

SISTEMA DIGESTÓRIO

Aula 4:

Digestão Química de Carboidratos, Proteínas e Lipídeos

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DIGESTÃO QUÍMICA (secreções digestivas)

Digestão Intracelular

organismos unicelulares
protozoários

Digestão Extracelular

metazoários

↓

- ingestão de grandes pedaços de alimento
- trato digestivo (lumen)

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SECREÇÕES DO TRATO DIGESTÓRIO

A digestão do alimento depende da motilidade gastrointestinal e das secreções digestivas

Região	Secreção	Quantidade diária (l)	pH	Composição*
Cavidade bucal				
Esôfago	Saliva	1+	6,5	Amilase, bicarbonato
Estômago	Suco gástrico	1-3	1,5	Pepsinogênio, HCl
Pâncreas	Suco pancreático	1	7-8	Tripsinogênio, quimotripsinogênio, carboxi- e aminopeptidases, lipase, amilase, maltase, nucleases, bicarbonato
Íleo	Bile	1	7-8	Gorduras e ácidos graxos, sais biliares e pigmentos, colesterol
Jejuno	"Suco entérico"	1	7-8	Enterocinase, carboxi- e aminopeptidases, maltase, lactase, sacarase, lipase, nucleases

*Incluindo muco e água, que juntos somam até 95% da secreção.

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Ação das principais enzimas secretadas pela cavidade oral, estômago, pâncreas e intestino delgado (mamíferos)

Enzyme	Site of action	Substrate	Products of action
Mouth			
Salivary α -amylase	Mouth	Starch	Disaccharides (few)
Stomach			
Pepsinogen-pepsin	Stomach	Proteins	Large peptides
Pancreas			
Pancreatic α -amylase	Small intestine	Starch	Disaccharides
Trypsinogen-trypsin	Small intestine	Proteins	Large peptides
Chymotrypsin	Small intestine	Proteins	Large peptides
Elastase	Small intestine	Elastin	Large peptides
Carboxypeptidases	Small intestine	Large peptides	Small peptides (oligopeptides)
Aminopeptidases	Small intestine	Large peptides	Oligopeptides
Lipase	Small intestine	Triglycerides	Monoglycerides, fatty acids, glycerol
Nucleases	Small intestine	Nucleic acids	Nucleotides
Small intestine			
Enterokinase	Small intestine	Trypsinogen	Trypsin
Disaccharidases	Small intestine*	Disaccharides	Monosaccharides
Peptidases	Small intestine*	Oligopeptides	Amino acids
Nucleotidases	Small intestine*	Nucleotides	Nucleosides, phosphoric acid
Nucleosidases	Small intestine*	Nucleosides	Sugars, purines, pyrimidines

*Intraeclular

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Ação das principais enzimas secretadas pela cavidade oral, estômago, pâncreas e intestino delgado (mamíferos)

TABLE 18-3

Categories of digestive enzymes. (Modified from Flory 1966.)

Proteases

Endopeptidases (proteinases): protein \rightarrow polypeptides

Pepsinases (1.5-2.5 pH_{opt})

Cathepsins (1.8-6 pH_{opt})

Trypsinases (>7 pH_{opt})

Exopeptidases (peptidases): polypeptides \rightarrow peptides, amino acids

Polypeptidases

Tripeptidases

Dipeptidases

Carbohydrases

Polysaccharidases (polysases): high MWt carbohydrates \rightarrow oligo-, di-, and monosaccharides.

Amylases (starch)

Cellulases (cellulose)

Chitinases (chitin)

Oligosaccharidases (oligases): tri- and disaccharides \rightarrow monosaccharides

Glucosidases (maltose, saccharose, glucoside)

Galactosidases (mellibiose, galactoside)

Glucosidases (cellobiose, glucoside)

Galactosidases (lactose, galactoside)

Fructosidases (saccharose)

