Important Doctors slides

Extra Information **Doctors notes**

Biochemistry

Role of Salivary Glands and Stomach in Digestion

Don't watch the clock .
Do what it does
"KEEP GOING"

تمت المراجعة
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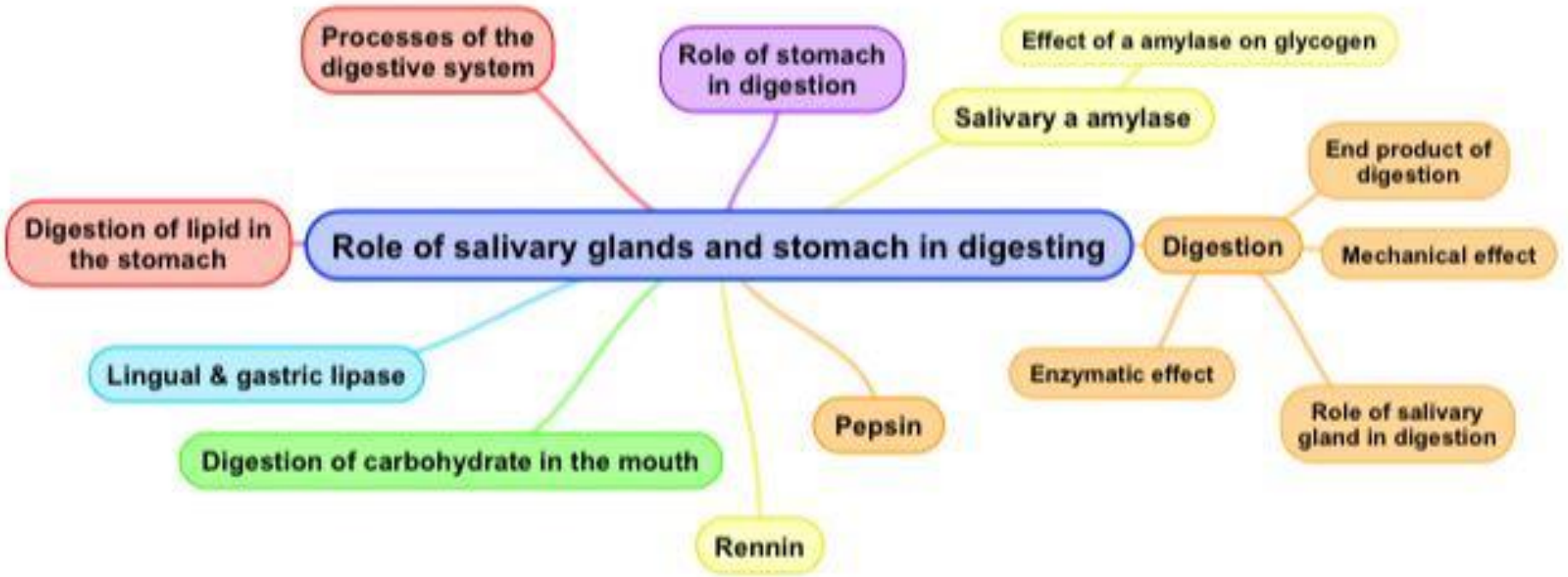
Editing file

OBJECTIVES

By the end of this lecture, the students should be able to know:

- Understand the principle and importance of digestion of dietary foodstuffs
- Understand the role of salivary glands indigestion
- Understand the role of stomach indigestion

Key Principles:

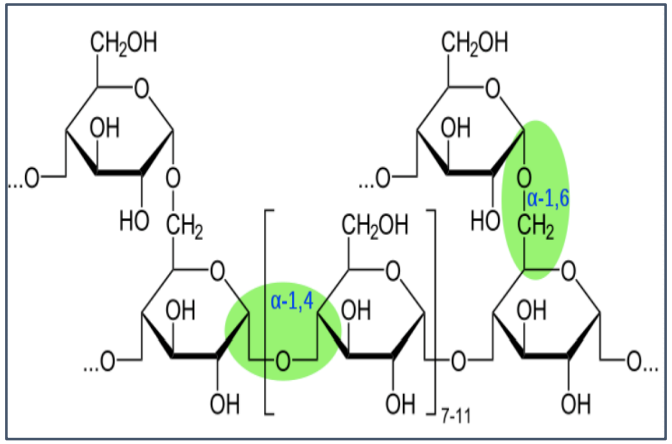


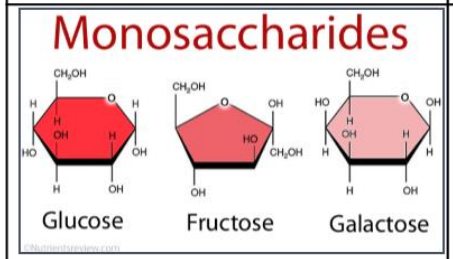
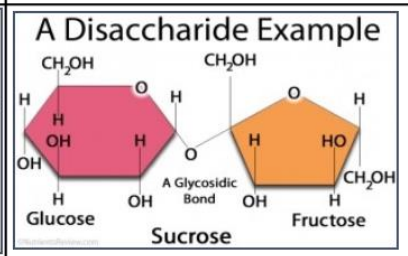
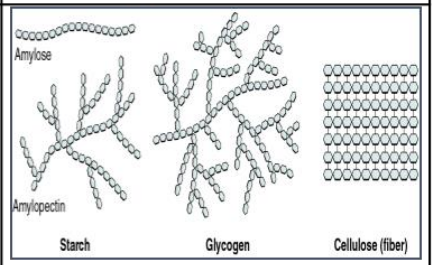
Background

The lecture talks about 2 aspects:
Role of salivary glands and stomach in digestion.

