Role of salivary glands and stomach in digestion

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Editing File

Objectives:

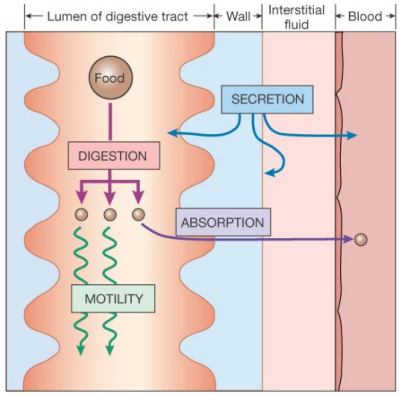
- Understand the principle and importance of digestion of dietary foodstuffs
- Understand the role of salivary glands in digestion
- Understand the role of stomach in digestion

And.....

background

Most of dietary foodstuffs are ingested in the form that cannot be readily absorbed from the digestive tract

Digestion: The breakdown of the naturally occurring foodstuffs into smaller, easily absorbable forms.



Processes of the digestive system

- Motility
- Secretion
- Absorption
- Elimination

Digestion:

Mechanical effects:
e.g., mastication

Enzymatic effects:
Digestive enzymes (Hydrolases)

End Products of Digestion:

Carbohydrates	Monosaccharides
Triacylglycerols (TAG)	Fatty acids & monoacylglycerols
Proteins	Amino acids

Role of Salivary Glands in Digestion:

They secrete saliva **saliva:**

1. Acts as lubricant
2. Contains salivary **α-amylase**
3. Contains lingual lipase

Salivary α-Amylase

Substrates:
Starch and glycogen

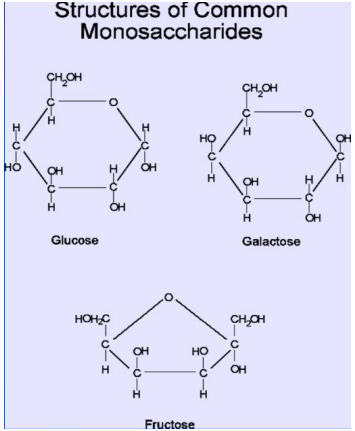
Optimum pH:
6.6-6.8

Hydrolyzes:
α(1,4) glycosidic bonds

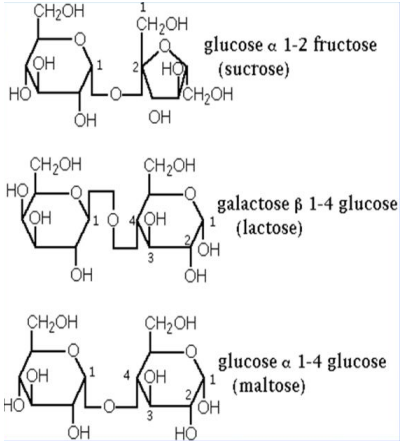
Secreted by:
Parotid glands

Produces:
Short Oligosaccharides

Simple sugars



Disaccharides

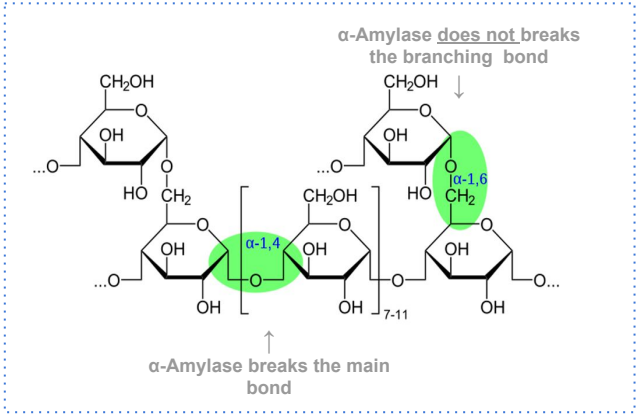


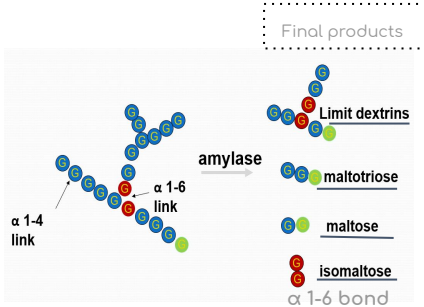
Dr. note: no structures this is just for your understanding

Digestion

Pre-stomach[1] –Salivary amylase :

α 1-4 endoglycosidase[2]





[1]in the mouth
[2]Its called (endo) because it only breaks the middle bonds not the peripheral ones

