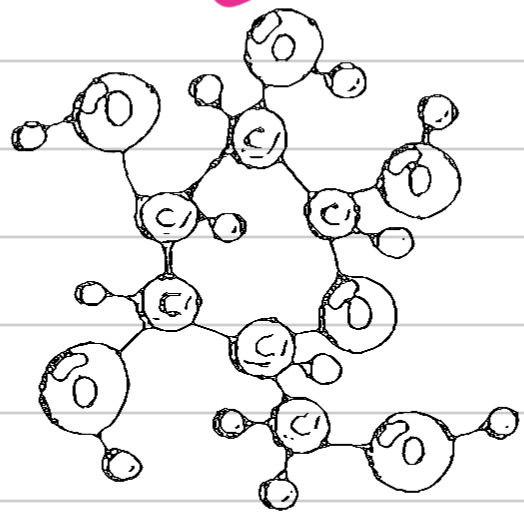
Carbohydrates 3



CARBOHYDRATE

vector illustration

Disaccharides

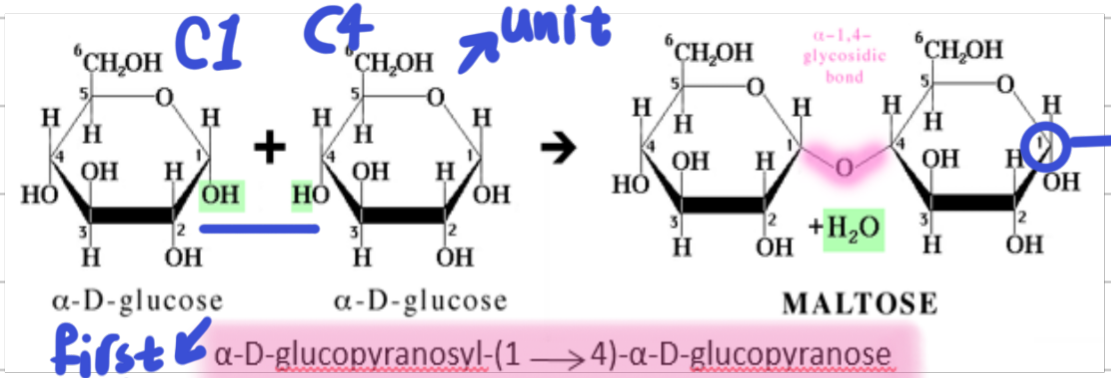
→ These are two monosaccharides linked together via the glycosidic bond.

→ Three common disaccharides :

- Maltose
- Lactose
- Sucrose

Moltose «malt suger»

- consist of two α-D-glucose units.
- is a disaccharide released during the hydrolysis of starch



- During the degradation of starch, maltose sugar is produced.

- In maltose, the bond will from between C1 of the first unit and oxygen located on C4 of the second unit.
  α-(1-4)O-glycosidic bond.

- Maltose is reducing suger as it has a free anomeric carbon of the second unit.

Glycosidic bond

- type of covalent bond with a water molecule is removed in this reaction (condensation reaction).

- This type of bond is called O-glycosidic bond.

  because O atom binds the two carbon atoms together.

Loctose «milk sugar»

- consists of glucose and galactose.

- is a disaccharide occurs naturally in the milk. (dairy products)

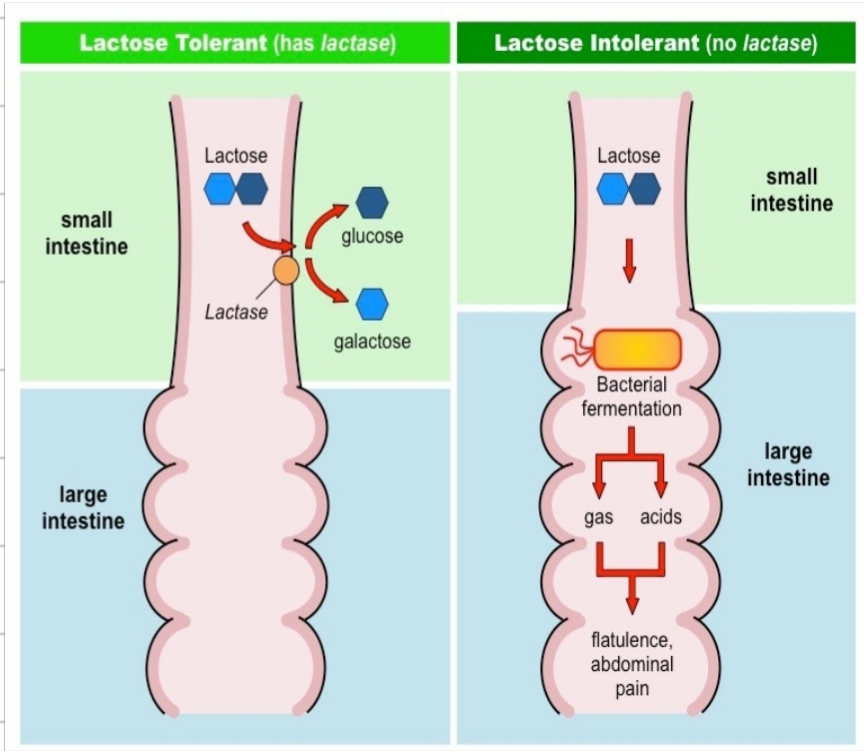
ex:-

- β-D-Galactopyranosyl-(1→4)-α-D-glucopyranose.
- β-D-Galactopyranosyl-(1→4)-β-D-glucopyranose.
- Lactose is a reducing suger as it has a free anomeric carbon of the second unit.