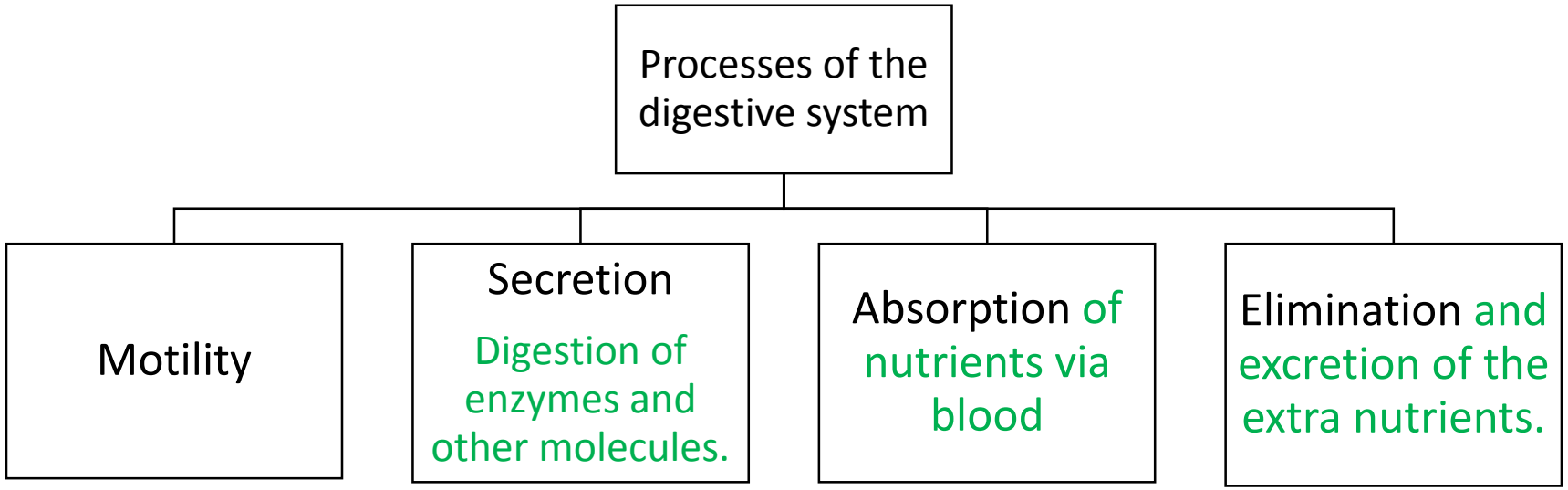
- ✓ Most of dietary foodstuffs are ingested (ابتلاع)in the form that cannot be readily absorbed from the digestive tract.

- ✓ **Digestion:** The breakdown of the naturally occurring foodstuffs (complex) such as fat ,glucose ,protein and carbohydrates into smaller, easily absorbable forms.
- ✓ Major form of fat that we take is “triacylglycerol”

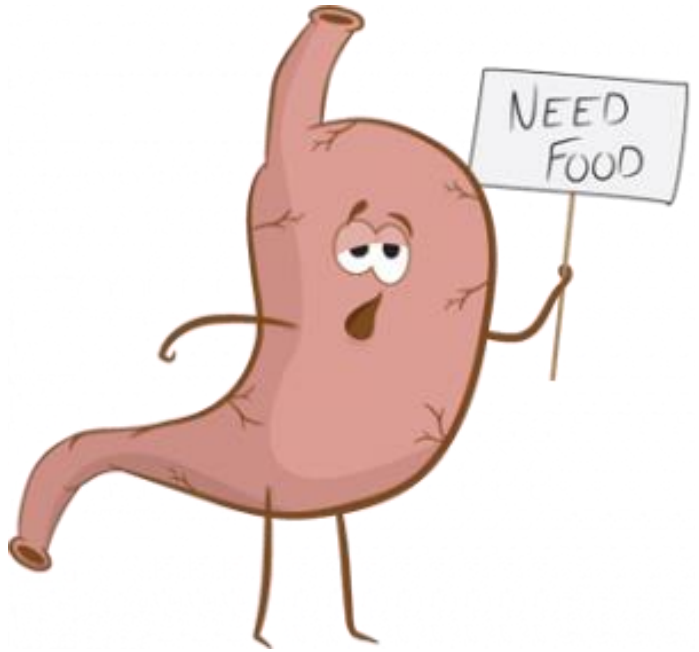


Carbohydrates		
Monosaccharides	**Disaccharides**	**Polysaccharides**
		
-Glucose (major) -Fructose -Galactose	-Sucrose = glucose + fructose -Lactose from milk = glucose + galactose -Maltose	-Glycogen (Animal Source) -Cellulose (Plant source) -Starch

Processes of The Digestive System:

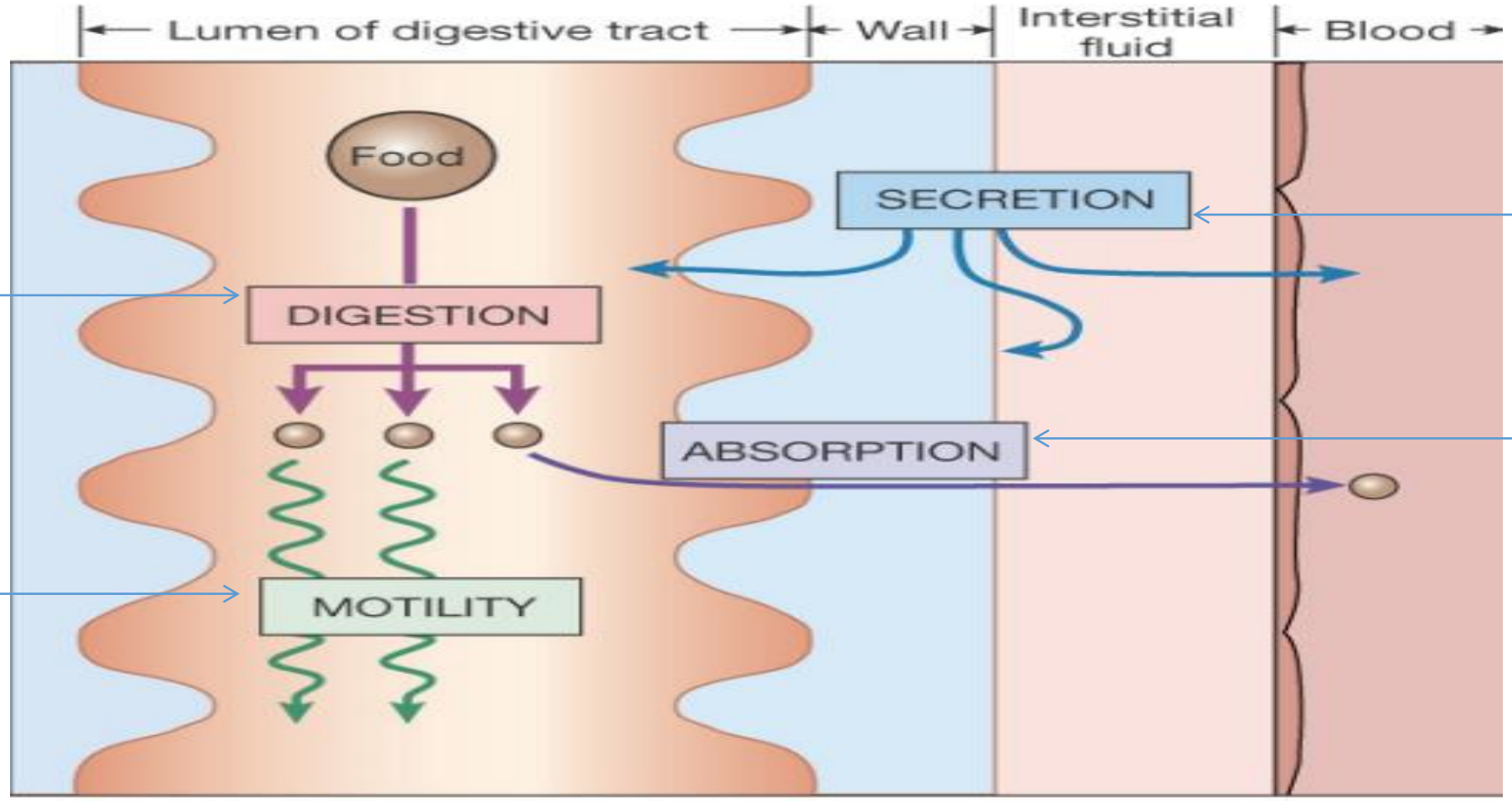


Food has to pass through the digestive tract completely starting from the esophagus to stomach then small intestine then it will be eliminated at the end.
The wall of the lumen contains epithelial lining that is involved in secretion of enzymes and other molecules.
After that it will go to the interstitial fluid and blood which is the ultimate absorber of the nutrients.



Processes of The Digestive System:

مجرد صورة توضيحية للكلام السابق ☺



Breaking down of complex molecules into simple.

Facilitates the movement of food

افراز الانزيمات التي تساعد على الهضم والامتصاص

الامتصاص يتم في الدم والانترستيشيال فلويد

Remember!

Secretion: *release of a substance through normal body functions.*

Excretion: *expelling waste products from the body via biological functions.*

Absorption: assimilating substances into cells or across the tissues and organs through diffusion or osmosis.

Processes of The Digestive System

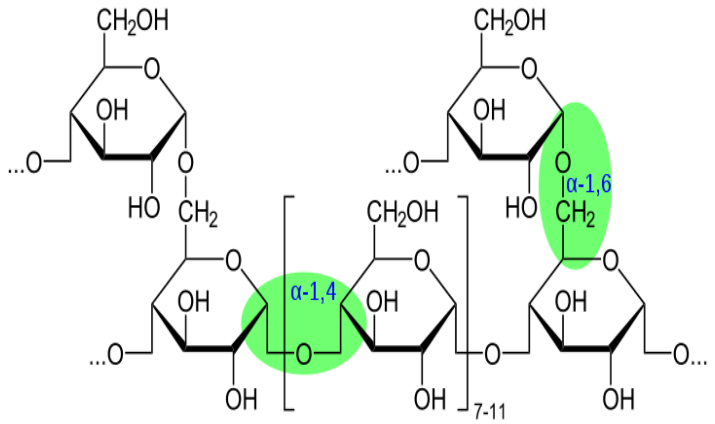
Digestion:	***- Mechanical Effect:*** E.g. Mastication (Chewing) Food should be physically broken down first, and then the enzymes and digestive juices will easily reach the food and will digest it faster due to increase surface area of the food .
	- Enzymatic Effect: Digestive enzymes (hydrolases) digestion enzymes for fat, carbohydrates and protein but not all of them will be digested at the same time .
End Products of Digestion:	**Carbohydrates** broken down into → Monosaccharides
	Triacylglycerol (3 fatty acids) **(TAG)** → Fatty acids (2 molecules) and monoacylglycerols (1 molecule)
	Proteins → Amino Acids.