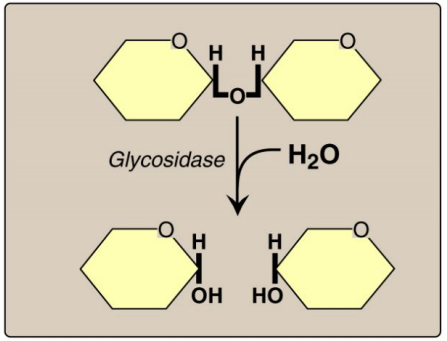
Effect of α-Amylase on Glycogen

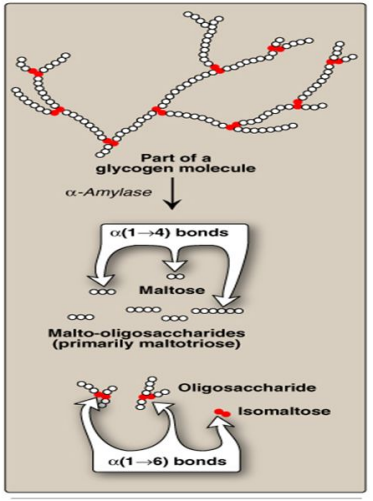
Hydrolysis of: α(1,4) glycosidic bonds

Products:

- Mixture of short oligosaccharides (both branched & unbranched)
- Disaccharides: Maltose and isomaltose

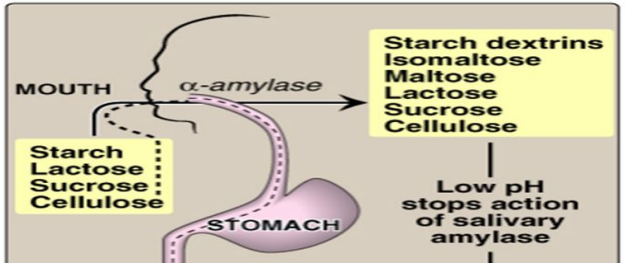
Hydrolysis of α(1,4) Glycosidic Bonds





- ➔ 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
- ➔ Salivary amylase is inactivated by the acidity of stomach (The enzyme is inactivated at pH 4.0 or less)
- ➔ Salivary a-amylase does not hydrolyze: α(1,6) glycosidic bonds (The branch points of starch and glycogen)
- ➔ Salivary a-amylase cannot act on: β(1,4) glycosidic bonds of cellulose
- ➔ Salivary a-amylase does not hydrolyze: disaccharides

Digestion of Carbohydrates in the Mouth



Role of Stomach in Digestion

- No further digestion of carbohydrates
- Lipid digestion begins by lingual and gastric lipases
- Protein digestion begins by pepsin and rennin

Lingual Lipase

Secreted by the dorsal surface of the tongue (Ebner's glands)

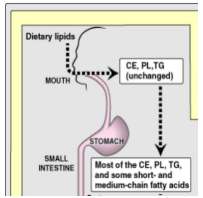
Produces fatty acids and monoacylglycerols

Acts in the stomach for the digestion of TAG

Its role is of little significance in adult humans

Digestion of Lipids in Stomach

In adults	VS	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



Lingual and Gastric Lipases (Acid-Stable Lipases)

Substrate

TAG molecules, containing medium- and short-chain fatty acids; such as found in milk fat

End product

2-monoacylglycerols and fatty acids

Role

both lipases role in lipid digestion is of little significance in adult human (The lipids in the stomach is not yet **emulsified**, **Emulsification** occurs in duodenum)

It has very little significance although it breaks lipids down to very small molecules, because lipids need another process which is called (**emulsification**) which basically means that the molecule will take more **surface area** so the enzyme will act easily on the molecule.

They are important in:

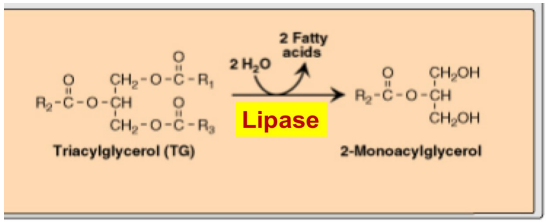
1. **Neonates and infants**

for the digestion of TAG of milk Because it has low amount of lipids

2. **Patients with pancreatic insufficiency**

Because there is absence of pancreatic lipase

(Acid-Stable Lipases)



TAG's are broken down by **lipase** to **2** fatty acids and 1 (2*-monoacylglycerol)

*the number 2 is due to the location of carbon bonded to

Target substrate for acid-stable lipases is TAG containing:

R1 – C(=O) – O and R3 – C(=O) – O **as short- or medium-chain fatty acids**

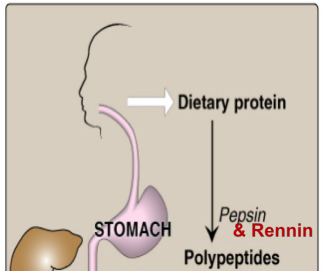
Digestion of Dietary Proteins in Stomach

Pepsin :
Cleaves proteins into polypeptides

HCL :
Denatures proteins
Activates pepsin

Rennin :
Formation of milk clot*

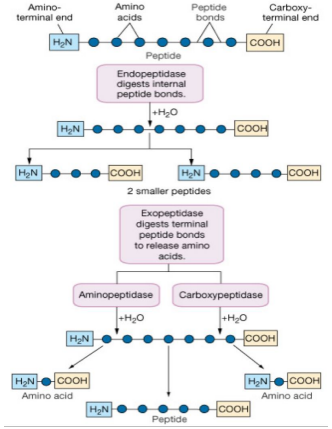
*To make it stay in the stomach for longer time so that pepsin have enough time to act on it