Esterases

Lipases: triglycerides \rightarrow fatty acids, monoglyceride, glycerol

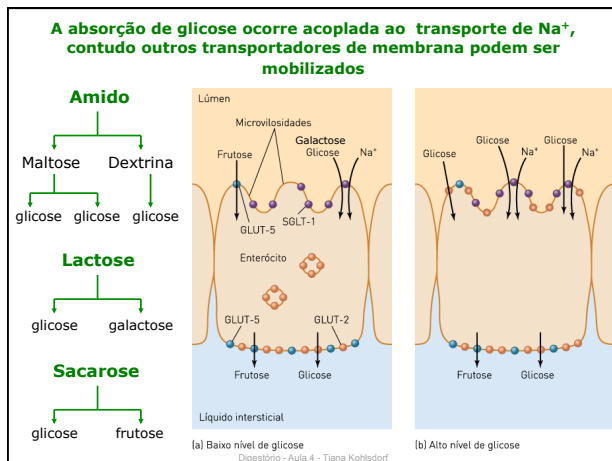
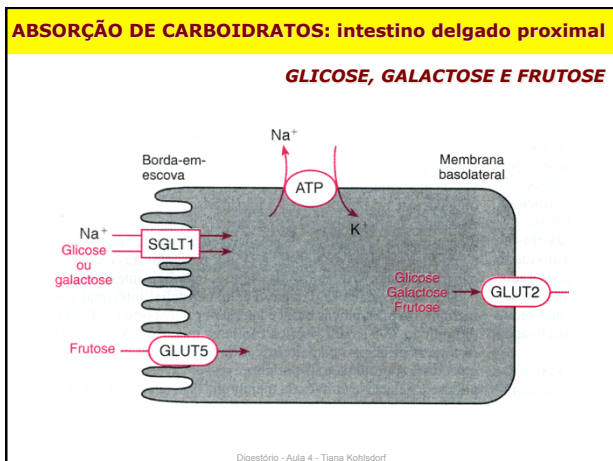
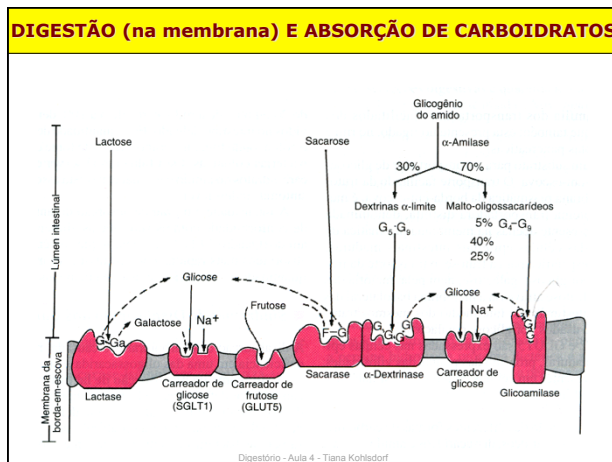
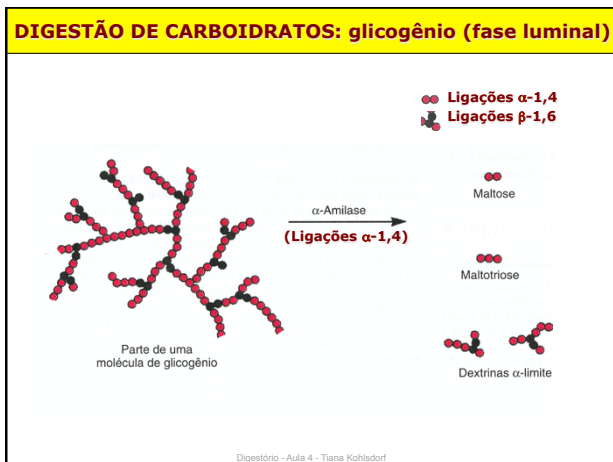
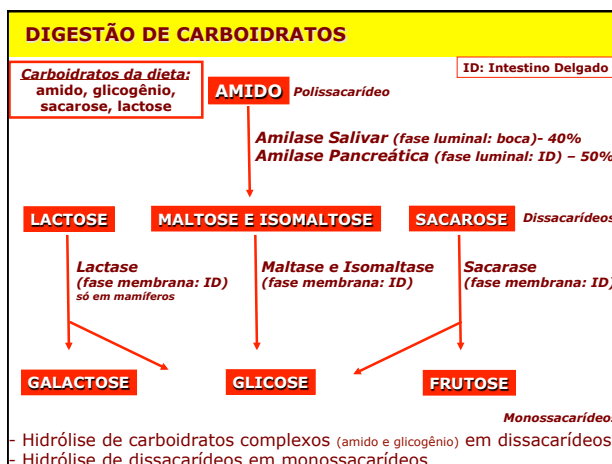
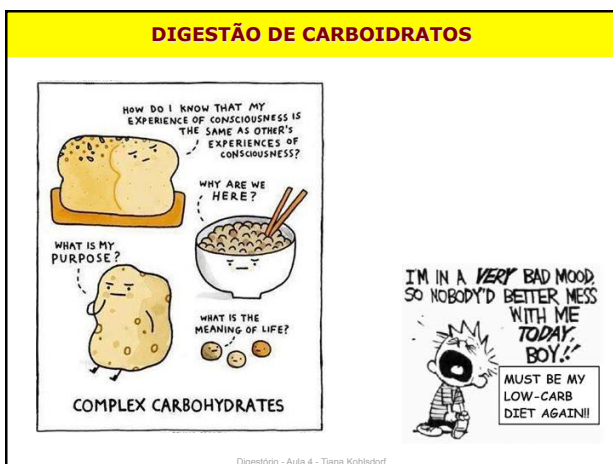
Esterases: simple esters, complex phospholipids, cholesterol esters, waxes \rightarrow carboxylic acids, alcohols, cholesterol, fatty acids, etc.

