

# VEIN BATCH 2027



Sub: Molecular المادة:

Lecture: 3 المحاضرة:

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Edited: تعديل:



# Carbohydrates of biological importance- lecture 3

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Majority of slides: Dr. Walaa Bayoumie El Gazzar

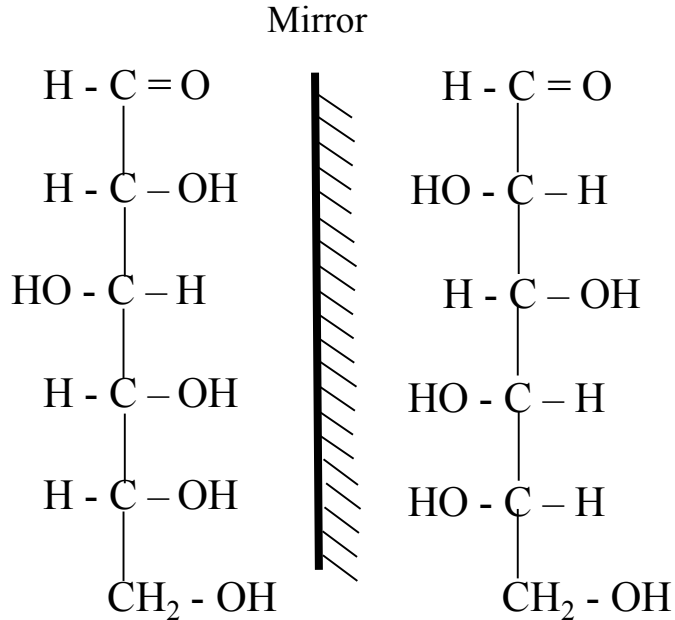
تفريغ : محمد العمري / تالا العمري

Isomerism in carbohydrates: (Summary of what we have seen)

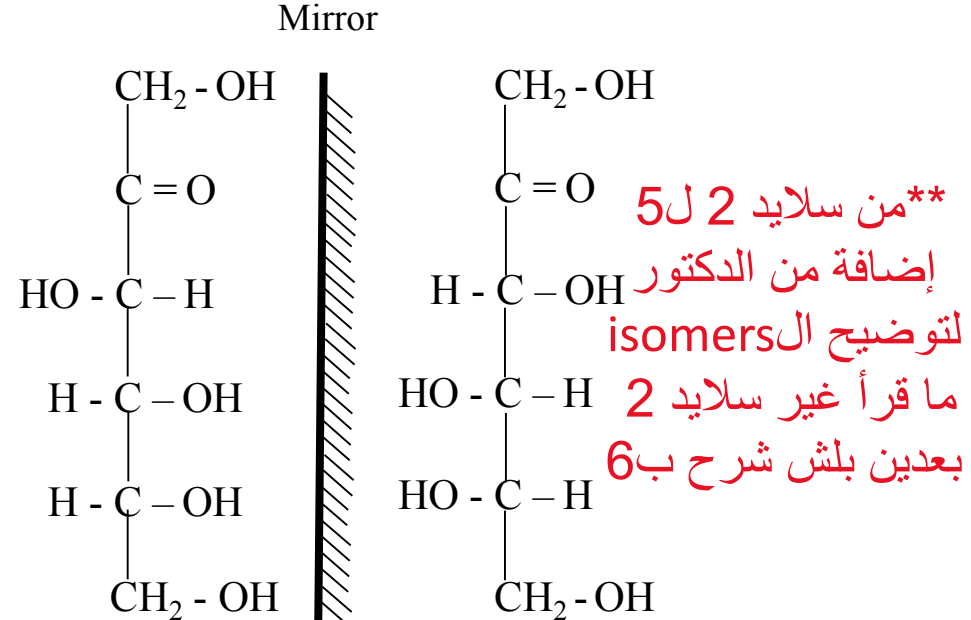
Isomers: are compounds that have the same chemical formula (number and type of atoms) but differ in structure (three dimensional orientation of atoms). Several types of isomers exist for carbohydrates:

1. Aldo-keto-isomers: sugars that have either **an aldehyde or a ketone group**, e.g., D-glucose and D-fructose are aldo-keto hexose isomers; while D-ribose and D- ribulose are aldo-keto pentose isomers, D-glyceraldehyde and di-hydroxyl-acetone are aldo-keto triose isomers. **الفرق الوحيد بينهم بال active group**
2. Epimers: sugars that **differ in the configuration around a single carbon atom** other than the aldehyde or ketone group are called epimers, e.g., D-galactose is an epimer of D-glucose (differ in configuration around carbon 4), D-mannose is an epimer of D-glucose (differ in configuration around carbon 2). However, D-galactose and D-mannose are not epimers to each other as they differ in the configuration around 2 carbon atoms. **المركبات اللي الفرق الوحيد بينها انه هاي D وهاي L تعتبر Enantiomers**
3. Enantiomers: are **mirror-image isomers and are designated as either D- or L- sugar**. The vast majority of sugars in humans are D-sugars. Racemases are enzymes that can interconvert D- and L- isomers. Most enzymes are specific for either D- or L-forms. We need to have at least one asymmetric carbon atom (i.e., a carbon atom attached to 4 different groups or atoms) to have enatiomeric forms. Glucose has 4 asymmetric carbon atoms and D-glucose and L-glucose are enantiomers.
4. Anomers: are isomers which have different distribution of atoms or groups around the anomeric carbon atom in ring structure of sugars. The anomeric carbon atom is the one that carries an aldehyde or a ketone group in the open chain structures, and only becomes asymmetric in ring structures, e.g.,  $\alpha$  glucose and  $\beta$  - glucose are anomers.

Each of D- and L-Glucose and D- and L-Fructose Are Enantiomers or mirror images to each other



D- Glucose	L- Glucose
Enantiomers	



D- Fructose	L- Fructose
Enantiomers	

\*\*من سلايد 2 ل 5  
إضافة من الدكتور  
لتوضيح ال isomers  
ما قرأ غير سلايد 2  
بعدين بلش شرح ب 6

D- Glucose and L-Glucose are mirror images of each other: They are Enantiomers. Both have 4 asymmetric carbon atoms. D- and L-fructose enantiomers have only 3 asymmetric carbon atoms each. Fructose: is a keto-hexose, a sugar with 6 carbon atoms that contains a ketone group. It is the fruit sugar and can be converted to glucose in the liver. It is also produced from glucose in the body during the early stages of glucose oxidation in the cytoplasm of all cells in glycolysis. It is present in the seminal fluid and is important for nourishing the sperms. Fructose is the monomer from which inulin, a homo-polysaccharide is composed. Inulin is used in renal function testing to estimate the glomerular filtration rate.



# ENANTIOMERS VERSUS EPIMERS

Enantiomers are optical isomers that are non-superimposable mirror images of each other

Epimers are stereoisomers that contain more than one chiral carbon but differ from each other in the configuration at only one chiral carbon

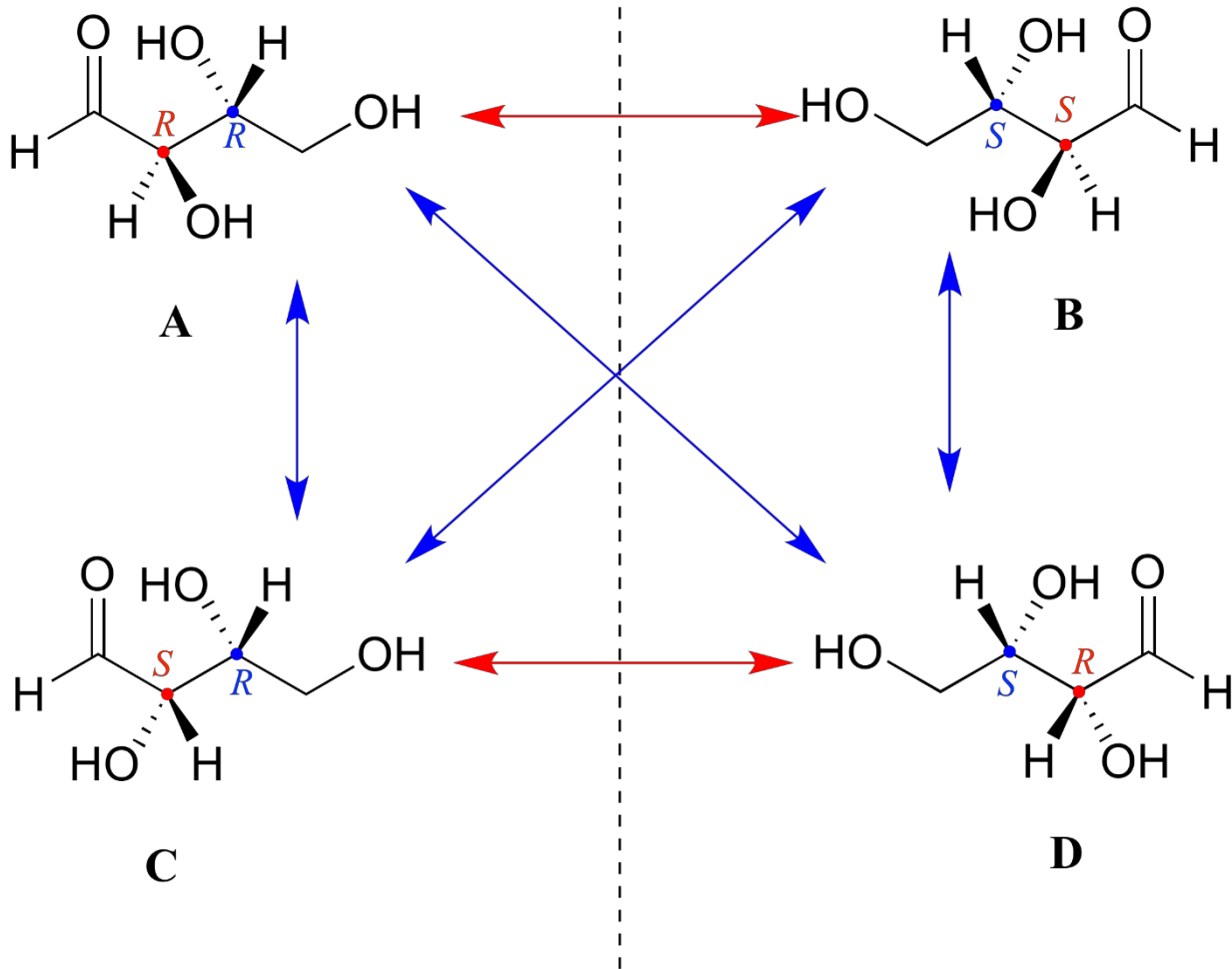
Non-superimposable mirror images of each other

Not mirror images of each other

Physical and chemical properties are the same except for the rotation of plane polarized light

Physical and chemical properties are different from each other

*mirror plane*



enantiomers

diastereomers

التسميات بتختلف من مكان وكتاب للثاني, يعني عادي نشوف أحد المصادر مصنف ال Di-saccharide لحالهم

