polysaccharides can contain more than 9 monosaccharide units.

-Complex carbohydrates can be broken down into smaller sugar units through a process known as hydrolysis.

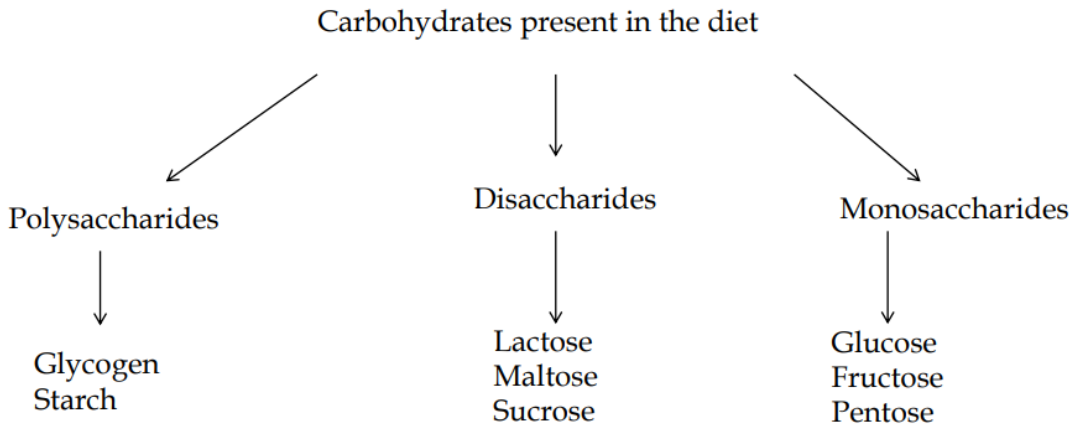
Reducing and non-reducing sugars:

Reducing and non-reducing sugar :If the oxygen on the anomeric carbon of a sugar is not attached to any other structure, that sugar can act as a reducing agent and is termed a reducing sugar.

Solubility of sugars [physical property]:

Monosaccharide and disaccharide can be dissolved freely in water because water is a polar substance, while polysaccharide cannot be dissolved easily in water, because, it has high molecular weight , which give colloidal solutions in water.

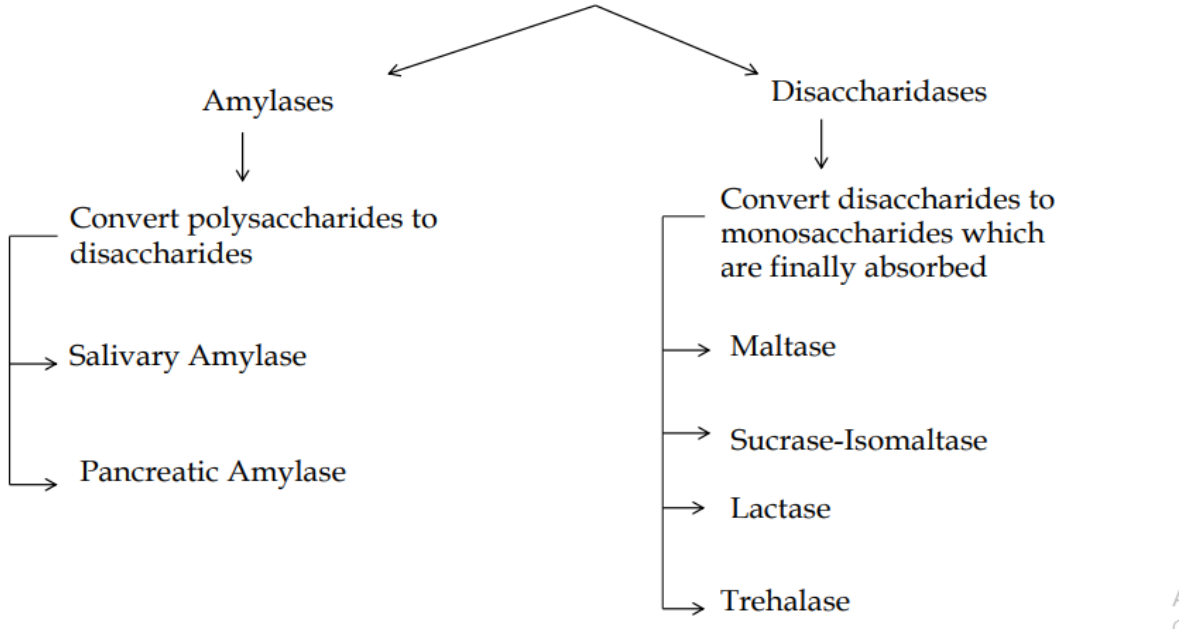
Digestion and Absorption of Carbohydrates:



In GIT, all complex carbohydrates are converted to simpler monosaccharide form which is the absorbable form

Details of Digestion of Carbohydrates:

Two types of enzymes are important for the digestion of carbohydrates



Digestion in the Mouth:

• Digestion of Carbohydrate starts in the mouth, upon contact with saliva during mastication.