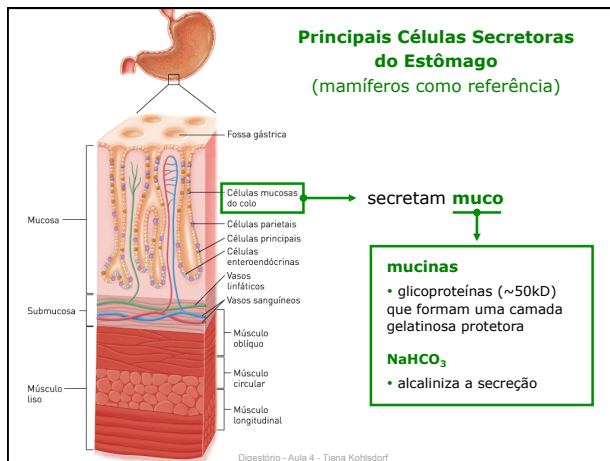
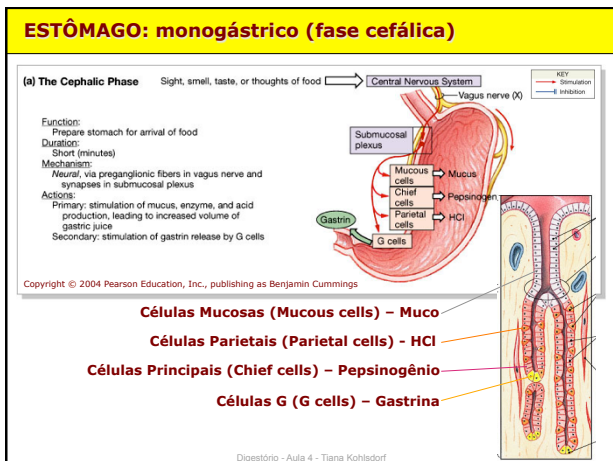
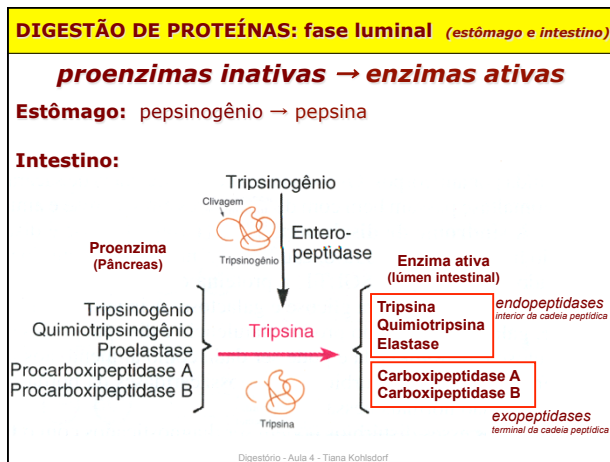
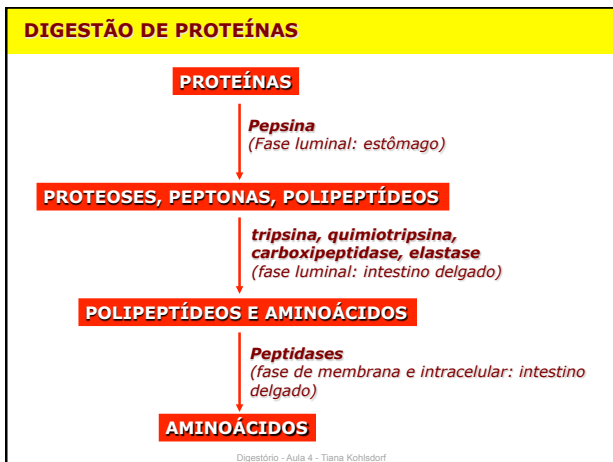
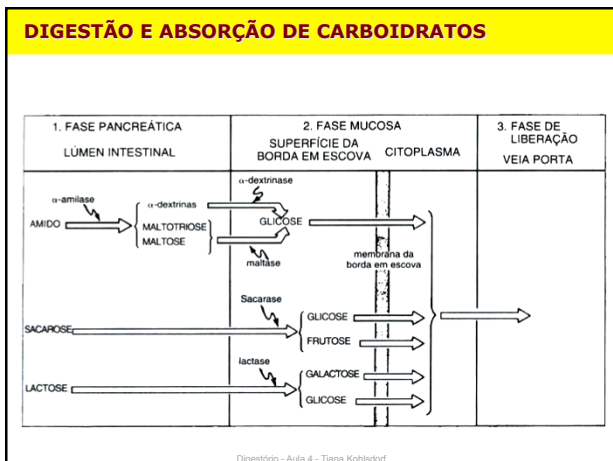
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Ph e temperatura afetam a atividade enzimática da digestão

