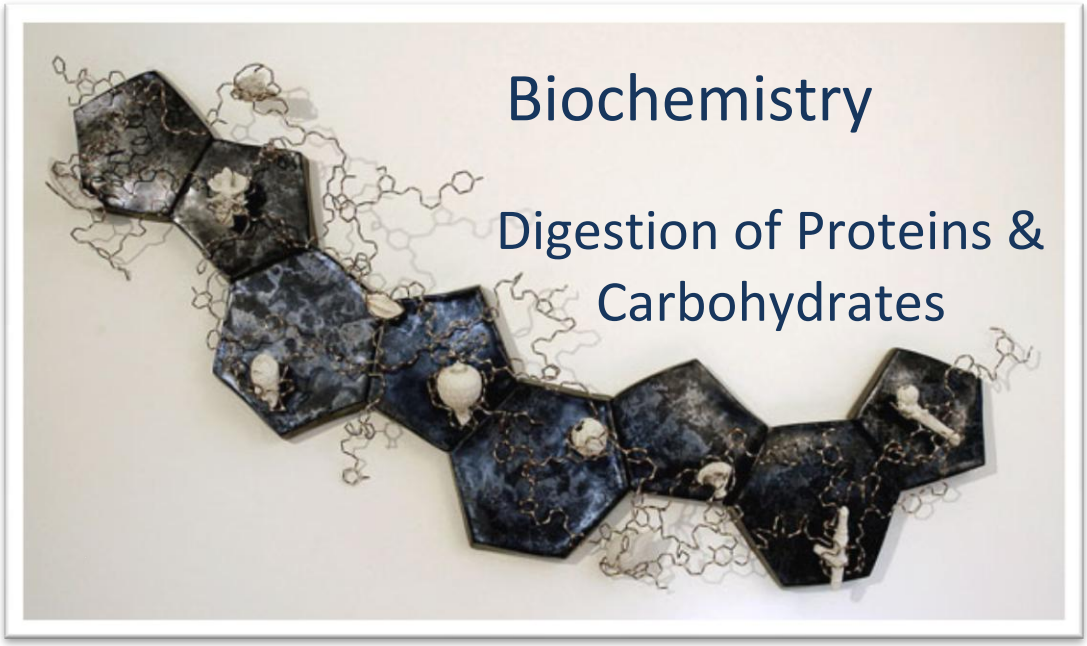


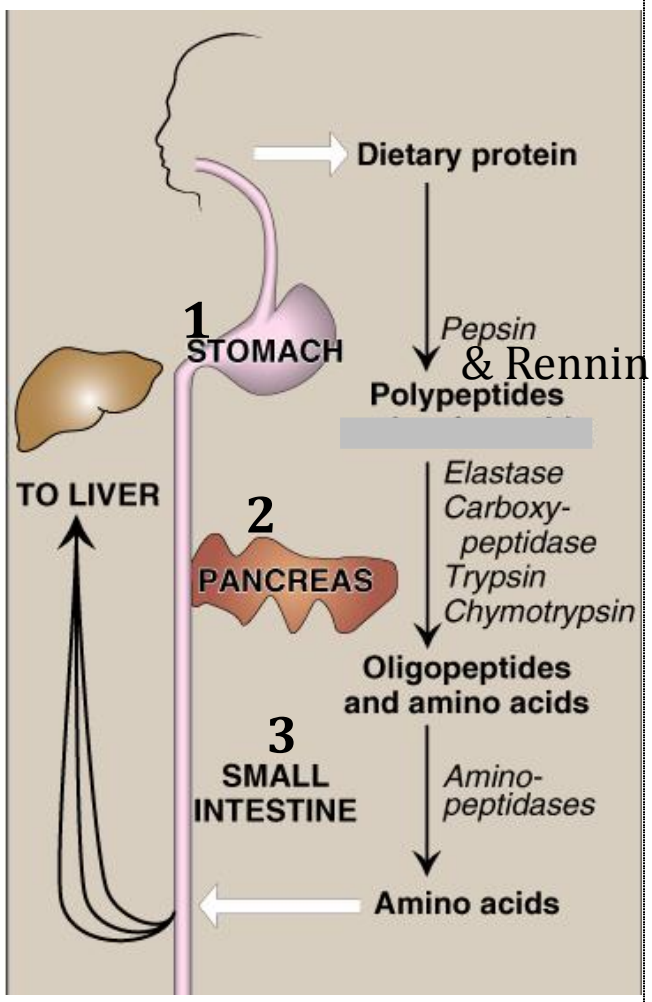
Osamah Al-Jarallah	Al-Anood Asiri
Abdulaziz Al-Shamlan	Lama Mokhlis
Abdullah Al-Mazyad	Noha Khalil
Turki Al-Otaibi	Reem Al-Mansour
Khalid Al-Khamis	Hadeel Helmi
Saud Al-awad	Nuha Al-Furayh
Khaled Almohaimede	Jumana Al-Shammari
Meshal Al-Otaibi	Deema Jomar