Pepsin		Rennin
		Don't mix it with renin
chief cells of stomach as inactive proenzyme, pepsinogen	Secreted by	chief cells of stomach in **neonates** and **infants**
denatured dietary proteins (by HCl)	Substrate	Casein of milk (in the presence of calcium)
Smaller polypeptides	End product	Paracasein with the formation of milk clot
Acid-stable, **endopeptidase***. Activated by **HCl** and **autocatalytically by pepsin.**		**Effect** : It prevents rapid passage of milk from stomach, allowing more time for action of pepsin on milk proteins

*Cleaves the **inner** parts in the protein

Endopeptidase (breaks the middle bond)
Exopeptidase (breaks the periphery bonds)



Endopeptidases and exopeptidases

Take Home Messages

- Digestion involves both mechanical and enzymatic processes
- Digestion makes dietary foodstuffs readily absorbable by the digestive tract
- Salivary a-amylase is of limited, but initial effect on digestion of starch and glycogen in the mouth
- Salivary a-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

	Secreted by	Substrate	Action	Produces	PH	Notes
Salivary α-Amylase	Parotid glands	Starch and glycogen	Hydrolyzes of α(1,4) glycosidic bonds	- Short oligosaccharides (brached, unbranched) - Disaccharides (Maltose, isomaltose)	6.6 – 6.8 (inactivated at pH 4.0 or less)	**Can't act on:** - α(1,6) glycosidic bonds - β(1,4) glycosidic bonds of cellulose - disaccharides
Lipase	Lingual from dorsal surface of the tongue	TAG containing medium- and short-chain fatty acid	Acts in the stomach for the digestion of TAG	- 2-monoacylglycerols - fatty acids	Acid-stable	- important in neonates and infants for digestion TAG of milk - important in patients with pancreatic insufficiency - In adults, no significant effects because of lack of emulsification that occurs in duodenum
Pepsin	chief cells of stomach	denatured dietary proteins (by HCl)		Smaller polypeptides	Acid-stable	Secreted As inactive proenzyme pepsinogen, Activated by HCl and another pepsin
Rennin	chief cells of stomach in neonates and infants	Casein of milk (in the presence of Ca)	prevents rapid passage of milk from stomach, allowing more time for action of pepsin on milk proteins	- Paracasein - milk clot	-	-

Special thanks to Dimah Alarifi #med437

Quiz

MCQs :

Q1: which of the following does a-Amylase hydrolyse?
A) α(1,6) Glycosidic bond B) β(1,4) glycosidic bonds of cellulose
C) α(1,4) Glycosidic Bond D) Disaccharides

Q2: which of the following Produces fatty acids and monoacylglycerols?
A) salivary Amylase B) lingual lipase C) pepsin D) rennin

Q3: which of the following is not produced by Hydrolysis of α(1,4) glycosidic bond?
A) glucose B) maltose C) isomaltose D) short oligosaccharides

Q4: why lipases are of little significance in lipid digestion in adults?
A) Emulsification occurs in duodenum B) lipids are more complex in adults
C) changes in pH D) none

Q5: Rennin acts on casein in the presence of
A) Phosphate B) Calcium C) sodium D) potassium

Q6: What is the most important enzyme for milk digestion in neonates?
A) Colipase B) Phospholipase A2 C) Gastric lipase D) Amylase

SAQs :

Q1: why is the salivary Amylase is not active in the stomach?
Q2: why pepsin isn't denatured by HCl like most of the proteins?

Q3: TAG's are broken down by…. to...

Q4: compare between rennin and pepsin regarding their secretion, substrate and end product

★ MCQs Answer key:

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

★ SAQs Answer key:

1) Because the stomach is the acidity is higher (Acidic ph 4.0) while salivary Amylase optimum ph is 6.6-6.8
2) Because it is acid stable
3) Lipase, to 2 fatty acids and 1 2-monoacylglycerol
4) 8th Slide

Team members

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- Amira AlDakhilallah
- Arwa Al Emam
- Deema Almaziad
- Ghaliah Alnufaei
- Haifa Alwaily
- Leena Alnassar
- **Lama Aldakhil**
- Lamiss Alzahrani
- Nouf Alhumaidhi
- Noura Alturki
- Sarah Alkhalife
- **Shahd Alsalamah**
- Taif Alotaibi

Boys Team:

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- Alkassem Binobaid
- Khayyal Alderaan
- Mashal Abaalkhail
- Naif Alsolais
- Omar Alyabis
- **Omar Saeed**
- Omar Odeh
- Rayyan Almousa
- Yazen Bajeaifer

Team Leaders

Lina Alosaimi

Mohannad Alqarni

★ There is no elevator to success, you have to take the stairs 😆

438 BIOCHEMISTRY TEAM

We hear you