Processes of The Digestive System

Role of Salivary Glands in Digestion:	They secrete saliva. Saliva is composed of: enzymes, mucus, water and electrolytes. Saliva - Acts as lubricant it reduces the friction of dry food which may damage the mucosal lining of the esophagus (protection) - Contains salivary α-amylase digestion Enzyme , We have 3 sources of alpha amylase: 1-Stomach 2-Pancrease 3-Salivary glands. (acts on CHO) - Contains lingual lipase. It is present in the saliva but it Starts acting when it reaches the stomach (acts on lipids). So, no lipid digestion in the mouth as well the protein . Only CHO starts the digestion in the mouth

1-Salivary alpha-amylase

A-Salivary alpha-Amylase in Monosaccharide and disaccharide:	
Secreted by:	Parotid glands
Optimum pH:	6.6 – 6.8 Every enzyme has an optimum pH where is the maximum activity of the enzyme present - Salivary amylase is inactivated by the acidity of stomach (The enzyme is inactivated at pH 4.0 or less). - مثل ما ذكرنا يوجد اكثرمن مصدر للانزيم لذلك بمجرد ما يتوقف عن العمل بسبب حموضة الستوميك يبدأ يشتغل الانزيم الاخر الذي في الستوميك - Its digestive action on the polysaccharides is of little significance because of the short time during which the enzyme can act on the food in the mouth
Substrate:	Starch and glycogen

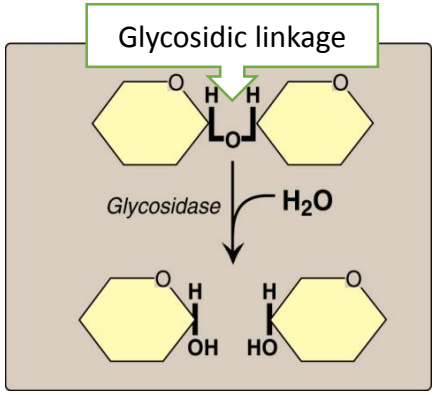


Starch and glycogen are polymers of glucose
And they contain alpha 1-4 linkage , when we break it down we will have maltose

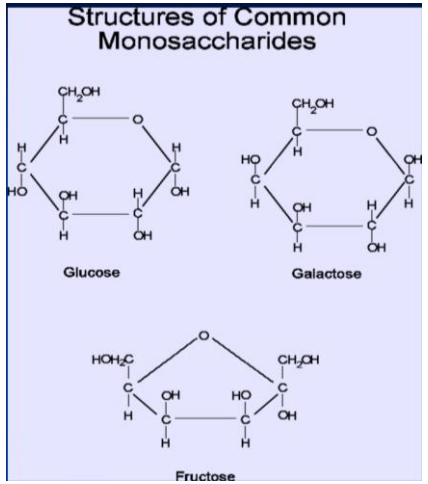
1-Salivary alpha-amylase

A-Salivary alpha-Amylase in monosaccharide and disaccharide:	
Hydrolyzes :	α(1,4) glycosidic bonds Hydrolyzes means any enzyme that breaks the bond Bonds present in starch &Glycogen : **Alpha(1,6) glycosidic bonds and beta (1,4) glycosidic bonds** -Salivary α-amylase doesn't hydrolyze **α(1,6) glycosidic bonds.** **(the branch point of starch and glycogen)** - Salivary α-amylase cannot act on: **β(1,4) glycosidic** bonds of **cellulose**. That's why we can't digest it but animals can do - Salivary α-amylase does not hydrolyze **disaccharides .**
Produces:	Short oligosaccharides

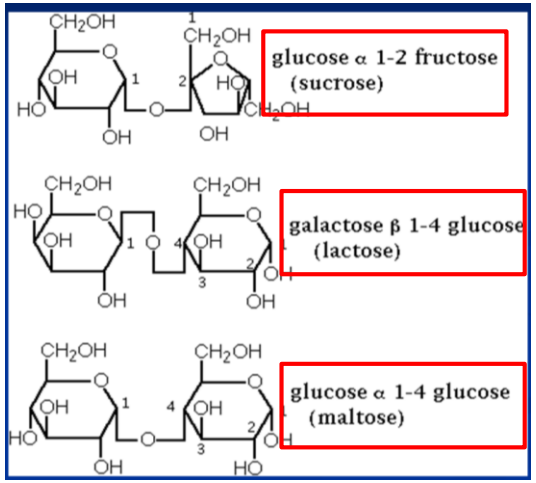
Alpha Amylase that is secreted from saliva breaks down from polysaccharide to oligosaccharide. and it's inactivated by the acidity of the stomach.
What is important to us is the pancreatic alpha amylase .



Use water in hydrolysis



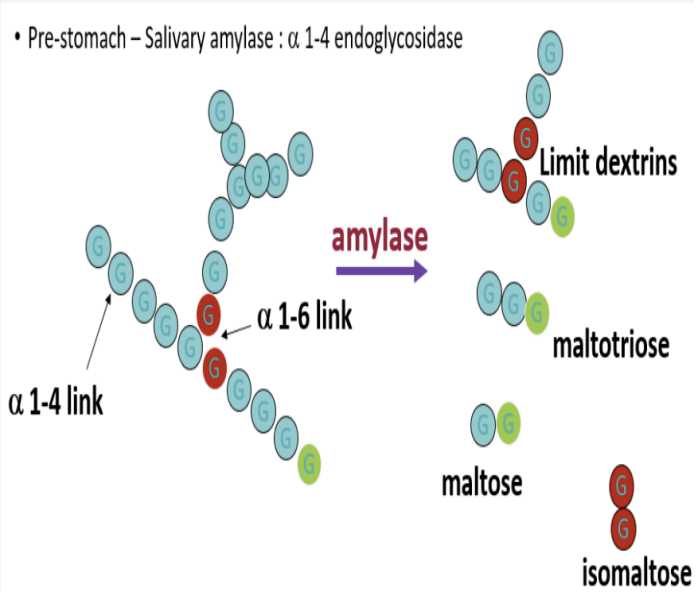
Simple sugar



Disaccharides

1-Salivary alpha-amylase

B-Effects of α-Amylase on glycogen:	
Hydrolysis of:	**α(1,4)** glycosidic bonds.
Produces:	Mixture of short oligosaccharides (both branched and unbranched) Alpha 1,4 linkage
	Disaccharides: maltose and isomaltose Alpha 1,6 linkage



Glucose Key:

Green: reducing end

Red: branched = alpha 1-6 linkage

Blue : alpha 1-4 linkage

Exoglycosidase means:

break up the bond at the terminus (end) will produce polysaccharide chain

Endoglycosidase means :

cutting in between will produce 2 oligosaccharides.