# Classification and Nomenclature

## Carbohydrates

### Monosaccharide

### Oligosaccharide

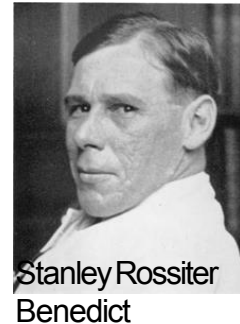
### Polysaccharide

Functional group	Number of carbon atoms	Di-saccharide	Tri-saccharide	Tetra-saccharide	Homopoly-saccharide	Hetropoly-saccharide
Aldoses e.g Glucose	Trioses	Maltose	Raffinose	Stachyose	Starch	Hyaluronic acid
Ketoses e.g Fructose	Tetroses	Lactose			Dextrin	Heparin
	Pentoses	Sucrose			Glycogen	Chondroitin sulfate
	Hexoses				Cellulose	Dermatan Sulfate
	Heptoses				Inulin	Keratan Sulfate

# Reducing vs non-reducing sugars

- **Benedict's reagent:** Chemical reagent of sodium carbonate, sodium citrate, and copper(II) sulfate pentahydrate
- Detects the presence of aldehydes or ketones (active & free carbonyl group)
- If oxygen group on the carbonyl group is not attached to any other structure, the sugar is reducing
- Oxidation of the reducing sugar by the cupric ( $\text{Cu}^{2+}$ ) complex of the reagent produces a cuprous ( $\text{Cu}^{+}$ ), which precipitates as insoluble red copper(I) oxide ( $\text{Cu}_2\text{O}$ )

يستخدمهم للتفريق بين ال Reducing وال non-reducing ، مبدأهم : اذا ال O الموجودة عال carbonyl مثل متصلة بأي مركب ثاني فهو reducing (وبعطي محلول لونه أحمر عند التسخين) بس اذا كانت متصلة ف non-reducing ( و اتصالها مع ذرّة ال H يعني انها free برضه لانه كسر الرابطة بينهم سهل ف تعتبر reducing )



Stanley Rossiter  
Benedict



# Disaccharides

- Two monosaccharides can be joined by a glycosidic bond with the loss of a water molecule to make disaccharides  
التفاعل ينتج عنه H<sub>2</sub>O

- The glycosidic bond always involves the anomeric carbon of one participating sugar. The 2<sup>nd</sup> sugar participates in this bond by using either:

- ✱ Its anomeric carbon: in this case, the disaccharide (as sucrose) has no free reactive group.
- ✱ A carbon other than the anomeric one. In this case the disaccharide will have a free reactive group and shows reducing character

هسا ال O اللي بتحددلي اذا المركب reducing ولا non-reducing هي ال O المرتبطة

بال anomeric C ف لو المركبين مرتبطات عن طريق ال anomeric C ف هاض معناه انه المركبين بطل في عندهم free O وبالتالي نتج عندي مركب non-reducing, اما لو الارتباط ع أي ذرة C ثانية ف لسا ال O اللي عال anomeric C متاحة, ف يعتبر reducing والناجح ممكن يكون  $\alpha/\beta$

- They can be present either in  $\alpha$ - or  $\beta$ -form. This occurs if the second monosaccharide residue of the disaccharide contains a free anomeric carbon atom which has the ability to be present in  $\alpha$  or  $\beta$ -form

- **Glycosidic bond: covalent between the hydroxyl group of anomeric carbon**



لازم يكون في C anomeric مشاركة في الbond

بختلف المصطلح المستخدم في الكتب ما بين gly أو glu ,  
بس فعليا فـش فرق كبير بينهم, لكن glycosidic هي الأعمّ و الأشمل



- The glycosidic linkage is named according to:
  - anomeric carbon to which it is attached (a or b)
  - according to the parent sugar e.g. glucosidic, galactosidic or fructosidic bond

- The most important disaccharides widely distributed in nature are:

### **Reducing disaccharides:**

1. Lactose.
2. Maltose.
3. Isomaltose.
4. Cellobiose (formed of two  $\beta$  glucose)

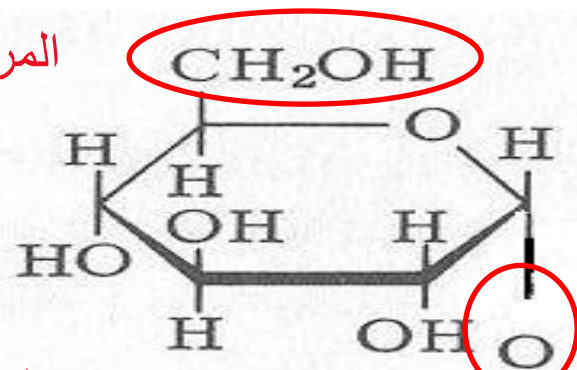
### **Non-reducing disaccharides:**

1. Sucrose.

- 1. Sucrose: (سكر الطعام)
- It is called cane or beet sugar (قصب السكر/البنجر)
- It is the common sugar of the table & the kitchen so, it is called table sugar
- It is formed of  $\alpha$ -glucose &  $\beta$ -fructose linked together by **a-1, b-2** **glucosidic linkage**
- Sucrose is digested by the enzyme sucrase which is present on the brush border membrane of small intestinal mucosa into glucose and fructose

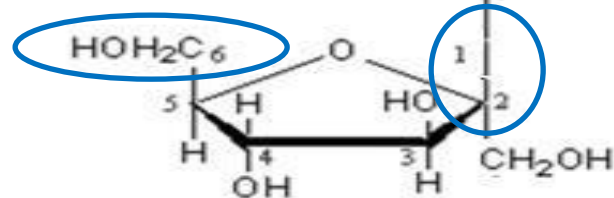
**$\alpha$ -D-Glucopyranose**

المركب بالاساس  
alpha



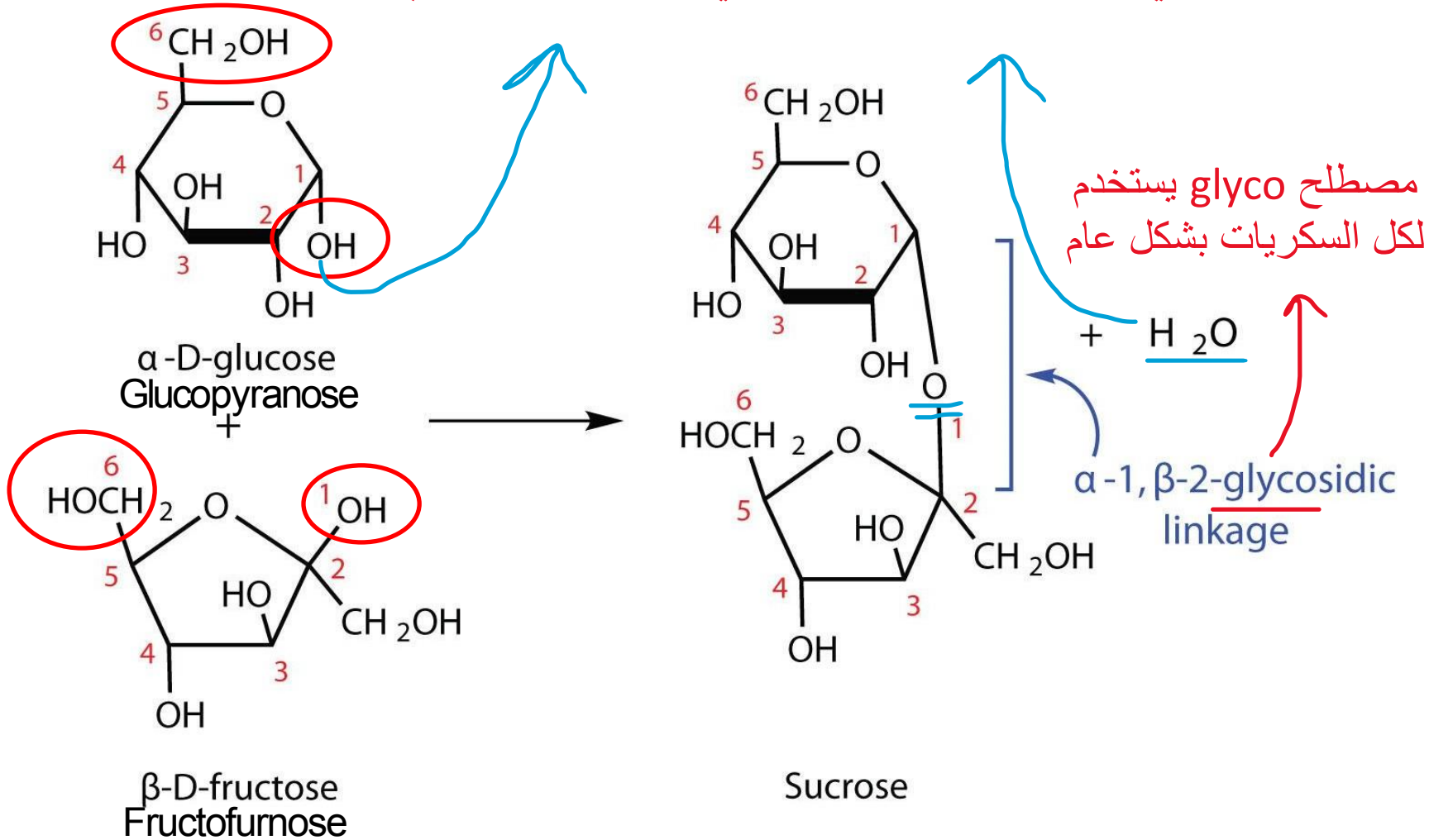
**$\beta$ -D-Fructofuranose**

المركب بالاساس  
beta كان



و اذا بتلاحظ ف المركبين اربطو من عند ال C anomeric ,  
بالتالي الناتج non-reducing

هاي ال O ضلت مكانها وشكلت الرابطة, بس ضل عندي ال H اللي كانت معها  
وال OH اللي كانت عال C2 بالمركب الثاني, اتحدوا وعملوا جزيء H<sub>2</sub>O



- Sucrose is a **Non-reducing sugar**: because the reducing groups of both glucose & fructose are involved in the linkage between the two sugars. So, They cancel the action of each other.

- **Invert sugar:**

- Sucrose before hydrolysis is dextrorotatory



- \* After hydrolysis by *sucrase or invertase*, It gives a mixture of D-glucose ( $\alpha = + 52.5^\alpha$ ) and D-fructose ( $\alpha = - 92^\alpha$ ) which is **levorotatory**.

الليمون يحتوي على citric acid لما أضيفه عال sucrose بعمله hydrolysis و يرجع السكر لمكوناته, بس ليش اسمه invert ؟ لأنه بحوله من d إلى l (لو ناسيهم ارجع للمحاضرة الماضية ادرسها كويس 😊)

- \*This change from dextro (before hydrolysis) to levo- (after hydrolysis) called inversion and the sugar is called invert sugar (equimolecular mixture of glucose and fructose is called invert sugar) ↴

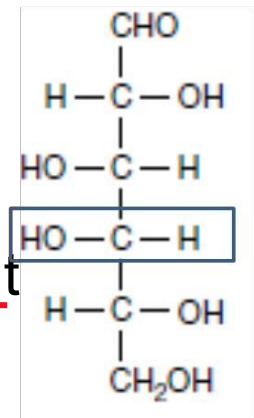
نواتج ال hydrolysis بتكون خليط من ال glucose وال fructose

\*\*ليش ال fructose اكثر حلاوة من ال glucose؟

لأنه ال H bonds في ال fructose أقصر منها في ال glucose

## 2. Lactose:

- It is also called **milk sugar**
- It is formed of one glucose unit & another one galactose unit
- Lactose is a reducing sugar



D-Galactose

- Usually appear in urine of pregnant female
- Less sweety ( شهوة ) ( حلاوته قليلة ) not block the appetite Lactose (appropriate for infants as it is less sweet and babies tolerate large volumes of milk)
- It can be digested by lactase enzyme
- Deficiency of this enzyme leads to lactose intolerance which cause distension & diarrhea.