Biochemical Aspects of Digestion of Dietary Protiens:

Dietary proteins constitute 70-100 g/day
Proteins are generally too large to be absorbed by the intestine.
They must, therefore, be hydrolyzed to their constituent amino acids, which can be absorbed

The source of proteolytic enzymes responsible for degrading dietary proteins:

- The stomach
- The pancreas
- The small intestine



1

Digestion of Proteins by Gastric Secretion:

The gastric juice contains 3 components important for protein digestion:

- Hydrochloric acid
- Pepsin
- Rennin (in neonates and infants)

Digestion by stomach:

Protein is broken down into polypeptides by pepsin enzyme
Pepsinogen (the proenzyme) is activated by HCl or autocatalysis

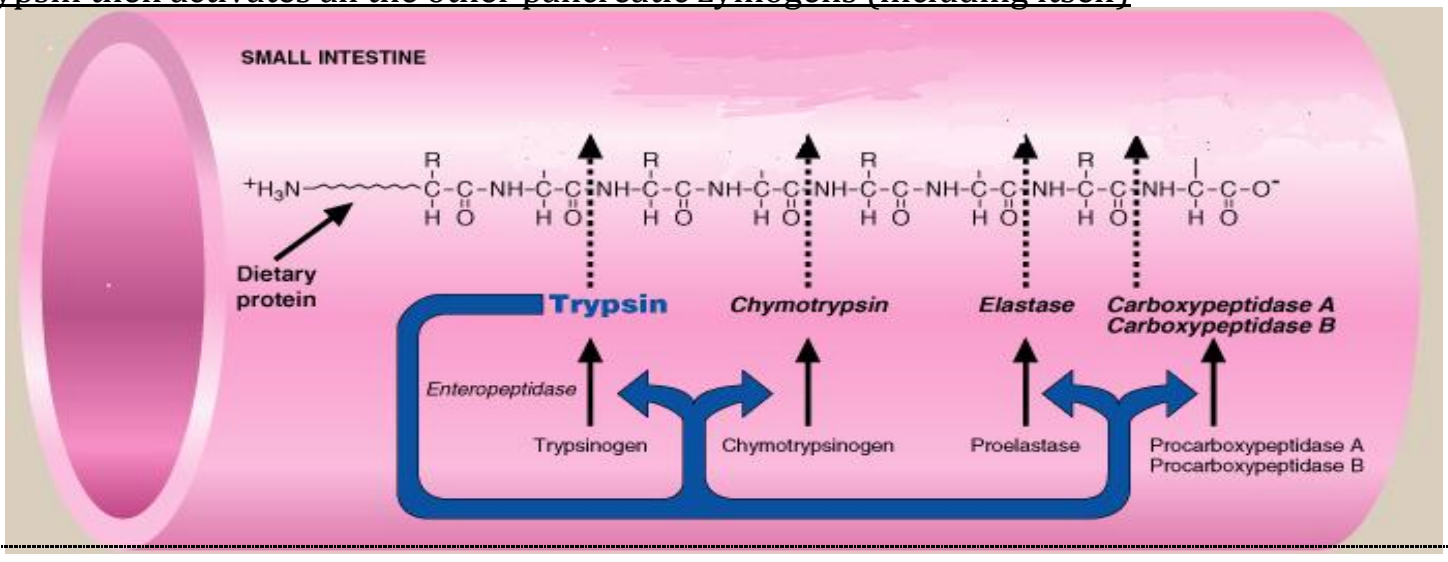
2

Digestion of Proteins by Pancreatic enzymes:

- The pancreatic secretion contains a group of pancreatic proteases
- Each of these enzymes has a different specificity for the cleavage sites
- These proteases are synthesized and secreted as inactive zymogens to avoid destruction of protein content of pancreatic tissue

Activation of Pancreatic enzymes:

Enteropeptidase is an enzyme synthesized by, and present on the luminal surface of intestinal mucosal cells (the brush border membrane)
Enteropeptidase activates trypsin by removal of a peptide group {conversion of trypsinogen into trypsin}
Trypsin then activates all the other pancreatic zymogens (including itself)



Pancreatic enzymes

Zymogen:
Trypsinogen
Active enzyme:
Trypsin (endopeptidase)
Activating enzyme:
1- Enteropeptidase
2- Trypsin (autocatalysis)

Zymogen:
Proelastase
Active enzyme:
Elastase (endopeptidase)
Activating enzyme:
Trypsin

Zymogen:
Chymotrypsinogen
Active enzyme:
Chymotrypsin (endopeptidase)
Activating enzyme:
Trypsin

Zymogen:
ProCarboxypeptid-ases
Active enzyme:
Carboxypeptidases (exopeptidase acting at C terminus)
Activating enzyme:
Trypsin

Function:

Breakdown of polypeptides into oligopeptides (mainly) + some amino acids
The importance of the multiple types of enzymes and the specificity of their cleaving sites is to produce all types of amino acids

Control:

The digestion in small intestine is hormonally controlled.
Two small peptide hormones are released from cells of the upper part of small intestine:

1- Cholecystokinin (CCK)

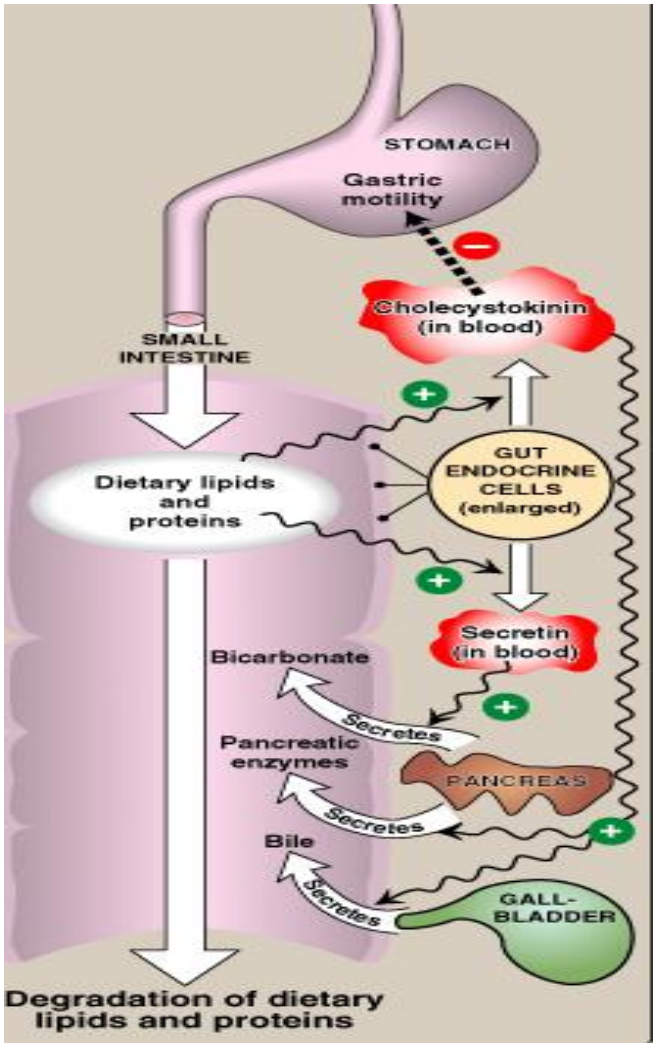
Stimulus of secretion:
The presence of partially digested proteins (& lipids) in the upper small intestine.