Lactose Intolerance

- deficiency of lactase enzyme leading to Gastrointestinal tract (GIT) disturbances such as:
  - Bloated stomach.
  - Flatulence due to intestinal gases.
  - Diarrhea.
  - Nausea and vomiting
  - Stomach pain and cramping
  - Stomach gurgling and rumbling.

4 types of Lactose Intolerance:



Primary → lactase level declines with age.

Seconday → lactase level declines with injury of small intestine due to inflammatory bowel diseases.

Congenital → rare genetic disease, deficiency of lactase at birth.

developmental → premature babies.

sucrose «table sugar»

- consists of glucose and fructose.
- is a disaccharide obtained commercially from cane / beet
- ex:- α-D-Glucopyranosyl-(1→2)-β-D- fructofuranose.
- Sucrose is not a reducing sugar
  because the anomeric carbon of the second residue is not free but involved in the glycosidic bond formation.
- Sucrose is ideal as preservative commonly used with dried fruits.

. polysaccharides (glycans).

- consist of long chains of monosaccharide units bound together via the glycosidic linkages.

polysaccharides
- composed of same type of monosaccharide. homoglycans.
- consisting of more than one type. heteroglycans.

polysaccharides
- storage polysaccharides.
- Structural polysaccharides.

- They form branched as well as linear polymers.

Storage Polysocchorides

Starch → in plant

- polymer composed of α-D-glucose monomers.
- mixture of
  - amylose (20% water soluble).
  - amylopectin (80% water insoluble)

Amylose unbranched starch (linear).
- α(1-4) glycosidic bonds.

Amylopectin branched starch.
- α(1-4) glycosidic bonds.
- α(1-6) branch points → every 24-30 units.

Glycogen → in animals and human.

- polymer composed of α-D-glucose units like amylopectin but glycogen is more higly branched with branch points occurring every 8-14 residues.

- Due to α-linkage, it adopts a helically coiled conformation (similar to starch) to be easily accessible for metabolic enzymes.

- Mainly found in
  - skeletal muscle (1-2% of muscle mass)
  - liver cells (10% of liver mass)

Synthesis and Breakdown of Glycogen :-

- Some tissues particularly the brain cells require a constant supply of blood glucose for survival.

- Tissues such as liver and skeletal muscles store glucose in a form that can be rapidly mobilized glycogen

→ Glycogen is synthesized glycogenesis when blood glucose is high.

→ Glycogen is degraded glycogenolysis releasing glucose into the blood stream when blood glucose is low.
- (normal blood glucose level is 80-100 mg/dl)

★ Starch and glycogen have one reducing end.

- On the other hand, the branches ends are all called non-reducing ends and being sites where enzymatic lengthening and degradation occur.

Structural Polysocchorides

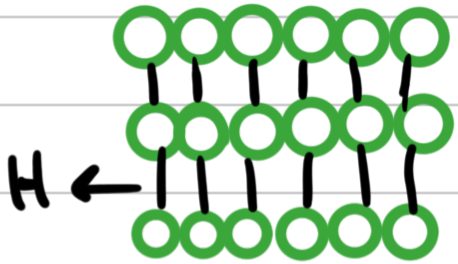
Cellulose

- the primary structural component of plant cell walls.

- A linear polymer of β-D-glucose residues linked via β-(1-4) glycosidic bonds.

- It adopts very different molecular architecture from that of starch (hollwo helix) due to its β-linkage.

- Cellulose forms very long straight chains. The parallel chains interact with one another through H-bond → so plant cells are rigid.



- herbivores and termites can digest cellulose because they have cellulases enzymes → enzymes capable of hydrolyzing the β-(1-4) bonds of cellulose.

- Cellulose rich food (like vegetables) is used in patients who have constipation by supporting the regular bowel movements.

Chitin

- It is the structural component of the exoskeletons of the invertebrates like insects and spiders. Also, it is the main component of the cell walls of fungi.

- Cockroach - Spider - Shrimp. - fungi

- A long chain polymer of N-acetyl-D-glucosamine residues joined by β-(1-4) bonds.

- It has similar structure to cellulose with the only difference is the replacement of oH at C2 of each monomer with acetyl amine group.

Heteropolysaccharides

- consist of two or more different monosaccharide units.
  (mostly found in the connective tissues).
  - cartilage
  - tendon
  - blood vessel walls

Hyduronic acid (Hyaluronate)

- the major component of joints fluid (synovial fluid)
  - It acts as a lubricating agent and shock absorber.
- It is also a major component of skin
  - it is involved in tissue repair and acts as moisturizing agent

Dry and scaly skin such as that caused by eczema may be treated with a prescription of skin lotion containing sodium hyaluronate as it is active ingredient

- liner polymer of the disaccharides
- D-glucuronic acid and N-acetyl-D-glucosamine.
- Hyaluronate (anionic polymer).
- D-glucuronate and N-acetyl-D-glucosamine.
  (anion)

Sulfated heteroglycons

Dermatan sulfate
found mostly in the skin.

chondroitin sulfate
the major compounent of cartilage
used with glucosamine to treat osteoorthritis.

Keratan sulforte
found in the cartilage and bone.

Heparin
in the mast cells
used as an injectable anticoagulant. (post surgical patients.

chondroitin sulfate

- 4-sulfate
- 6-sulfate

D-Glucuronate +
N-acetyle-D-galactosamine

Dermatan sulfate

L-Iduronate
N-acetyl-D-glactosamine-4-sulfate.
* D-glucose and L-idose → C5 epimers.

Keratan sulforte

D-galactose +
N-acetgl-D-glucosamine-6-sulfate.

Heparin

L-Iduronic acid (L-Iduronate-2-sulfate)
D-glucosamine (N-sulfo-D-glucosamine-6-sulfate).