Amylase will cut in between alpha 1-4 linkage (polysaccharides only not disaccharides)

and will produce :

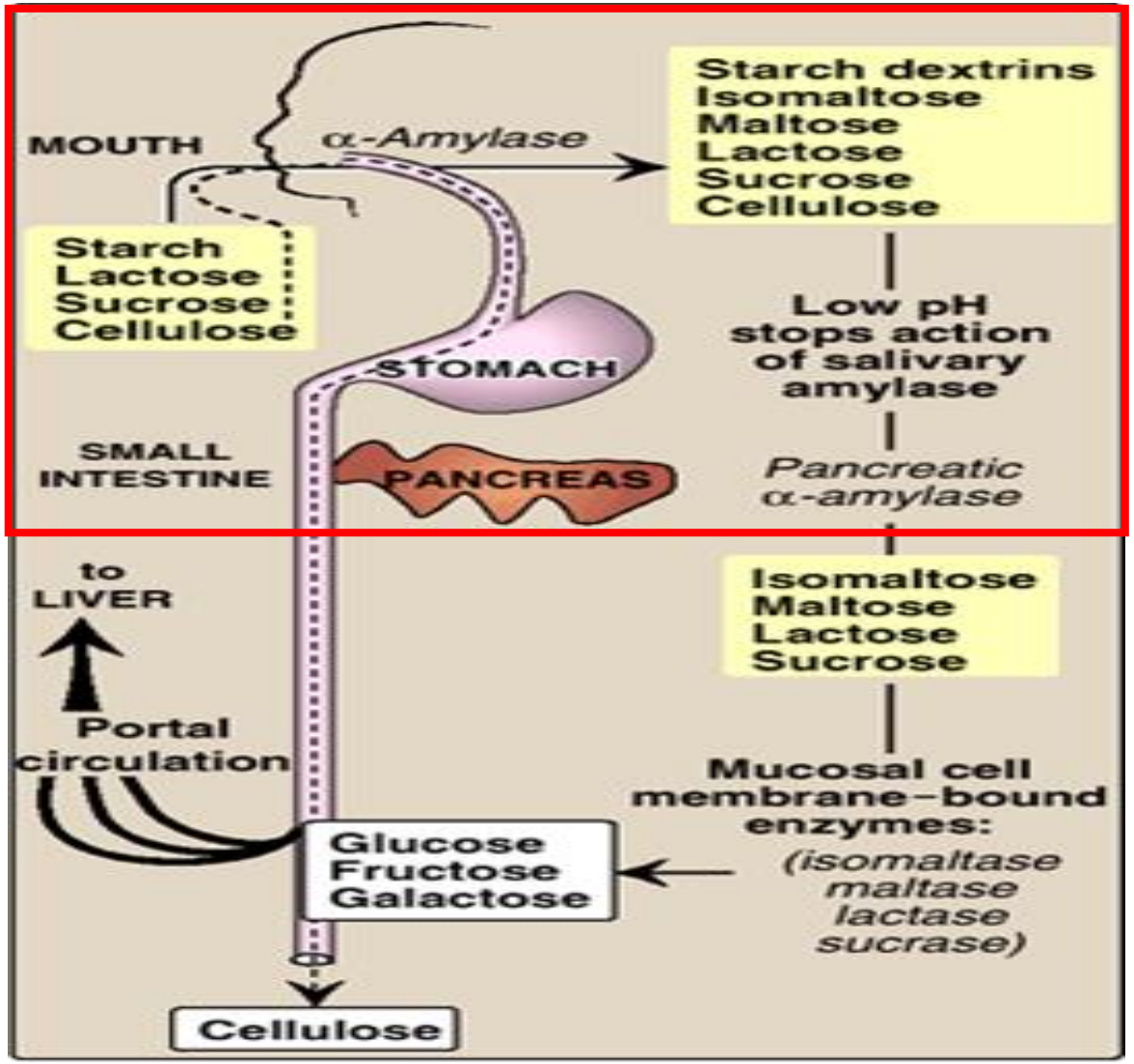
Limited dextrins (short oligosaccharides)

Maltotriose

Maltose : disaccharide of glucose with alpha 1-4 linkage

Isomaltose : disaccharide of glucose with alpha 1-6 linkage

Digestion of Carbohydrates in the Mouth

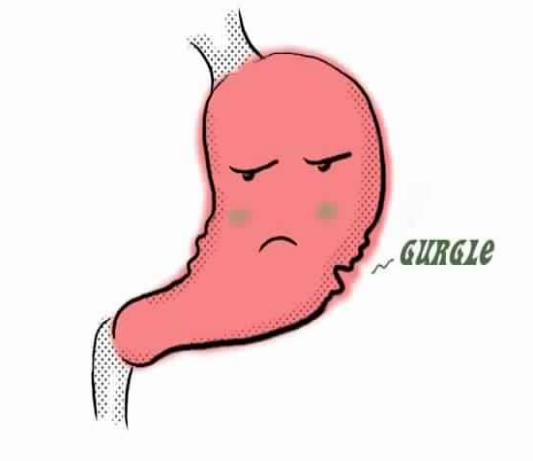


The difference between starch and glycogen is the organization.
Glycogen has much less number of alpha 1,6 linkages and more 1,4 linkages

الانزيم الفا اميليز يستهدف هضم الكربوهيدرات لذلك يتم افرازه ابتداءً من الفم ومن هنا تبدأ عملية الهضم وعند وصوله للستوميك بسبب شدة الحموضة يقف عن العمل ويتم افراز انزيم اخر في الستوميك والبنكرياس لاستكمال العملية