• Saliva contains a carbohydrate splitting enzyme called salivary amylase, also known as ptylin.

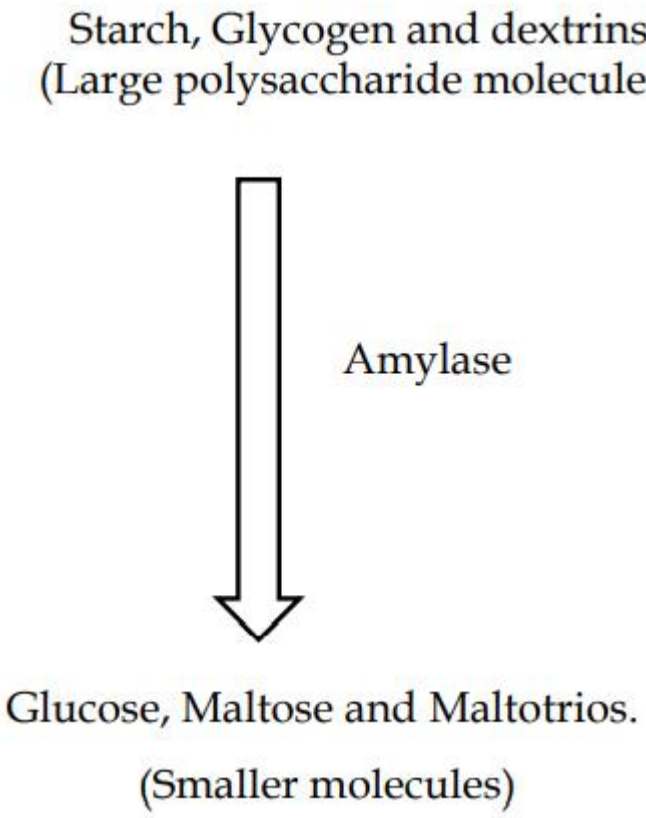
Action of Ptylin (Salivary Amylase):

• Location: mouth

• It is an α-amylase and requires Cl − ion for activation with an optimum pH of 6.7 (Range 6.6 to 6.8).

• The enzyme hydrolyse α 1→4 glycosidic linkages deep inside polysaccharide molecules

• However, ptylin action stops in the stomach when the pH falls to 3.0.



Drawback:

• Shorter duration of food in mouth.

• Thus it is incomplete digestion of starch or glycogen in the mouth

Digestion in the Stomach:

• There is no enzyme to break the glycosidic bonds in gastric juice.

• However HCl presents in the stomach causes hydrolysis of sucrose to fructose and glucose.

$$\text{Sucrose} \xrightarrow{\text{HCl}} \text{Fructose + Glucose}$$

Digestion in Duodenum:

• Food bolus reaches the duodenum from the stomach where it meets the pancreatic juice.

• Pancreatic juice contains a carbohydrate splitting enzyme.

• Pancreatic amylase (amylopsin) is similar to salivary amylase.

Properties of Pancreatic Amylase:

• It is an α-Amylase

• Optimum pH=7.1

• Like Ptylin, it requires Cl^- ion for its activity.

• It hydrolyses α 1→4 glycosidic linkages situated well inside polysaccharide molecules.

-Note:

- Pancreatic amylase, an isoenzyme of salivary amylase, differs only in the optimum pH of action.
- Both the enzymes require Chloride ions for their actions (Ion activated enzymes).

Digestion in Small Intestine:

- Note:

• Main digestion takes place in the small intestine by pancreatic amylase.

• Digestion is completed by pancreatic amylase because food stays for a longer time in the intestine.

What are Disaccharidases?

• They are present in the brush border epithelium of intestinal mucosal cells where the resultant monosaccharide and others arising from the diet are absorbed.

• **The different disaccharidases are:**

1) Maltase

2) Sucrase-Isomaltase (A bifunctional enzyme catalyzing hydrolysis of sucrose and isomaltose)

3) Lactase

Reactions catalyzed by Disaccharidases:

- Maltose $\xrightarrow{\text{Maltase}}$ Glucose + Glucose
- Sucrose Isomaltose $\xrightarrow{\text{Sucrase-Isomaltase}}$ 3 Glucose + fructose
- Lactose $\xrightarrow{\text{Lactase}}$ Glucose + Galactose

Absorption of Monosaccharides:

• The major monosaccharides resulting from carbohydrate digestion are:

• D-glucose

• D-galactose

• D-fructose.

• Monosaccharides are first transported from the lumen to the small intestinal epithelial cells and then into capillaries of portal venous system.

Factors affecting rate of absorption of Monosaccharides :

• The absorption is faster through intact mucosa.

• The absorption is decreased if there is some inflammation or injury to the mucosa.

• Thyroid hormone (increases) the rate of absorption of glucose.

• Mineralocorticoid, i.e: Aldosteron (decreases) the rate of absorption

• Vitamin B6,B12 pantotheni acid, folic acid are required for absorption of glucose. With advancing age, rate of absorption declines.