Lec.7 · By. Rofida Awwad

'Disaccharides'

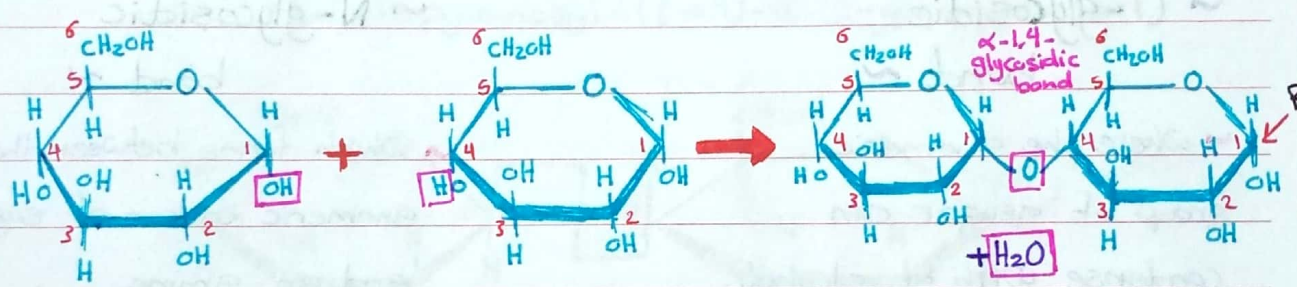
- these are two monosaccharides linked together via the [glycosidic bond].

Three common disaccharides (most common three)

1. MALTOSE 2. LACTOSE 3. SUCROSE · CELLOBIOSE [uncommon] [not much]

~ MALTOSE ~ malt sugar

• consists of two α-glucose units, is a disaccharide released during the hydrolysis of the starch.



α-D-glucose α-D-glucose MALTOSE

~ α-D-glucopyranosyl-(1-4)-α-D-glucopyranose ~

two monosaccharides يرتبطوا مع بعضهم عن طريق الـ (C1) من الـ first unit عن طريق الـ (OH) الموجودة هنيك و (C4) من الـ second unit عن طريق الـ (H) الموجودة هنيك ؛ فتنزل الـ O وتتكون رابطة ما بين C1 first unit and C4 second unit ← هي الرابطة اسمها α-1,4-glycosidic bond, وينتج جزيء ماء H_2O (condensation reaction)

. Barely grains (حبوب الشعير) is used for prepation of malt beverage. During the degradation of starch, maltose sugar is produced.

repeated units of α-D-glucose (long chain)

Starch: energy stores found in plants cells.

starch يتكسر ← ينتج maltose (disaccharide)

note -All monosaccharides Reducing sugars.

- Most of disaccharides are reducing sugars, but the [sucrose] is [non-reducing sugar].

* We call disaccharides, reducing sugars when we find at least one reducing and [free anomeric carbon].

~ Glycosidic bond ~

- type of covalent bond -

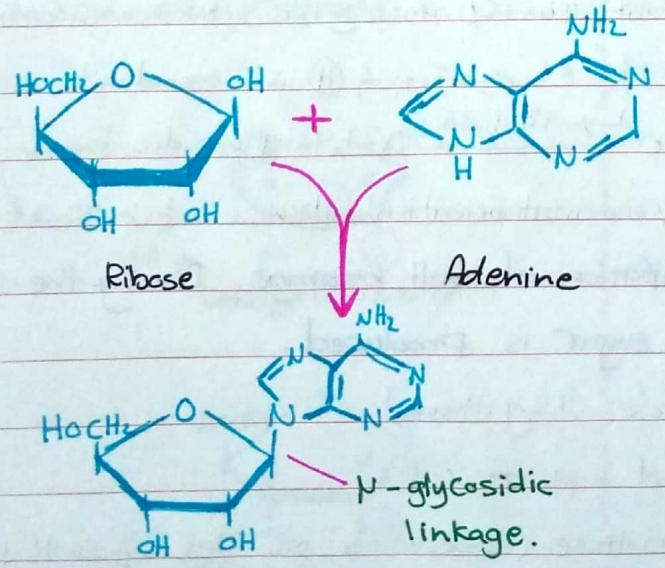
~ O-glycosidic bond ~

~ where the anomeric group of a sugar can condense with an alcohol.