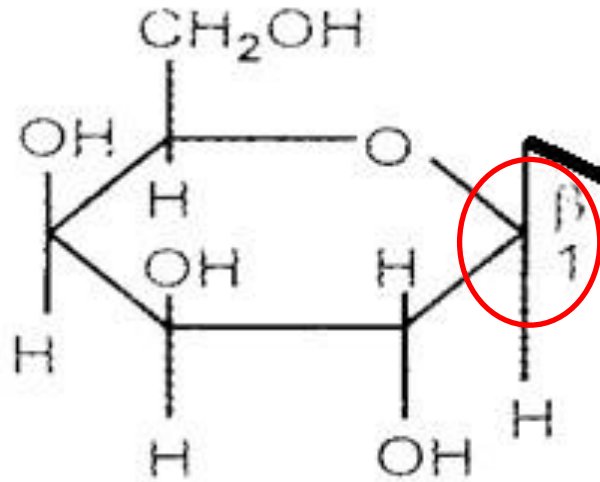
(انتفاخ)

النقص في ال lactase enzyme يؤدي إلى lactose intolerance

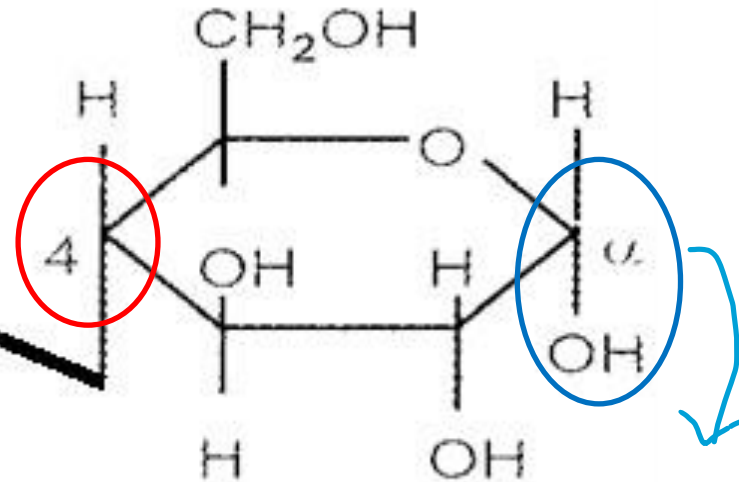




**$\beta$ -D-Galactopyranose**



**$\alpha$ -D-Glucopyranose**



ال anomeric C قاعدة عجنب لحالها, وال O اللي عليها  
مش مرتبطة بمركب آخر, عشان هيك يعتبر reducing

***$\beta$ -1,4 galactosidic linkage***

# Lactose intolerance

- Lactase deficiency: خلل جيني في الإفراز
  - (خلقي) Congenital: due to defect in gene producing enzyme
  - (مكتسب) Acquired: after surgery in GI tract or infections حدوث التهاب في الجهاز الهضمي بعد إجراء عملية, وسبب الالتهاب هو بقاء ال milk products لفترة طويلة في الأمعاء ف بصير إليها تخمر
- Lactose accumulates in small bowel
- Osmotic effect of unabsorbed lactose leads to influx of fluid لما ما ينهضم ويتجه للأمعاء عشان يتم إخراجها والتخلص منه رح يعمل osmotic effect يسحب معه كمية من السوائل من الجسم
- Symptoms: Nausea, colic, distention and diarrhoea after milk intake وبتظهر هاي الأعراض بعد شرب الحليب (لأنه هو مصدره)

### 3. Maltose: سكر الشعير

-It is called malt sugar

-The main product of digestion of starch by amylase. مصدره هضم النشا

*-It is present in 2 forms :*

(**a**- maltose form) = **a**-glucose + **a**-glucose

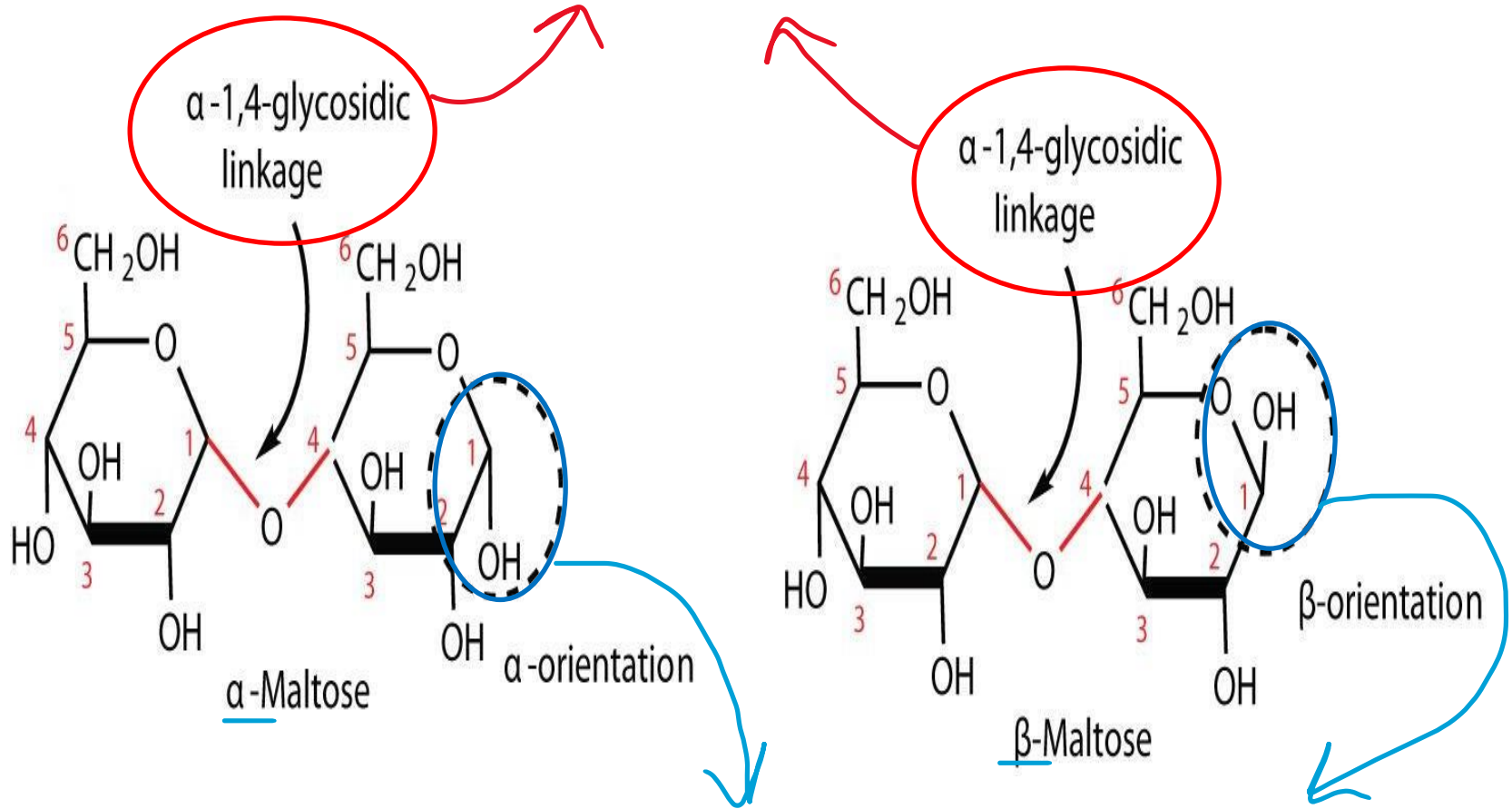
(**B**-maltose form) = **a**-glucose + **B**-glucose

-It is a reducing sugar

**Maltose** gives the sweet taste that you feel if you **masticate** (chew) bread for a long time

لما أترك قطعة خبز ب ثمي لفترة ال salivary amylase رح يبيلش يهضم  
ال starch الموجود بالخبز و يحوله ل maltose و رح أشعر بحلاوة طعمه

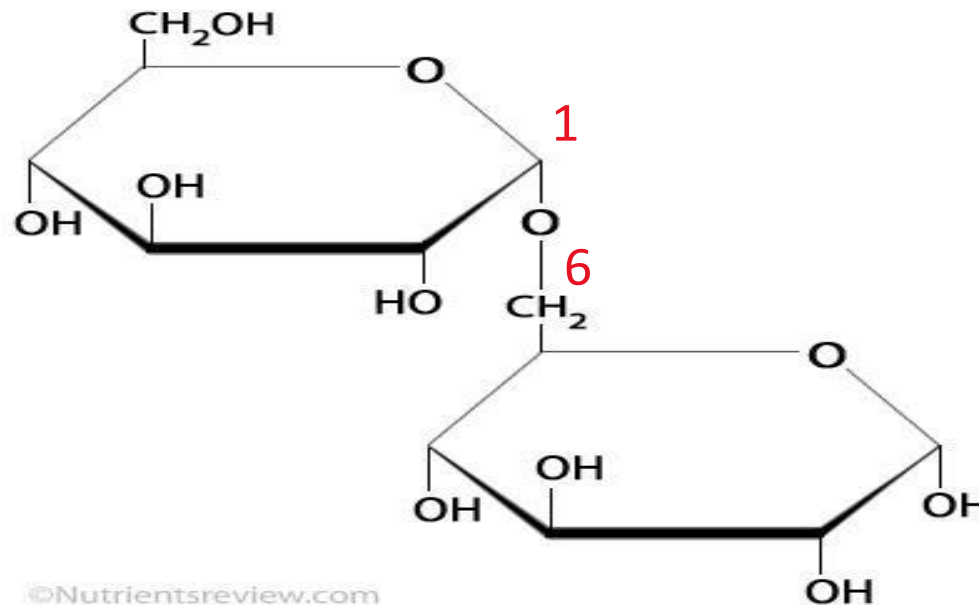
هاي تسمية الرابطة الناشئة بينهم, وبتعتمد على رقم الذرات المرتبطة,  
 بالإضافة لنوعها alpha/beta اذا كان anomeric C



أما لتحديد تسمية المركب فالموضوع معتمد على free O اللي عال anomeric C ,  
 لو كانت alpha فالمركب alpha ولو beta فالمركب beta

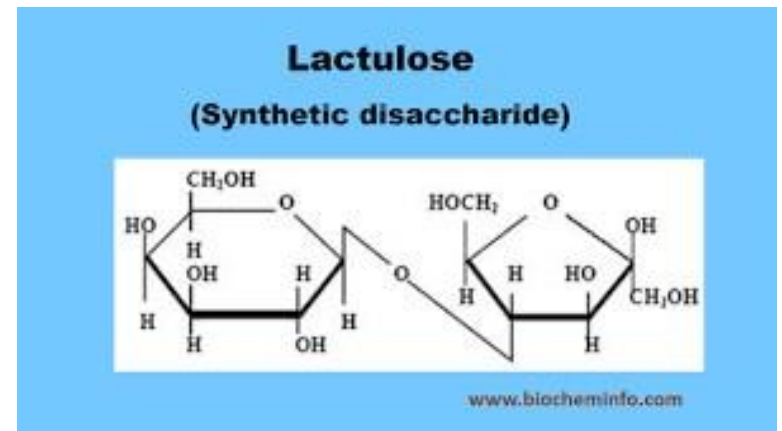
❖ Isomaltose is similar to maltose but the linkage is  $\alpha$ -1,6-glucosidic. It is one of the hydrolysis products of starch and glycogen by amylase.