2-Lingual and gastric lipases

A-Lingual Lipase: (Present in Saliva)	
Secreted by :	the dorsal surface of the tongue (Ebner's glands) We have 3 types of lipase mainly for digestion lingual , gastric (which produced by stomach cells) and pancreatic lipase (major lipase enzyme)
Acts in:	the stomach for the digestion of TAG "Alpha amylase doesn't work (inactivated) in the stomach due to the acidic pH"
Produces:	fatty acids and monoacylglycerols
Role:	Its role is of little significance in adult humans



Role of stomach in digestion:

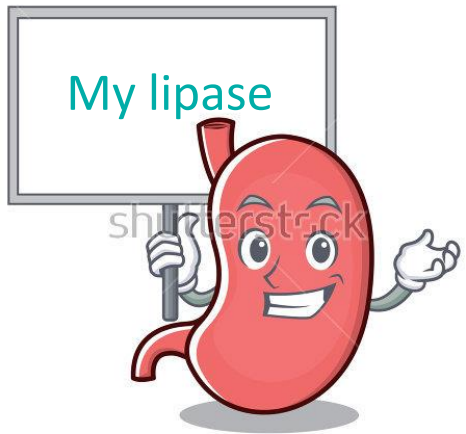
- No further digestion of carbohydrates.
- Lipids digestion begins by lingual and gastric lipases
- Proteins digestion begins by pepsin and rennin.

*Upper gastric muscles will relax so the food can get inside the stomach where the lower muscles will start doing all the movement to mix the food together

*Pancreatic ligases increases the surface area of the lipid by breaking it down

2-Lingual and gastric lipases

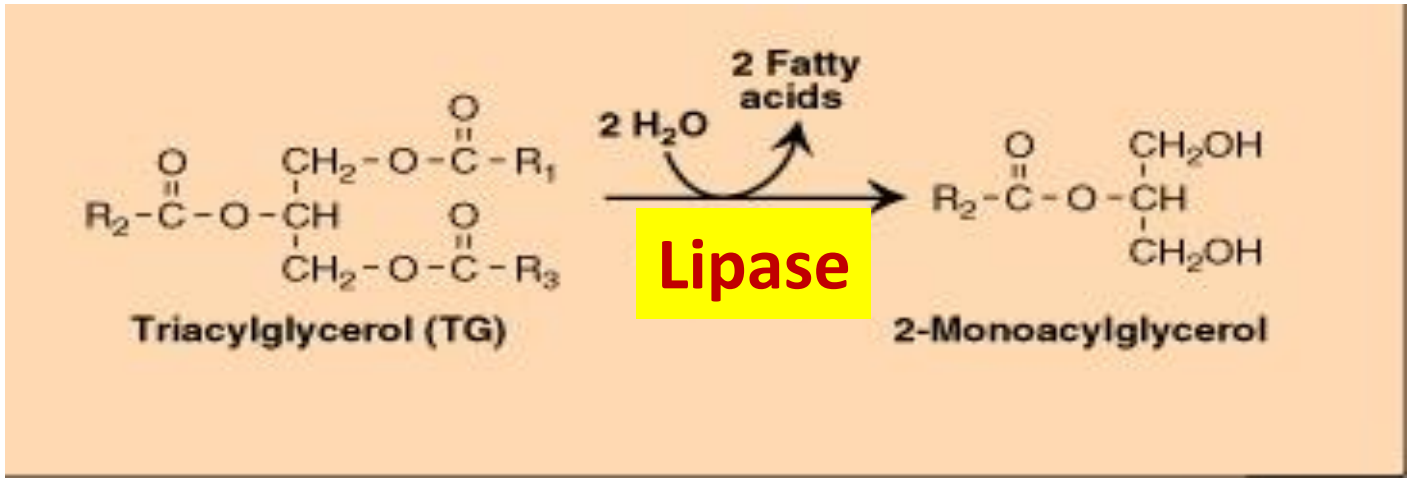
B-Lingual and Gastric Lipases (Acid-Stable Lipases):	
Substrate:	TAG molecules, containing medium- and short-chain fatty acids; such as found in milk fat .
The end product:	2-monoacylglycerols and fatty acids
Role:	both lipases in lipid digestion is of little significance in adult human (The lipids in the stomach is not yet emulsified. Emulsification occurs in duodenum)
Importance:	They are important in neonates and infants for the digestion of TAG of milk They are also important in patients with pancreatic insufficiency where there is absence of pancreatic lipase



*TAG = Triacylglycerol

Emulsification : The breakdown of fat globules in the duodenum into tiny droplets

2-Lingual and gastric lipases



Target substrate for acid-stable lipases is TAG containing:
R1 – C – O and R3 – C – O as short- or medium-chain fatty acids

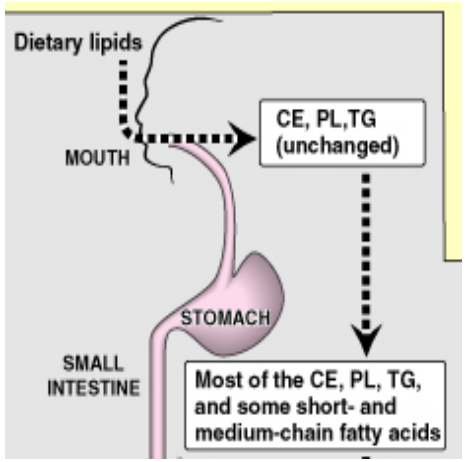
Explanation

Glycerol group (backbone) & 3 R groups which are fatty acids

- Fat →hydrophobic
- Enzymes → hydrophilic (in watery environment)
- The water has to interact with lipids and we call it lipid-water interphase
- If we don't modify lipids we will have lipids bolus and Only lipid which present on the surface will interact with enzymes so we need to emulsify the fat and this is will increase the surface area
- It will be cleaved into 2 fatty acids, and the glycerol group will be attached to the third fatty acid group forming ONE molecule of 2-Monoacylglycerol (2 refers to the location of the bond and doesn't mean 2 molecules)
- ***What kind of lipids are present in the stomach ?** Cholesteryl aster, phospholipids, TAG , some short and medium chain fatty acid which haven't been reduced by the action of lingual and gastric lipases and 2-monoacylglycrol

Digestion of lipids in the stomach

Digestion of Lipids in Stomach	
In adults	In neonates and infants
no significant effects because of lack of emulsification that occurs in duodenum.	digestion of milk TAG and production of short and medium-chain fatty acids. Only the lipids that is present on the surface are interacted by enzymes.