~ N-glycosidic bond. ~

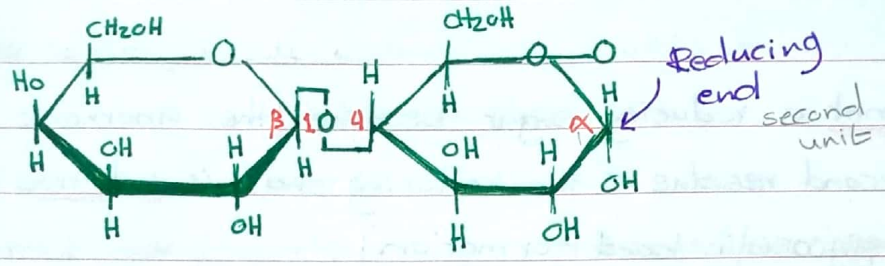
~ which forms between the anomeric carbon of sugar and an amine.

e.g the bonds that link D-ribose and D-deoxyribose to purines and pyrimidines in the nucleic acids: RNA & DNA, respectively.



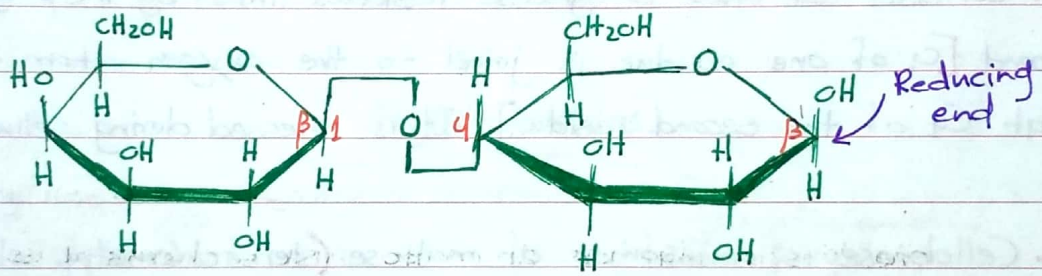
~ LACTOSE ~ milk sugar

• Consists of glucose & galactase, is adisaccharide occurs naturally in the milk [dairy products].



α-Lactose

β-D-Galactopyranosyl-(1→4)-α-D-glucopyranose.



β-Lactose

β-D-Galactopyranosyl-(1→4)-β-D-glucopyranose

. Lactose Intolerance (عدم تحمل سكر اللاكتوز): deficiency (نقص) of lactase enzyme leading to error in lactose enzyme in small intestine.

Gastrointestinal tract [GIT] disturbances (مشاكل في الجهاز الهضمي) such as:-

nausea (غثيان), bloating (انتفاخ), abdominal cramps and diarrhea due to digestion of lactose [intact] by bacteria found in Colon.

← ينتج عند الطفل أقل مايولد [حالة] منذ الولادة .

LF: lactose free

SUCROSE — table sugar

. Consists of glucose & fructose, is a disaccharide obtained commercially from cane or beet.

. is not a reducing sugar because [the anomeric carbon of the second residue (the reducing end) is not free but involved in the glycosidic bond formation].

CELLOBIOSE

• Consists of two D-glucose residues linked by the β-glycosidic bond [C_1 of one residue is joined to the oxygen atom attached at C_4 of the second residue]. It is released during cellulase degradation.

• Cellobiase is an isomer of maltose (stereochemistry of the glycosidic bond which is β in cellobiase and α in maltose).

- Polysaccharides -

• 'glycans' are polymeric molecules consist of long chains of monosaccharide units bound together via the glycosidic linkage. ↳ (covalent bond).

- the most complex form of carbohydrates or sugars -

Polysaccharides are classified into 3 ways :-

1- [Polysaccharides]

according to monomers

• Homopolysaccharides
- homoglycans - composed of same type of monosaccharides.