## Isomaltose



يتم صناعته, يوجد في بعض الأدوية المستخدمة  
في ال GI dis-orders (أمراض الجهاز الهضمي)  
وتستعمل ك tool softener (مُلَيِّن مواد)

## Lactulose



It is a disaccharide composed of galactose and fructose linked through 1-4 - glycosidic bond, linking galactosyl carbon to carbon number 4 of fructose.

is a laxative used in treating constipation and improving ammonia and bacterial product toxic load in liver failure patients (بسحب الأمونيا من الجسم)

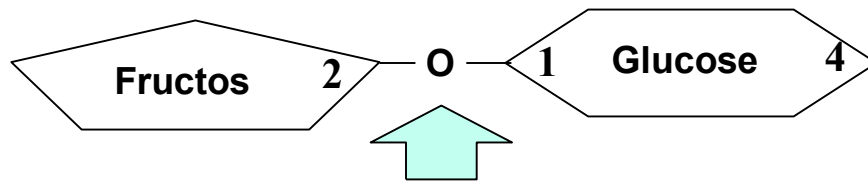
It works by drawing ammonia from the blood into the colon where it is removed from

the body. It is a non-digestible, and therefore non-absorbable

It produces an osmotic effect that retains water in the gut which softens stools

يستخدم عند الإمساك مثلا

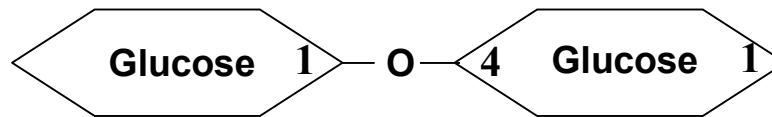
# Molecular Structures of Some Important Sugars: Disaccharides



1- $\alpha$ , 2-glycosidic bond

**Sucrose**  
(table or cane sugar)  
**Non-reducing sugar**

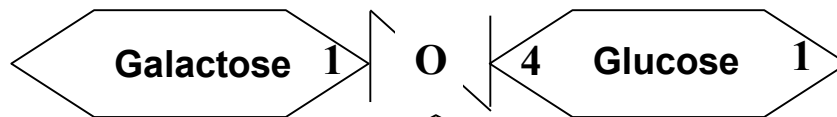
Bond between aldehyde group of glucose on CA No 1 and ketone group of fructose on CA No 2, blocks the two groups and hence sucrose is a non-reducing sugar.



$\alpha$ -1,4-glycosidic bond

**Maltose**  
(malt sugar)  
**Reducing sugar**

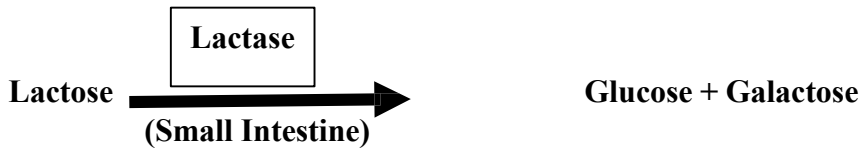
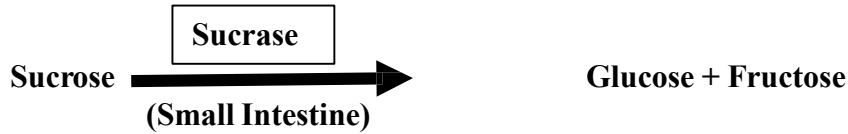
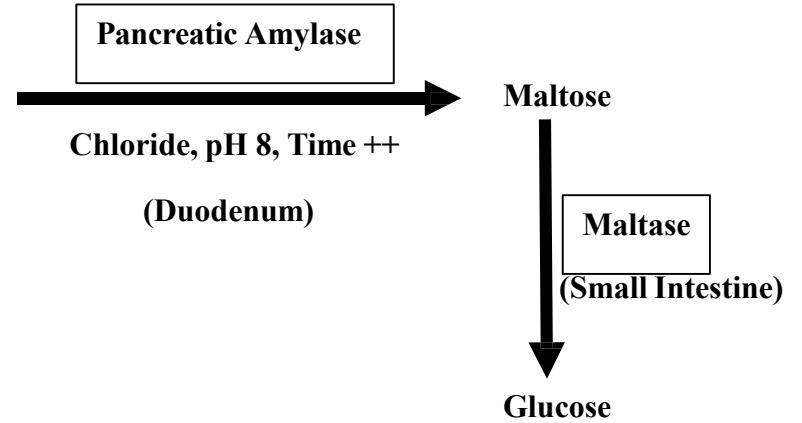
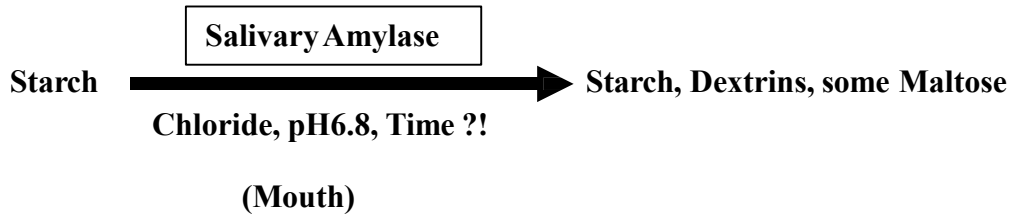
**Free aldehyde group**



$\beta$ -1,4-glycosidic bond

**Lactose**  
(milk sugar)  
**Reducing sugar**

# Digestion of Starch:



N.B: There is no digestion of cellulose in Man as humans lack  $\beta$ -1,4-glucosidase the enzyme needed to digest cellulose



# Oligosaccharides

- 3-10 monosaccharide units
- (غير قابلة للهضم)  
Most are indigestible
- Present in glycolipids/ glycoproteins
- Raffinose: non-reducing trisaccharide (galactose, glucose, fructose), fermented by bacteria, used for their identification

# Polysaccharides

- Polysaccharides are carbohydrates of **high molecular weight**
- 10 or more monosaccharide units **linked by glycosidic bond**
- They are widely distributed in nature
- As condensation involves carbonyl group, they are **non-reducing**

ليش non-reducing مع انه عالطرف ممكن نلاقي free O ؟ لأنه لما تشوف سلسلة طويلة جدا ممكن توصل ل 100 monosaccharide و بس بتحتوي ع free O وحدة ف فعليا ما الها أي تأثير يذكر

- Upon hydrolysis by acid or specific enzyme, monosaccharides **or** its derivatives are produced.

و عند الهضم يتم تكسيرهم ل polysaccharides أصغر حجما , أو ل monosaccharides

- Polysaccharides are classified chemically & functionally as follows:

- 1- Homogeneous polysaccharides: These are polysaccharides which give single type of sugar on hydrolysis as D-glucose units or D- fructose units.

لما أكسرههم رح ينتج عندي مركب واحد فقط, زي لما أكسر ال starch بنتج عنه glucose فقط.  
و مركب واحد بقصد فيها إنه كل ال monosaccharides الناتجة عن التكسير من نوع واحد

- 2-Heterogeneous polysaccharides: These are polysaccharides which give on hydrolysis different type of sugars associated with other substances. e.g. D-Glucosamine, D-glucuronic acid, N-acetyl neuraminic acid. etc.

التكسير بعطي أنواع مختلفة من ال monosaccharides

## \* Different homopolysaccharides of biological importance:

### • 1- Starch:

- It is the storage form of carbohydrates in plants (**never present in animals**)

ممکن نهضمه عادي, بس لا يمكن يتم تخزينه في الجسم

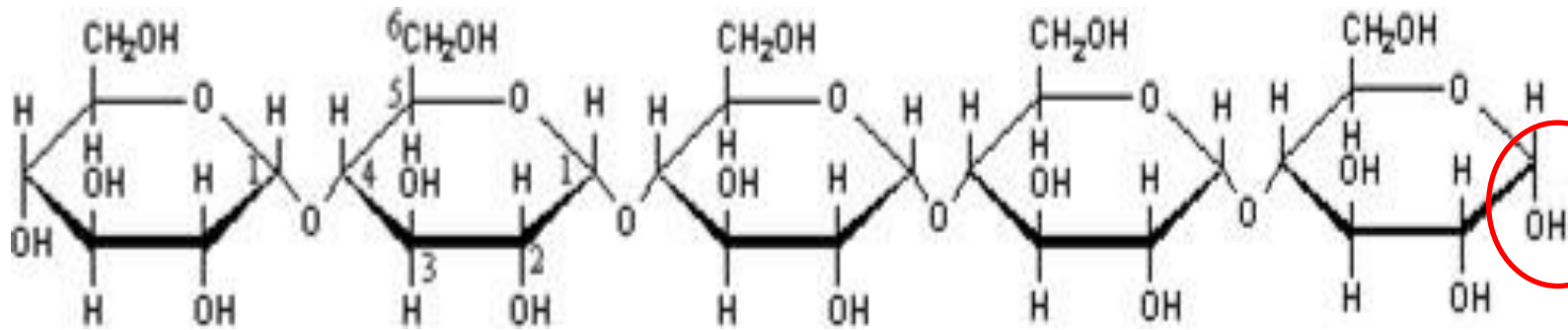
- On hydrolysis, **it gives only glucose** and so it is called **glucosans**.