Protease	Carbohydrase	Lipase
1.7 Man-pepsin		
2.0 Toad-pepsin		
2.2 Man-pepsin		
2.4 Fly		
2.6 Tick		
2.6 Bivalve mollusk		
3-4 Crayfish chitinase		
3.5 Crayfish-chitinase		
3.1 Man-pepsin		
3.1 Housefly		
3.7 Man-crenalin	4.5 Bivalve β -glucosidase	
4.9 Blood-sucking bug	4.5 α -amylase	4.5 Gastric lipase
4.9 Redbug	4.8 Acid phosphatase	
5.0 Man-pepsin	5.5 Invertase	
5.4 Man-crenalin	5.5 Bivalve glucosidase	
5.5 Bivalve mollusk	5.5 Rectile-cellulase	
	5.6 Amylase	
	5.7 Crayfish saccharase	
	5.9 Cockroach amylase	
	5.9 Copepod amylase	
6.9 Man-pepsin	7.0 β -amylase	6.5 Bivalve lipase
7.2 Cockroach	7 Glycogenase	
7.5 Man-carboxypeptidase	7 β -glucosidase	
7.5 Glycophoran	7.5 Amylase	7.5 Onychophoran lipase
7.7 Bivalve mollusk		7.3 Bivalve lipase
7.8 Man-trypsin		7.5 Onychophoran esterase
7.9 Mollusco		7.8 Bivalve lipase
8.0 Man-chymotrypsin		8 Lipase
8.0 Tsetse fly		8 Cockroach lipase
8.0 Spider		
8.2 Cockroach		
8.2 Locust		
8.5 Collagenase-blowfly		
8.5 Housefly		
8.5 Blackfly		
8.5 Mealworm		
9.5 Silkworm	9.5 Silkworm amylase	8.7 Bivalve lipase
10.0 Clothes moth	9.5 Alkaline phosphatase	

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Principais Células Secretoras do Estômago (mamíferos como referência)

secretam ácido clorídrico

cél. parietal **lúmen**

$CO_2 + H_2O \xrightarrow{a.c.} CO_2 + OH^-$
 $HCO_3^- + H^+ \rightleftharpoons CO_2 + H_2O$

Na⁺ K⁺ Cl⁻ H⁺

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HCl:

- quebra do alimento
- morte de microorganismos 'patogênicos'
- desnaturação de proteínas
- ativação de pepsina (endopeptidase)

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Principais Células Secretoras do Estômago (mamíferos como referência)

secretam pepsinogênio

- secretado no lúmen gástrico onde permanece inativo até que entre em contato com o HCl ou com pepsina previamente formada
- molécula de **pepsinogênio** (de 42,5kD) desdobra-se e vira a molécula de **pepsina** ativa (de 35kD)

pepsinogênio \xrightarrow{HCl} **pepsina**

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Principais Células Secretoras do Estômago (mamíferos como referência)

Células de Gastrina ou Células G secretam **gastrina**

- hormônio polipeptídico que atua intensamente sobre as **células parietais** estimulando-as a secretar **HCl** e moderadamente sobre as **células principais** estimulando a secretar **pepsinogênio**

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ESTÔMAGO: monogástrico (fase gástrica)

(b) The Gastric Phase

Functions: Enhance secretion started in cephalic stage; homogenize and acidify chyme; initiate digestion of proteins by pepsin

Duration: Long (3-4 hours)

Mechanisms: Neural: short reflexes triggered by (1) stimulation of stretch receptors as stomach fills (2) stimulation of chemoreceptors as pH increases
 Hormonal: stimulation of gastrin release by G cells through parasympathetic activity and presence of peptides and amino acids in chyme
 Local: release of histamine by mast cells as stomach fills (not shown)

Actions: Increased acid and pepsinogen production; increased motility and initiation of mixing waves

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ESTÔMAGO: monogástrico (fase intestinal)

(c) The Intestinal Phase

Function: Control rate of chyme entry into duodenum

Duration: Long (hours)

Mechanisms: Neural: short reflexes (enterogastric reflex) triggered by distension of duodenum
 Hormonal: Primary: stimulation of cholecystokinin (CCK), gastric inhibitory peptide (GIP), and secretin release by presence of acid, carbohydrates, and lipids
 Secondary: release of gastrin stimulated by presence of undigested proteins and peptides (not shown)

Actions: Feedback inhibition of gastric acid and pepsinogen production; reduction in gastric motility

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