• Heteropolysaccharides
- heteroglycans - composed of more than one type of monosaccharides.

2- [Polysaccharides]

according to structure

• Branched متفرع

• Linear Polymers غير متفرع / سلاسل مستقيمة

3- [Polysaccharides]

according to function

• Storage polysaccharides
(starch, glycogen)

• Structural polysaccharides
(cellulose, chitin).

~ Storage polysaccharides ~

STARCH → energy stores in plant cells. is the storage polysaccharides in plants.

- Polymer composed of glucose monomers.
- a mixture of amylose (20%, water soluble ← linear form) and amylopectin (80%, water insoluble ← branched form) stored in plant cells as insoluble granules.

- [starch] in general → polysaccharide (homopolysaccharide).
- repeated units [α-D-glucose].
- the bond [α(1→4) glycosidic bond].

* Because the majority of the starch composed of amylopectin it consider as water insoluble.

* the main source of energy in our bodies is glucose [hexoaldose].

* If the plant cell have excess glucose, it will store it as starch form, when it need energy it will break down starch to get glucose which is used in energy needed metabolism.

* starch adopts aspecific secondary structure as coiled structure [hollow helix like spirell spring] (اجوف).

راجع الصورة في الملاحظة 10 ← same note

* α (1-4) glycosidic bonds (in main core chain and in the branch chain.).
* α (1-6) branch points (Just in branch points).

Digestion of starch

1- The salivary amylase enzyme randomly hydrolyses the α-(1→4) bonds.
2- Starch digestion to small oligosaccharides or maltose continues in the small intestine by pancreatic amylase.
(maltose → disaccharide)
3- further hydrolysis by α-glucosidase - which remove one glucose residue at time - and by adebranching enzyme - which hydrolyzes specifically α-[1→6] bond.
4- The produced monosaccharides [glucose residues] are absorbed by the intestine and transported to the bloodstream.

11 مراجع الكلية سلايد

GLYCOGEN → energy stores in animal and human cells
in animal & human.

- Polymer composed of glucose units like amylopectin but glycogen is more highly branched with branched points occurring every 8-14 residues.
- Mainly found in skeletal muscle [upto 1-2 % of muscle mass] and liver cells [upto 10 % of liver mass]. + Brain cells also store glycogen.
  → main storage site of glycogen

12 * مراجع الكلية سلايد
amylopctin شبيهة

"Synthesis & Breakdown of Glycogen"

~ glucose is the only brain food ~.

- Some tissues particularly the brain require a constant supply of blood glucose for survival.
- Some tissues particularly liver and skeletal muscles store glucose in a form that can be rapidly mobilized [i.e. glycogen].
  → easy for form or breakdown.

- glycogen in synthesized [glycogenesis] (synthesis) when blood glucose is high and glycogen is degraded (glycogenolysis) (Breakdown) releasing glucase into the bloodstream when blood glucose is low [normal blood glacose level is 80 - 100 mg/dl).
- This balance between the need and availability is called metabolic homeostasis. → this metabolism happened in liver.
  * Liver give glucase for all cells while skeletal-muscle produce glycogen for it self.
  * Starch and glycogen are in hollow helix structure to be accessable for enzyme.

- Starch and glycogen have one reducing end [the molecule end containing afree anomeric carbon C1]. On the other hand, the branches ends are all called non-reducing ends and being sites where enzymatic lengthening and degradation occur.

← راجع الصورة بعد رقم 14.

~ Structural Polysaccharides ~

CELLULOSE :- the primary structural component of plant cell walls.

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

← راجع الصورة في البداية

~ It is the most abundant organic molecule on the earth. Cellulose accounts for over half of the carbon in the biosphere.

~ It adopts a very different molecular architecture from that of starch [hollow helix] due to its β-linkage.

not accessable for enzymes.

- Cellulose forms very long straight chains. The parallel chains interact with one another through H-bonds.
  - this H-bonds give the cellulose rigidity and support.