CE: Cholesteryl ester.
PL: Phospholipids
TG: Triacylglycerol.

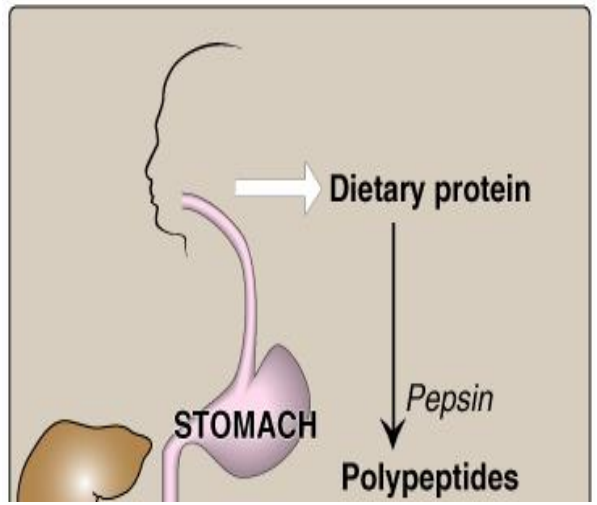
Digestion of lipids in the stomach

1-Pepsin	
Secreted by:	chief cells of stomach as inactive proenzyme (enzymogen which is inactive enzyme that require modification) , pepsinogen
Activated by:	1- HCl present in stomach 2- auto-catalytically (the enzyme is catalyzing it's own molecule from the same type and make it active) by **pepsin.** Acid-stable, endopeptidase (it is cleaving in the middle of the chain)
Substrate:	**denatured** dietary proteins **(by HCl)**
End product:	Smaller polypeptides or oligopeptides
2-Rennin	
Secreted by:	Chief cells of stomach in **neonates and infants ONLY**
Substrate:	Casein of milk (in the presence of calcium)
End product:	Paracasein with the formation of **milk clot** if the infant throw up the milk after a while you can notice it is la clot because of rennin
Effect:	It prevents rapid passage of milk from stomach, allowing more time for action of pepsin on milk proteins

Digestion of lipids in the stomach

Digestion of Dietary Proteins in Stomach:

HCL	Denatures proteins Activate Pepsin from pepsinogen
Pepsin	Cleaves proteins into polypeptides
Rennin	Formation of milk clot and increases the stay of milk in the stomach so that the pepsin can also act on it.



HCL have 2 main functions in the stomach:

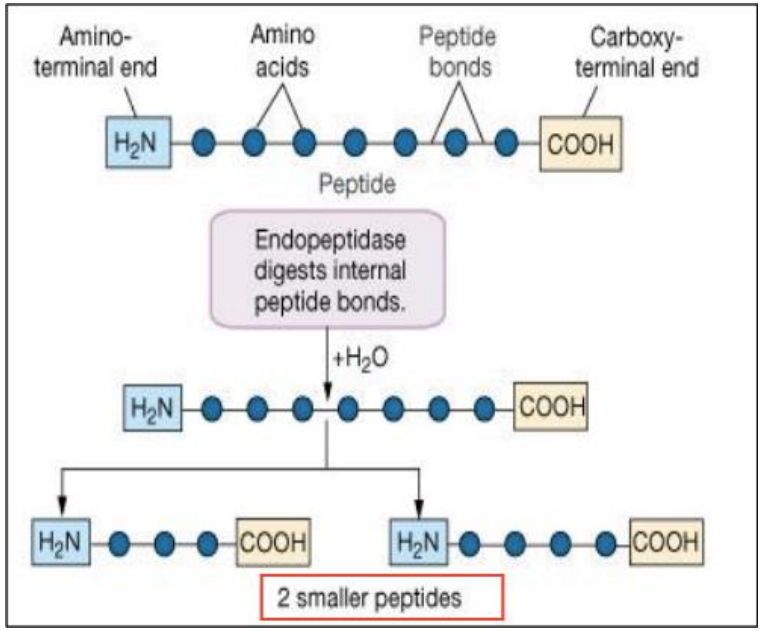
1- denature dietary protein so they become accusable for digestion

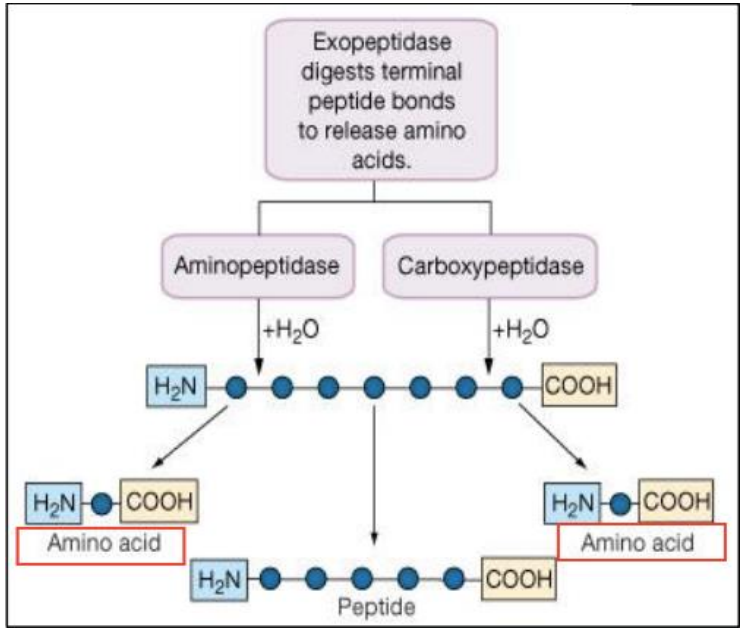
2- activation of pepsinogen to pepsin

Don’t mix between rennin and renin they are totally different enzymes

Endopeptidases and exopeptidases

"Will be explained better in the next lectures"