- It consists of two types of molecules, **amylose** ↘  
and **amylopectin**

\*\*بختلف عن ال amylase, هضاك انزيم

\*\* (أي اشي بنتهي بالمقطع ase فهو انزيم)

## Structure of amylose:



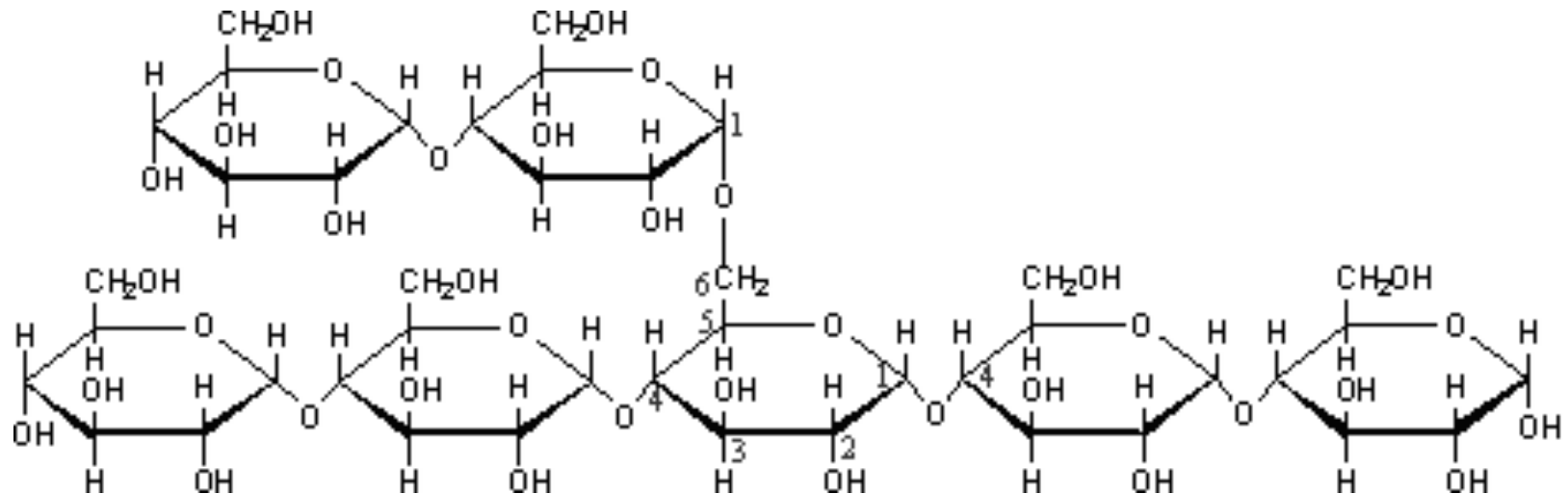
Long, **non-branched** chain of 300-400 (up to 1000) **a glucose units** linked together by  $\alpha$ -1,4 glucosidic bond.

صح إنه في بنهايته free O, بس جاية بعد سلسلة مكونة من 300 unit, و زي ما قلنا سابقا ما إلها أي تأثير

Forms 15-20% of the starch granules.

It is found in the **inner** part of the molecule

# Structure of amylopectin



Branched chain of a glucose units linked together by  $\alpha$ -1,4 glucosidic bond while at the branching point, it forms  $\alpha$ -1,6 glucosidic bond

Forms 80-85% of the starch granules.

It is found in the **outer** part of the starch molecule

- **Hydrolysis of starch occurs either by:**

- Dilute mineral acids and called acid hydrolysis which results in **complete hydrolysis** to a glucose units .

- Enzymes as **a-amylase** (salivary & pancreatic) which results in **partial hydrolysis** producing smaller molecules called dextrins and maltose.

(الجزئي/غير الكامل)

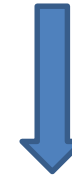
ال incomplete ممكن يعطي glucose و dextrin و maltose

Salivary amylase



Incomplete digestion of starch  
(Dextrin mainly)

Pancreatic amylase



Complete digestion  
(Maltose)

- The products of starch hydrolysis occur according to the following sequence:
- Starch ( Amylodextrin (the earliest dextrin produced; blue with iodine) ( Erythrodextrin (red) ( Achrodextrin (no colour) ( Isomaltose & Maltose ( Glucose.

أكثر من enzyme بلعبوا دور في تكسير starch, ال salivary amylase بعطي dextrans ,  
و ال duodenum بال intestines عن طريق ال pancreatic amylase  
بعدين ultimate(complete) hydrolysis عن طريق ال maltase ل glucose

- Dextrins are a group of low-molecular-weight polysaccharides produced by the hydrolysis of starch or glycogen
- Question: which is produced more, isomaltose or maltose?

ال maltose بتواجد بنسبة أكبر لأنه أصلا ناتج عن تكسر  
رابطة  $\alpha$ -1,4 الموجودة بكثرة جدا على طول السلسلة

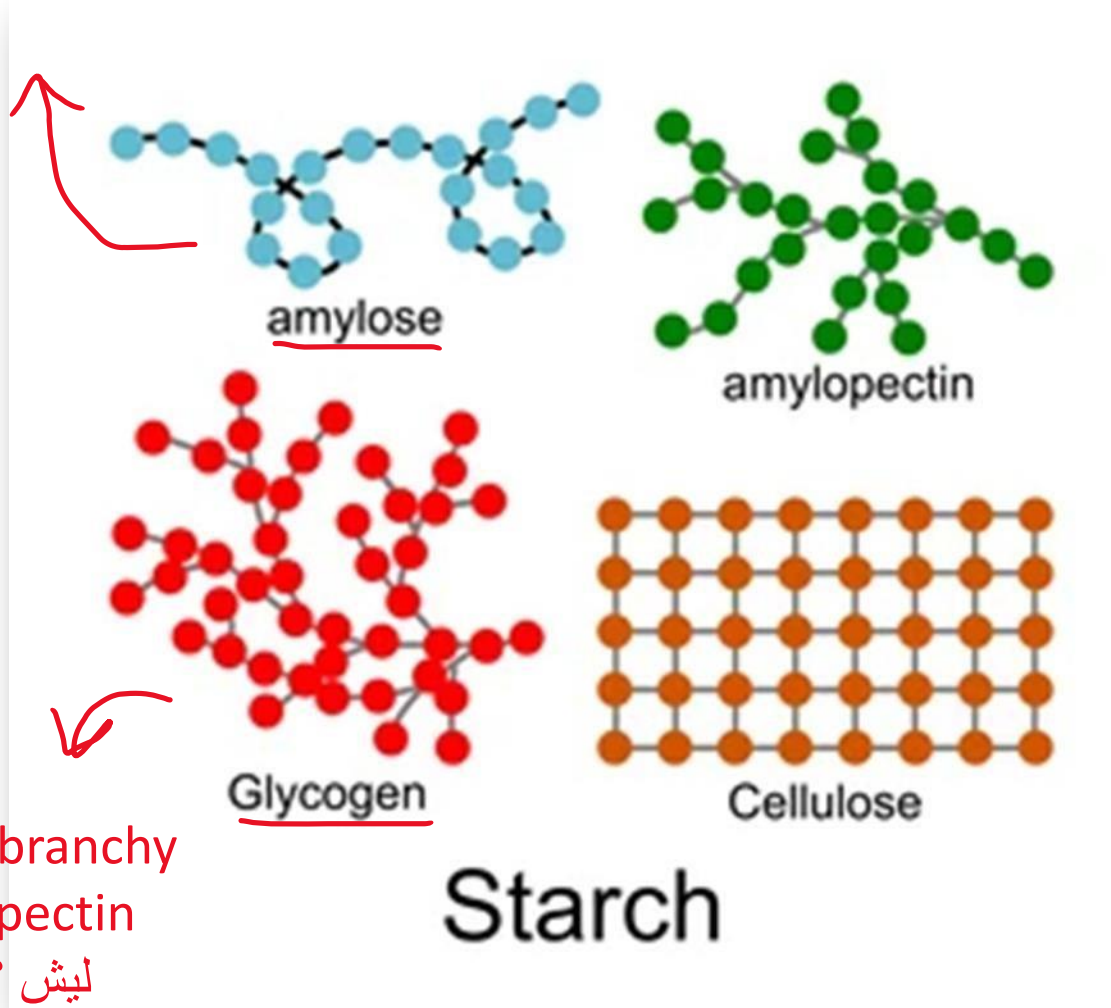
- (N.B.): The difference between maltose and isomaltose in the bond position as it is  $\alpha$ -1, 4 in maltose but  $\alpha$ -1, 6 in isomaltose (i.e. at the point of branching of starch).
- It is to be noted that hydrolysis of starch by boiling with dilute acids ends in the formation of glucose.



## 2- Glycogen (animal starch):

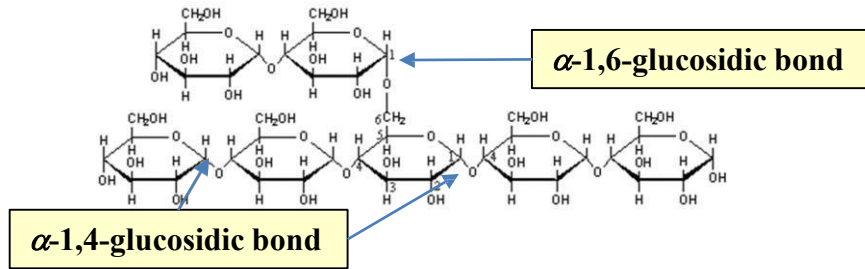
- It is the reserve carbohydrate of animals, and hence the name animal starch
- It is similar in its structure to amylopectin
- It is highly branched formed of a 1, 4 link and 1, 6 at the site of branching.
- Each branch is made of 12-14 glucose units.  
(It has shorter and more numerous chains)
- Inner chains are branched, outer chains are not
- It is stored in liver & muscle.

كان يُعتقد سابقا إنه خالي من الbranches تماما,  
لكن حديثا اكتشفوا وجود branches بسيطة جدا جدا

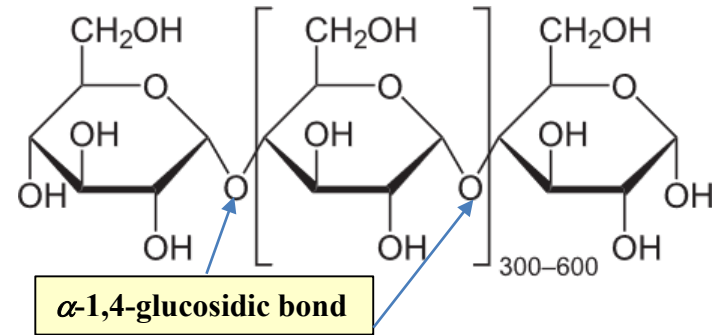


It looks more branchy  
than amylopectin  
ليش؟ لأنه أقصر  
والunits حجمها أصغر

## Starch (amylopectin form)



## Starch (amylose form)



Glycogen in animals is a more branched version of amylopectin.

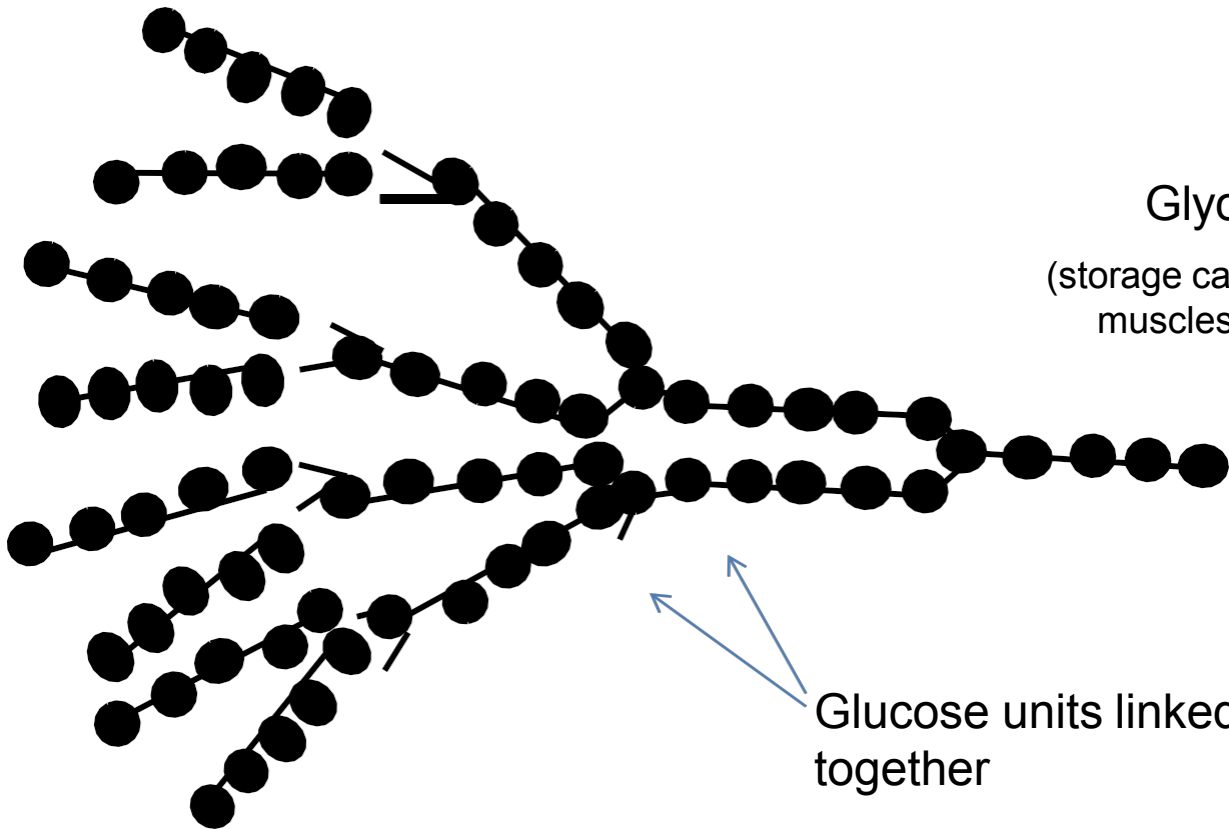
Amylose was traditionally thought to be completely unbranched, but it is now known that some of its molecules contain a few branch points.