*راجع الصورة في السلايد 16

- Compared to humans, herbivores and termites can digest cellulose because they have cellulases enzymes "enzymes capable of hydrolyzing the β-(1-4) bonds of cellulose."
  - while humans don't have this enzymes.

- Cellulose rich food (like vegetables) is used in patients who have constipation.

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.
- Along chain polymer of [N-acetyl-D-glucosamine] residues joined by β-(1-4) bonds.

← راجع الصورة سلايد 17.

- It has similar structure to cellulose with the only difference is the replacement of OH at C_2 of each monomer with [acetyl amine group].

← راجع الصورة سلايد 18.

'Chitosan' is a linear (not natural, not branched, not monoglycan and synthetic.) heteroglycan polysaccharide composed of randomly distributed β-(1-4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit). It is produced commercially by deacetylation of chitin [e.g. by treating shrimp shells with the alkali sodium hydroxide].

Medical uses:- It is useful in weight loss and obesity treatment plans because it can reduce fat absorption.

[Heteropolysaccharides]

✔ Consist of two or more different monosaccharide units and are closely associated with lipid [glycolipids] or protein [glycoproteins].

✔ The naturally occurring heteroglycans are mostly found in the connective tissues [such as cartilage, tendon, blood vessel walls, etc...]

1. Hyaluronic acid [Hyaluronate].

• It is the major component of joint fluid (synovial fluid). It acts as a lubricating agent and shock absorber.

• It is also a major component of skin, where it is involved in tissue repair. Dry and scaly skin such as that caused by eczema may be treated with a prescription skin lotion containing sodium hyaluronate as its active ingredient.

• Hyaluronic acid is a linear polymer of the disaccharides [D-glucuronic acid and N-acetyl-D-glucosamine] linked via alternating β-1,4 and β-1,3 glycosidic bonds.

← راجع الصورة في الشرح

2- Sulfated heteroglycans

- consist of sulfated disaccharide units such as :- chondroitin sulfate , dermatan sulfate , keratan sulfate and heparin.

- **chondroitin-4-sulfate & chondroitin-6-sulfate** : are unbranched polymers containing the disaccharide 'D-glucuronic acid and N-acetyl-D-galactosamine' with the N-acetyl-D-galactosamine OH groups at position 4 and 6 being sulfated , respectively. ← راجع الصورة في السلايد

- Chondroitin sulfate is a major component of cartilages. they provide them with resistance to compression. Loss of chondroitin sulfate from the cartilage is a major cause of osteoarthritis.

- used as dietary supplement to treat osteoarthritis. It is commonly sold together with glucosamine.

- **Dermatan sulfate** : is a natural polysaccharide found mostly in the skin. It is a linear polymer of a disaccharide containing L-Iduronic acid (modified L-Idose sugar) and N-acetyl-D-galactosamine-4-sulfate.

← راجع الصورة في السلايد.

- **Keratan sulfate** : is a natural polysaccharide mainly found in the cartilage and bone. It is highly hydrated molecules (تقلل الاحتكاك والصدمات) which in joints can act as a cushion to absorb mechanical shock. This linear polymer is consisting of repeating disaccharide unit containing D-galactose and N-acetyl-D-glucosamine-6-sulfate.

negative charge. أعلى شحنة سالبة

• Heparin is the most highly charged Polymer of any known biological molecule. Heparin is a complex mixture of linear polysaccharide and it varies in the degree of sulphation of its sugar units. one example is the sulfated disaccharide unit containing L- Iduronate-2-Sulfate and N- sulfo-D-glucosamine-6-sulfate.

أعلى شيء موجودة منها

- راجع المحورة 6 بس اعرف الـ monomer اللي بتتكون منها.

∩ Heparin is stored almost exclusively within the secretory granules of mast cells and it inhibits blood clotting. So, heparin is widely used as an injectable anticoagulant [e.g. post surgical patients].

نوع من انواع الخلايا المناعية اكتشفها موجودة في الـ tissue.

تجلطات

وظيفة تمييع الدم.