Key

Blue balls = amino acids

Straight lines= peptide bonds

Endopeptidase = Endoglycosidase=cut in the middle →2-smaller peptides or 2 short oligopeptides

Exopeptidase = Exoglycosidase = cleave at the end →

if it is aminopeptidase it will cut the N terminus

and if it is carboxyl-peptidase it will cut the C terminus it is and this will lead to formation of amino acids and peptide chains

Take home messages

- ✓ Digestion involves both mechanical and enzymatic processes
- ✓ Digestion makes dietary foodstuffs readily absorbable by the digestive tract
- ✓ Salivary α-amylase is of limited, but initial effect on digestion of starch and glycogen in the mouth
- ✓ Salivary α-amylase converts starch and glycogen into short, branched oligosaccharides
- ✓ Limited digestion of TAG begins in the stomach by both lingual and gastric lipases producing 2-monoacylglycerols and fatty acids
- ✓ Digestion of proteins begins in the stomach by pepsin producing smaller polypeptides
- ✓ In neonates and infants, digestion of milk occurs in stomach by:
  - ➢ Acid-stable lipases for digestion of milk fat
  - ➢ Rennin and pepsin for digestion of milk proteins

Summary

Processes of the digestive system:			
Motility	Secretion	Absorption	Elimination
Digestion:			
Mechanical effect		Enzymatic effect	
End products of digestion:			
CHO	TAG	Proteins	
Role of salivary glands:			
Lubricant	Contains salivary enzymes, which are:		
A- Alpha amylase			
Secreted by:	Parotid gland.	Optimum pH:	6.6 - 6.8
Substrate:	Starch and glycogen		
Hydrolyzes:	Alpha (1,4) glyosidic bond which acts on: A- Monosaccharides and Disaccharides B-Glycogen.		
B- Lingual Lipase			
Secreted by:	Dorsal surface of the tongue	Acts in :	Stomach for the digestion of TAG
Produces:	Fatty acids and monoacyglycerol	Role:	Its role is little significance in the adults humans

Role of Stomach in digestion		
No further digestion of carbohydrates.	Lipids digestion begins by lingual and gastric lipases	Proteins digestion begins by pepsin and renin.

C- Lingual and gastric lipases: (Acid- Stable lipases)	
Substrate:	TAG molecules, containing medium- and short-chain fatty acids; such as found in milk fat .
The end product:	2-monoacylglycerols and fatty acids
Role:	both lipases in lipid digestion is of little significance in adult human
Importance:	1-They are important in neonates and infants for the digestion of TAG of milk 2-They are also important in patients with pancreatic insufficiency where there is absence of pancreatic lipase

Digestion of lipids in the stomach	
In Adults:	In neonate and infants:
no significant effects because of lack of emulsification that occurs in duodenum.	digestion of milk TAG and production of short and medium-chain fatty acids.

Pepsin			
Secreted by:	Chief cells of the stomach	Activated by:	HCl Autocatlyictally
Substrate:	**denatured** dietary proteins **(by HCl)**	End product:	Smaller polypeptides
Renin			
Secreted by:	chief cells of stomach in neonates and infants	Substrate:	Casein of milk
End product:	Paracasein with the formation of milk clot	Effect:	It prevents rapid passage of milk from stomach, allowing more time for action of pepsin on milk proteins

QUIZ

Q1 : Carbohydrates digestion starts in ?

A- Mouth
B- Stomach
C- Intestine
D- None of the above

Q2 : Proteins & lipids digestion starts in ?

A- Mouth
B- Stomach
C- Intestine
D- None of the above

Q3 : Enzyme important just for infants for milk clot ?

A- Renin
B- HCl
C- Pepsin
D- Rennin

Q4 : Which of the following enzymes get inactivated in the stomach ?

A- Renin
B- α-Amylase
C- Pepsin
D- Rennin

Q5 : Lipase acts on which type of fatty acids ?

A- Short
B- Short or medium
C- Long
D- All types

Q6 : Which of the following is responsible for Pepsinogen activation ?

A- HCl
B- Rennin
C- Lingual lipase
D- Gastric lipase

QUIZ

Q7 : Salivary α-amylase is able to hydrolyze which of the following

A- α(1,6) glycosidic bonds
B- β(1,4) glycosidic bonds of cellulose
C- α(1,4) glycosidic bonds
D- Disaccharide

Q8 : What are the end products of digestion ?

1. Carbohydrate = monosaccharides.
2. TAG = fatty acid & monoacylglycerols.
3. Proteins = amino acid.

Q9 : What is the effect of rennin ?

It prevents rapid passage of milk from stomach to allow more time
for pepsin to break milk protein.

Q10 : Lingual and gastric lipases are important for whom and why ?

They are important in neonates and infants for the digestion of TAG of milk and they are also important in patients with pancreatic insufficiency where there is absence of pancreatic lipase.

Q11 : Salivary α-amylase converts starch and glycogen into what ?

Short, branched oligosaccharides.

Suggestions and recommendations

1) A 2) B 3) D 4) B 5) B 6) A 7) C

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THANK YOU

FOR CHECKING OUR WORK

PLEASE CONTACT US IF YOU HAVE ANY ISSUE

- Lippincott's Illusrated Reviews Biochemistry 6th E

Review the notes

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