Although only about one quarter of the starch granules in plants consists of amylose, there are about 150 times more amylose molecules than amylopectin molecules because they have smaller masses.

بالرغم إنه نسبة ال amylose في ال starch أقل لكن عدد جزيئاته أكبر بسبب حجمها الصغير جدا

Starch is digested briefly by salivary amylase in the mouth but is mainly digested in the duodenum and jejunum by pancreatic

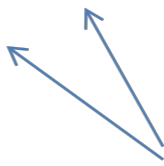
amylase in alkaline medium in the presence of chloride ions to gradually break into dextrans and finally produces maltose.



# Glycogen

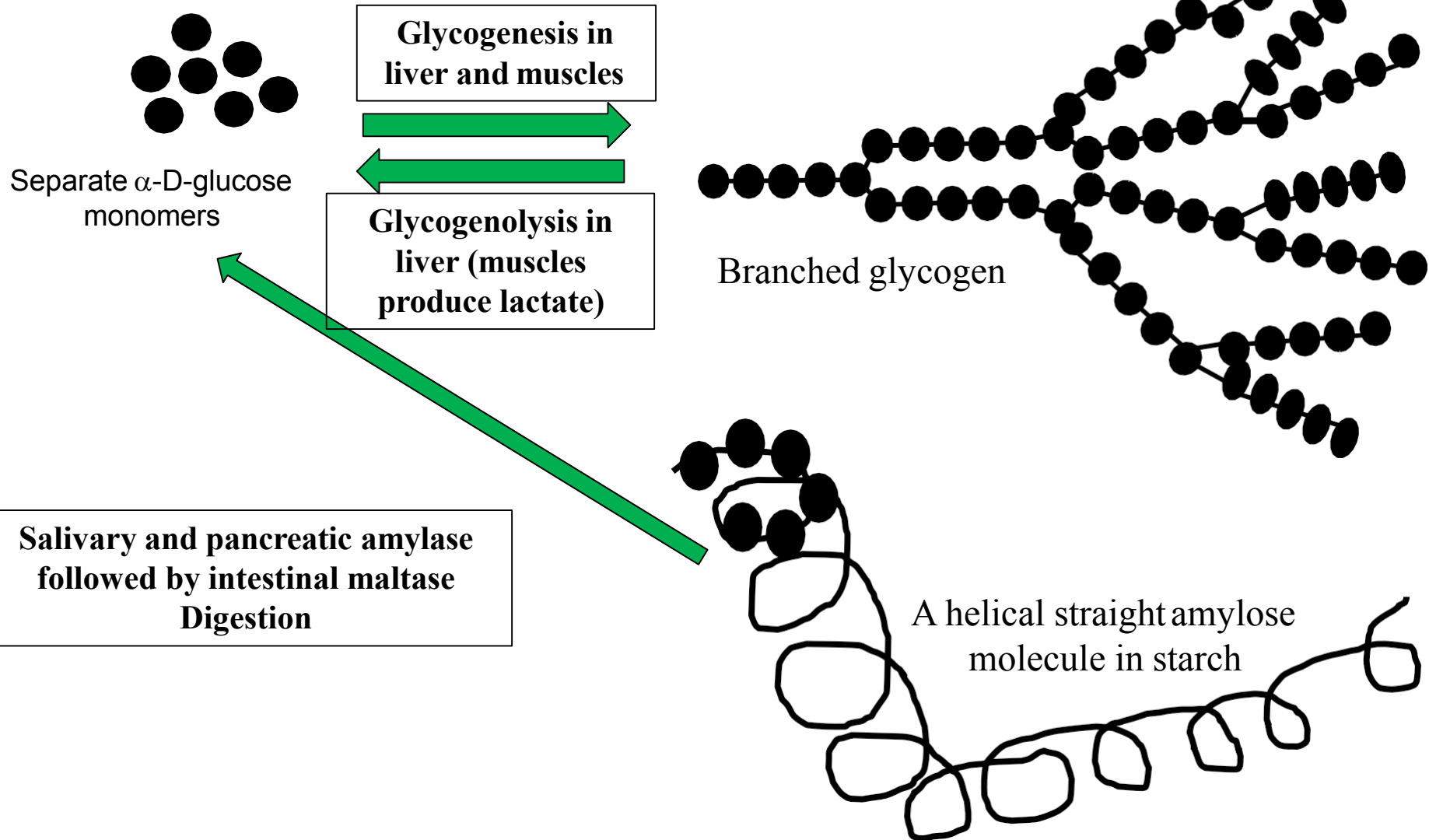
(storage carbohydrate in muscles and liver)

Glucose units linked together



The Homo-polysaccharides glycogen (in animals) and starch (in plants) are made of repeated  $\alpha$ -D glucose residues linked by  $\alpha$ -1,4-glucosidic bonds except at branch points where  $\alpha$ -1,6-glucosidic bonds are found.

الهدف من هضمهم الحصول على الـ glucose



# AMYLOPECTIN

VERSUS

# GLYCOGEN

Amylopectin is a branched-chain polysaccharide, which is found in plants

Glycogen is the storage polysaccharide of animals and fungi

Storage polysaccharide in plants

Storage polysaccharide in animals

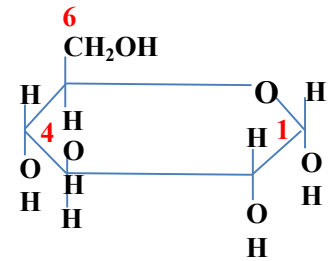
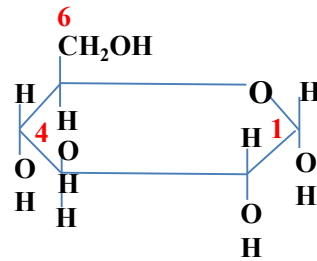
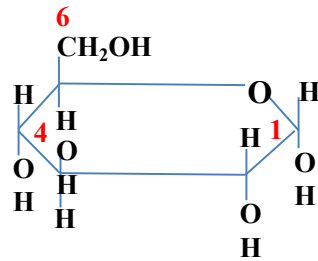
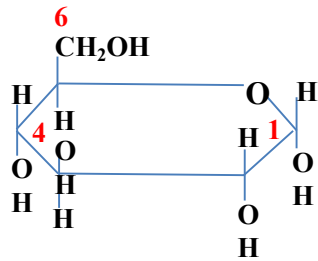
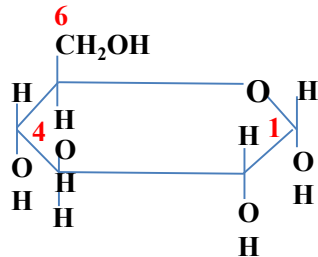
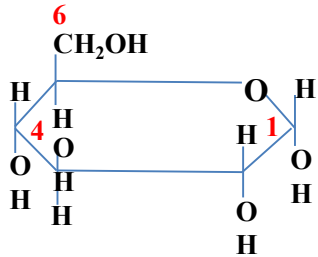
A branched polymer

Highly branched when compared to amylopectin

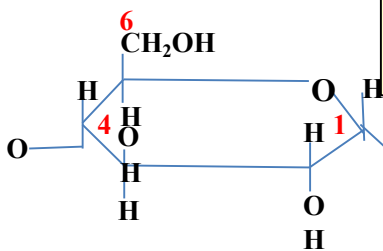
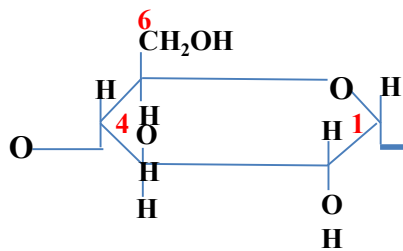
Can be broken down by amylase

Hydrolyzed when it is dissolved in water

# Basic Structure for Glycogen and Starch (Amylopectin)

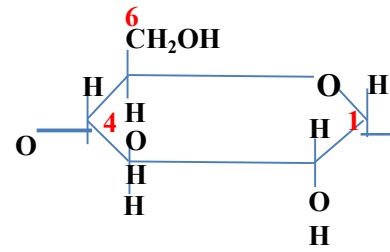
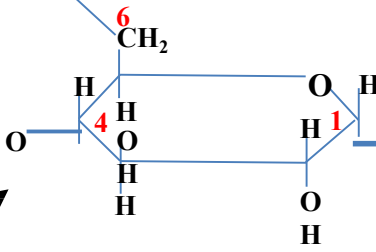
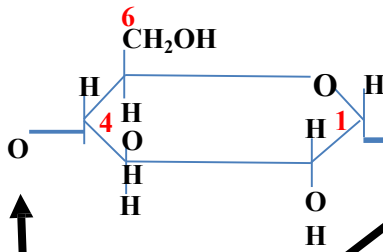
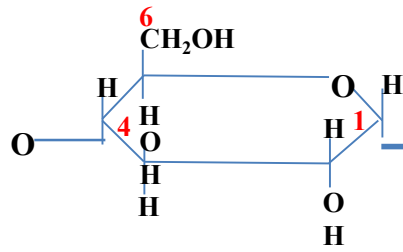


6  $\alpha$ -D-glucopyranose molecules



$\alpha$ -1,6-glucosidic bond

How the same six molecules link in a glycogen molecule



$\alpha$ -1,4-glucosidic bond

# Functions of glycogen :

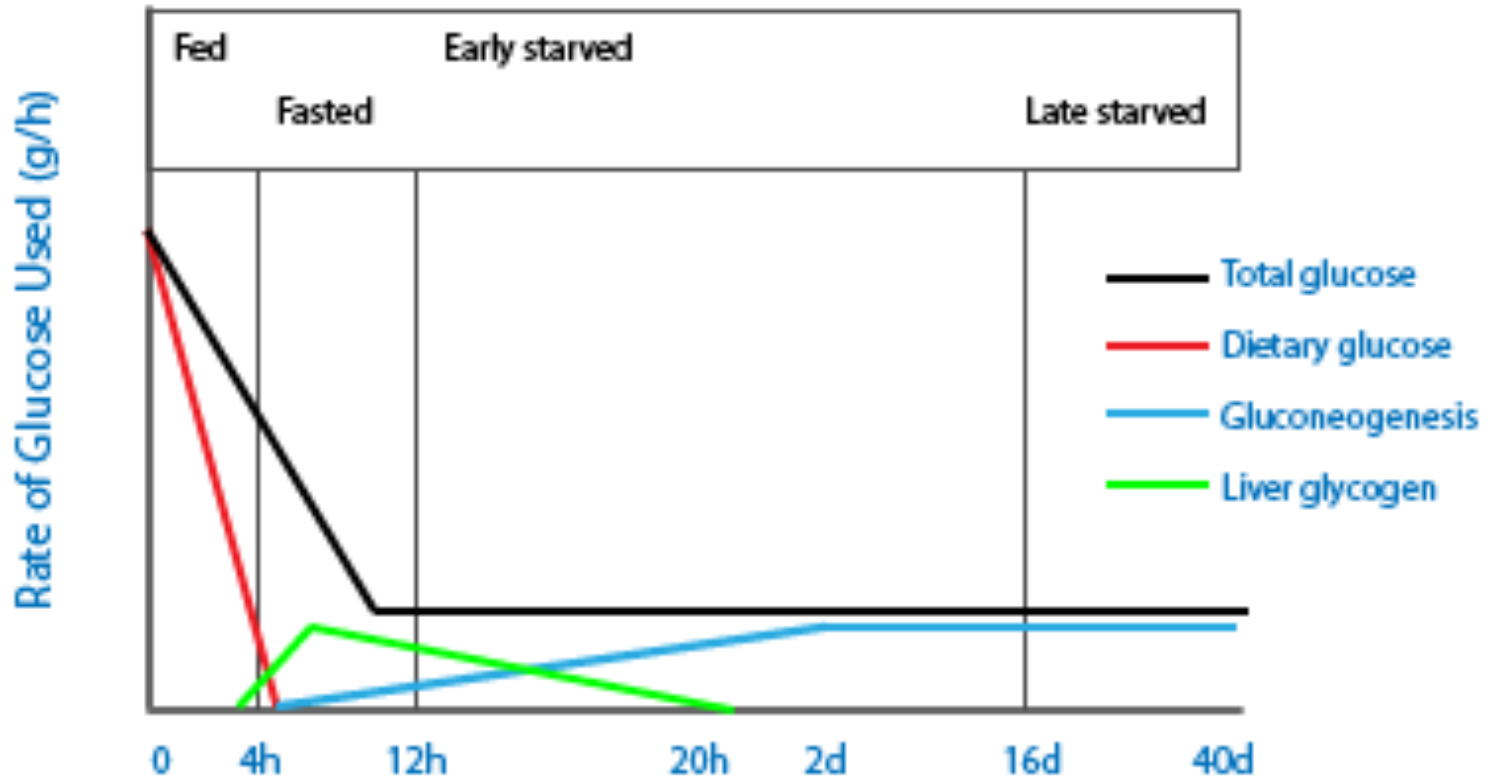
- Liver glycogen maintains normal blood glucose concentration especially during the early stage of fasting (between meals)

- After 12 -18 hours fasting, liver glycogen is depleted

الglycogen يحافظ على مستوى السكر في الدم في أول ساعات الصيام.. وبعد ما ينتهي الglycogen  
يتم استئناف عملية المحافظة على الglucose بطرق أخرى مثل الgluconeogenesis

- Muscle glycogen acts as a source of energy within the muscle itself especially during muscle contraction.





بعد ما يبيلش الصيام بتبيلش نسبة ال glucose اللي تم الحصول عليها من الغذاء بالإنخفاض,  
 ف يبيلش ال glycogen الموجود في ال liver شغله بالتعويض بس بعدين المخزون هاض رح يخلص,  
 ف بتبدأ ال gluconeogenesis بالتعويض,  
 للمحافظة على ثبات نسبة ال glucose

\*كل لون يمثل مرحلة

### 3- Cellulose:

- It is long unbranched polysaccharide of  $\beta$ -glucose units linked together by  $\beta$  1,4glucosidic bond
  - It is the main structural molecules in cell walls of plants. Cotton is almost pure cellulose
  - Many mammals including humans cannot digest cellulose of diet because of the absence of digestive enzyme that attacks  $\beta$ -linkage.
- (  $\beta$  1,4 linkages are not hydrolized by a amylase )

- The presence of cellulose in diet is important because it **increases the bulk of stool** (البراز)  
(Increase stool thickness)

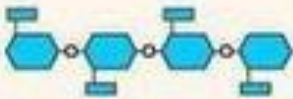
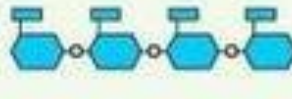
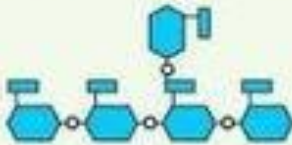
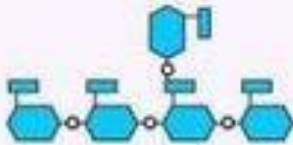




- This stimulate intestinal peristalses & prevent constipation (laxative)  
بحفز حركة الأمعاء وبالتالي ال stool رح يقعد فترة أقل فيها, وبالتالي كمية المواد السامة ومسببات الأمراض اللي كان ممكن يتم إعادة امتصاصها رح يتم التخلص منها أسرع

- Cellulose is a constituent of dietary fibers. These fibers help in decreasing absorption of toxic compounds and reduce the incidence of cancer colon  
صح إنه ما بنقدر نهضمه , بس فائدته كبيرة جدا , حيث يعتبر مُلَيّن يمنع حدوث الإمساك , بالإضافة لأنه بمتص المركبات السامة ومسببات السرطان

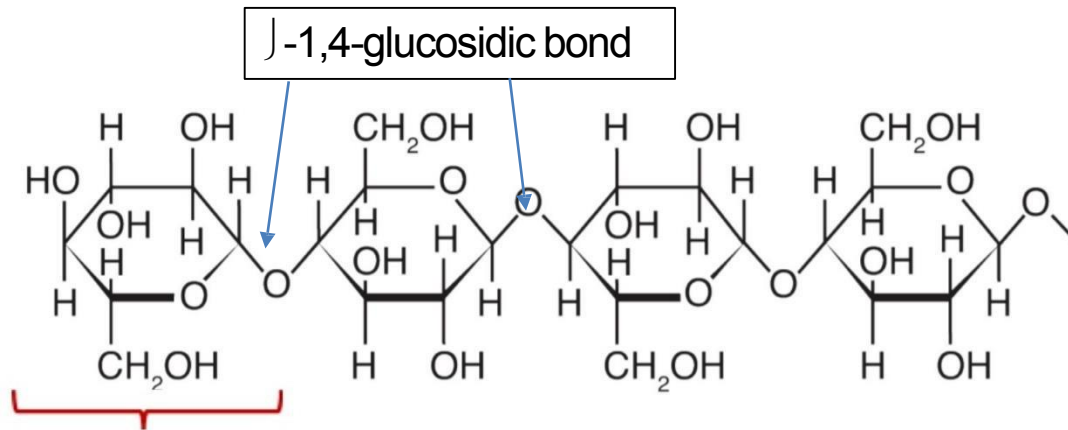
- Cellulose can be utilized & serve as a source of energy in herbivores because their gut contains bacterial enzyme that can attack  $\beta$ -linkage.

أما بالنسبة للحيوانات (آكله الأعشاب) فهو مهم جدا إلها , عشان هييك معظم غذائها من الحشائش والنباتات , وعندها القدرة على هضمه

الإختلاف الجوهرى الوحيد بينهم هو عدد ال units

	Cellulose	Starch		Glycogen
		Amylose	Amylopectin	
Source	Plant	Plant	Plant	Animal
Subunit	$\beta$ -glucose	$\alpha$ -glucose	$\alpha$ -glucose	$\alpha$ -glucose
Bonds	1-4	1-4	1-4 and 1-6	1-4 and 1-6
Branches	No	No	Yes (~per 20 subunits)	Yes (~per 10 subunits)
Diagram				
Shape				

**Cellulose Structural Units:** the units for cellulose are made of  $\beta$ -D-Glucopyranose molecules linked by  $\beta$ -1,4-glucosidic bonds.



Glucose

Cellulose is a scaffolding polysaccharide found in plants as microfibrils (2-20 nm diameter and 100 - 40 000 nm long)

These form the structurally strong framework in the cell walls

بالرغم من انه unbranched

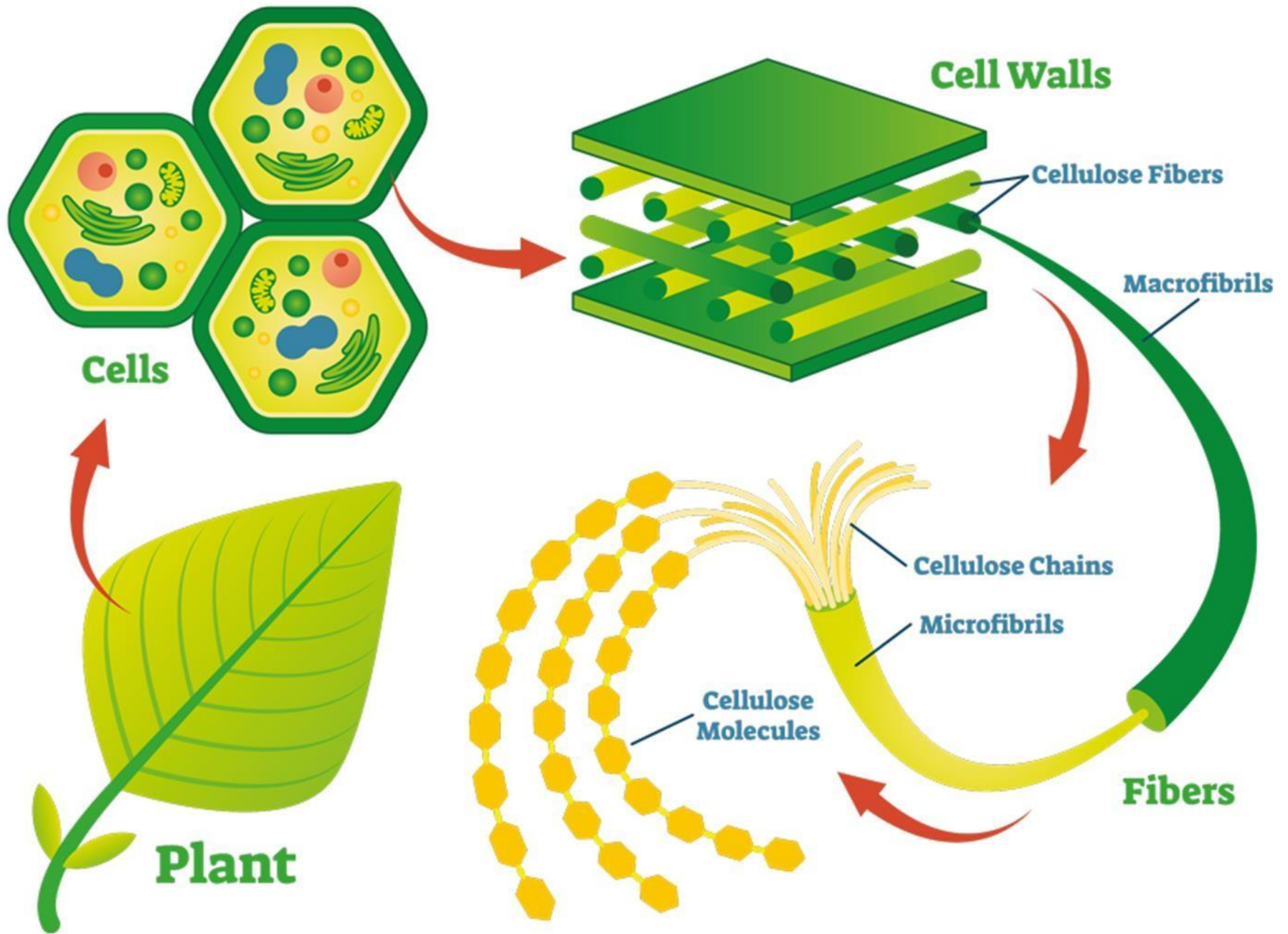
الا انه متماسك وقوي جدا وهذا

بسبب طبيعة الروابط بين الجزيئات وترتيبهم

Due to extensive inter-chain and intra-chain hydrogen bonding cellulose **is not water soluble**

It is a straight chain polymer: unlike starch, no coiling or branching occurs, and the molecule adopts an

extended stiff rod-like conformation. with high tensile strength.



Disaccharides.

Disaccharides \*

عند قابلية أو OH إما  
عينا اعداد وبالتالي q or p

لثابتين  
2 molecules of  
monosaccharides

صركيا بوجناين

glycosidic bond

دائما بتسند  
anomeric carbon

تكون  
one sugar

وال sugar  
التالي

تكون

بالا باله بال a.c. تكون  
glycosidic bond

ليس a.c. 2

لا sugar unit 2

التالي يكون glycosidic linkage

تكون مع غير ال a.c.

مثل المستور

وبالتالي مانع

reactive group

تكون ال disaccharides

بكون منه وحدة a.c.

free

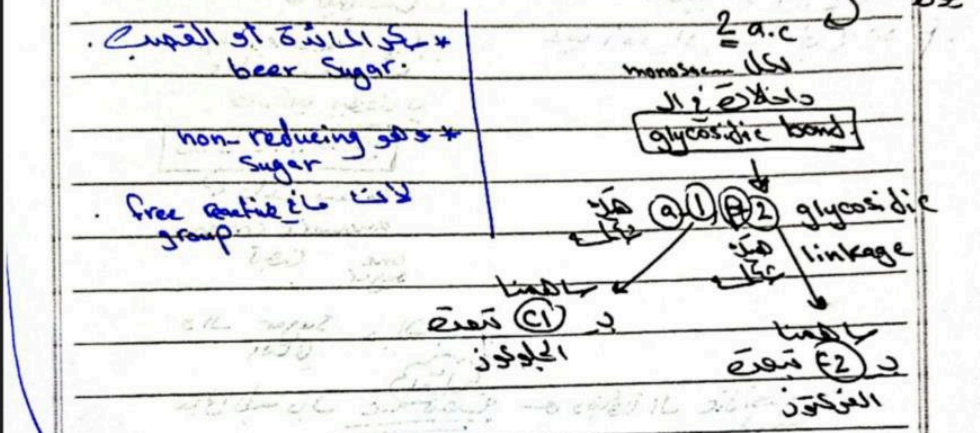
free reactive group

وبالتالي مانع

تكون له قوة اختزالية  
هذا ال كر يكون

وبالنهاية هضول كم  
سلايد فيهم شرح  
بخط اليد لبعض  
المواضيع في  
المحاضرة

في الأمتية dextrorotatory و مقادير  
 الـ  $\alpha = 66.5^\circ$  أما لو عكسنا  
 في hydrolysis عن طريق الإنزيم (sucrose)  
 في D-glucose و D-fructose بمقادير  
 $\alpha = 52.5^\circ$   
 في الأمتية dextrorotatory و مقادير  
 الـ  $\alpha = 66.5^\circ$  أما لو عكسنا  
 في hydrolysis عن طريق الإنزيم (sucrose)  
 في D-glucose و D-fructose بمقادير  
 $\alpha = 52.5^\circ$



\* سكر المائدة أو القصب  
 beer Sugar  
 \* وهو non-reducing sugar  
 لانت ماع active group

في الأمتية dextrorotatory و مقادير  
 الـ  $\alpha = 66.5^\circ$  أما لو عكسنا  
 في hydrolysis عن طريق الإنزيم (sucrose)  
 في D-glucose و D-fructose بمقادير  
 $\alpha = 52.5^\circ$

laboratory  
 $\alpha = 92^\circ$  و هي  
 تجبر وبالتالي يجعله  
 المستورن بعد التحلل hydrolysis  
 لانت  $\alpha < 92^\circ$

فتحولت من  
 dextro → levo  
 في الأمتية  
 في الأمتية

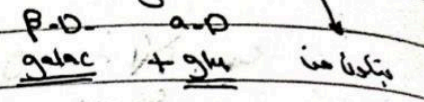


لفظ ال glycosidic linkage ← يتكون من واحد

Reducing Sugar

منه السكرين  
منه السكرين  
منه السكرين  
منه السكرين

لاكتوز ← milk sugar



\* من حلوكين  
\* ما كمل له تخثر بجلا  
\* يوجد في *intestin* وبالتالي  
ما بعد نفاذ

\* *Lactase* enzyme  
\* تهيئهم خلاصا نوع احمه

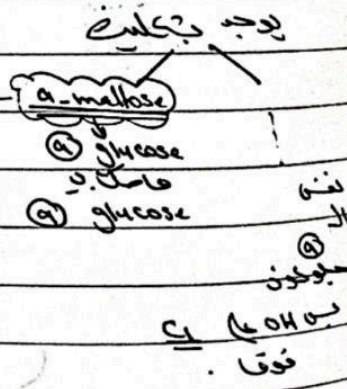
في خلاص مثلا ما كمل  
milk product

بتحس لعدم دلة لانته يكون  
عندهم نفعها في هاد الانزيم

وبالتالي ما يتحلوا ويقعد فترة  
قوتية في *intestine* ويجذب  
له تفر

مالتوز ← maltose  
malt sugar

Starch  
Storage form  
للجلوكوز في  
في النبات



Free C1  
وبالتالي  
فيه اخص اللي

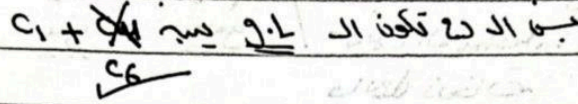
في  
في  
في  
فوق

وهو يعتبر من السكريات

Starch و glycogen  
product hydrolysis تبعه ال

Isomaltose

المشبه ال maltose



Poly Saccharides

لغني متعددة



لها تحللها كيميائية  
acid hydrolysis

أحادي أو ثنائي  
mono saccharides

amino sugar  
amino sugar acid

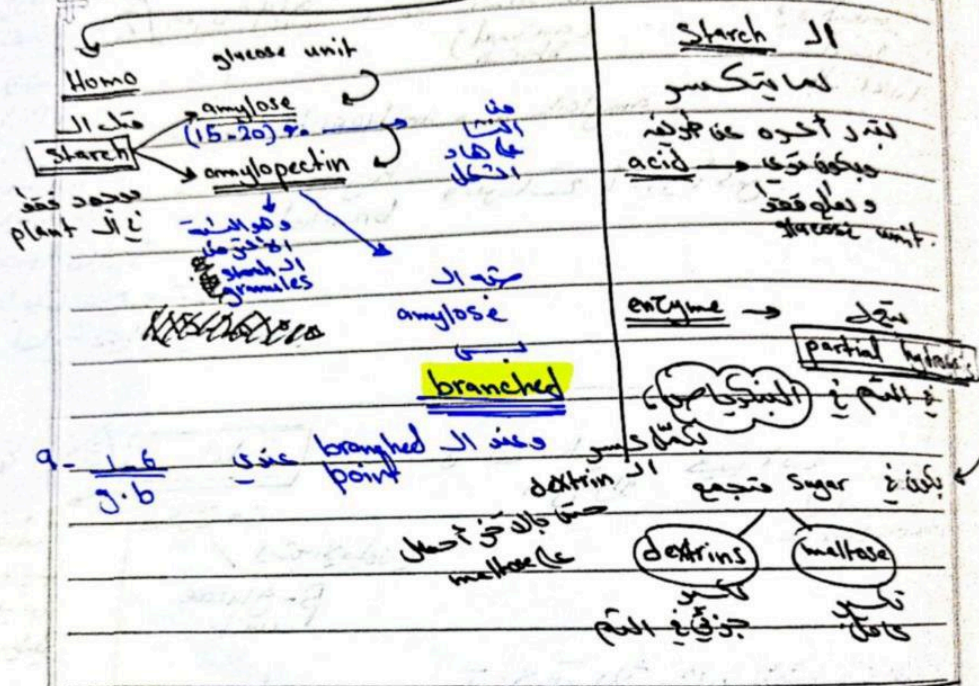
Homo --

تجانس لغني أو كبريتها  
يتضمن نوع واحد فقط sugar  
(مثلًا جلوكوز مثلاً)  
أو سكر و سكر

Hetero --

عكس العنق

لا يشمل متانوع واحد من السكر  
مثلاً جلوكوز أو ثنائي و مثلاً



9-  $\frac{1.6}{0.6}$

\*note: starch (مادة ال) is broken down by dilute acid (محلول حمضي مخفف)

then by hydrolysis (ثم بالتحلل المائي) and yields simple sugars (فإنه ينتج للسكريات البسيطة)

liver muscle

[70-110]

متخزن في الكبد والعضلات  
Liver muscle  
تخزن في الكبد والعضلات  
تخزن في الكبد والعضلات

hypoglycemia  
دوخة  
عرق  
تشنج

glycogen  
Starch (animal starch)  
حب الـ starch

الكبد liver

amylase  
amylpectin  
حب الـ amylpectin

highly branched  
شعبات كثيرة  
شعبات كثيرة

المuscle contraction  
تقلص العضلات

glycolysis  
تحليل السكر

amilon  
Starch glycogen  
حب الـ starch glycogen

branched  
poly sacch

$\beta$ -glucose unit

أغذية الأشجار لأنها غيرهم  
الإقليم التي يهبطت يتغيره من وجود  
الكلية

مما زاد ما يقدر أهفه  
تتغير أنه الإميلون يهبط لأنه

عدي (a-amylase) له أنا ما عدي

والتالي هو فايته؟ يكون الـ starch غليو ويجعل عاصية  
الأعضاء وبالتالي هو مليت وقله إراك  
Cancer colon  
الـ cancer colon

لأنه ما يتغذي  
الـ starch لفترة  
قوية بالأعضاء  
دواء سامة تسبب  
السرطان

ARARA

###