Effects:
- Stimulates the release of pancreatic digestive enzymes to increase digestion.
- Stimulates the contraction of the gall bladder & release of bile.
- Decreases gastric motility → slower release of gastric contents into the small intestine.

2- Secretin

Stimulus of secretion:
Low pH of the chyme entering the intestine

Effects:
Stimulates the pancreas to release a watery solution rich in bicarbonate to neutralize the pH of the intestinal contents (to reach the optimum pH for digestive activity by pancreatic enzymes).

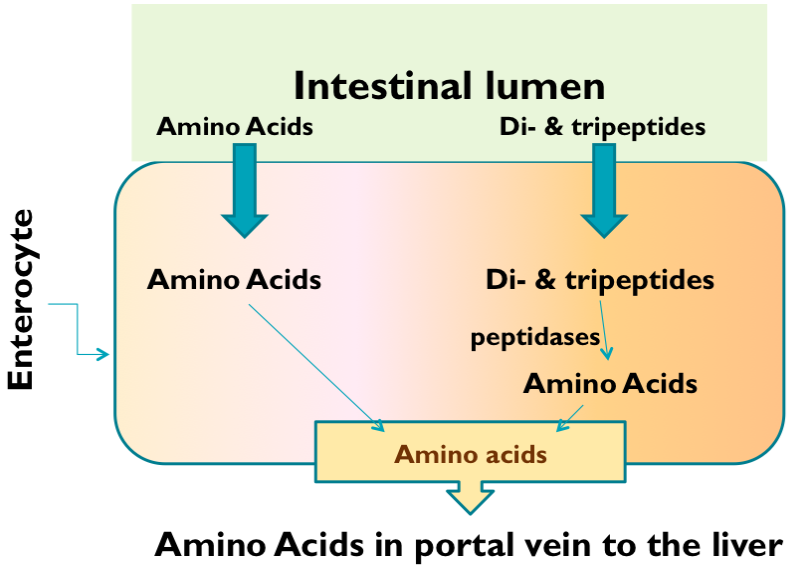


3 Digestion of proteins by small intestinal enzymes:

Oligopeptides that result from the action of pancreatic proteases are cleaved into free amino acids and smaller peptides (di- & tri-peptides) by intestinal aminopeptidase (an exopeptidase on the luminal surface of the intestine that acts on the N terminus)

Absorption of digested proteins:

Note that di and tri peptides are able to cross the luminal surface of the enterocytes but not the basolateral → require an intracellular enzyme (di or tri peptidase) to break them into amino acids first



Abnormalities in protein digestion:

Pancreatic insufficiency → decreased production of pancreatic enzymes→ incomplete digestion & absorption of lipids & proteins → abnormal appearance of lipids (steatorrhea) & undigested proteins in the feces, leading to fowl smelled floating feces
e.g., chronic pancreatitis, cystic fibrosis, surgical removal of the pancreas or auto-antibodies

Celiac Disease (Celiac sprue):

- It is a disease of malabsorption resulting from immune-mediated damage to the small intestine in response to ingestion of gluten
- Gluten is a protein found in wheat, rye, and barley

Biochemical Aspects of Digestion of Dietary Carbohydrates:

Considered the main food component
Carbohydrates digestion is rapid:
Generally completed by the time the gastric contents reach the junction between the duodenum & jejunum.

Sites for digestion of dietary carbohydrates:

- The mouth
- The intestinal lumen

Dietary carbohydrates:

Arranged according to size as well as portion of ingested food

1. Polysaccharides:
   - Starch from plant origin
   - Glycogen from animal origin
   - Cellulose from plant origin

Contain α (1→4) & α (1→6) bonds

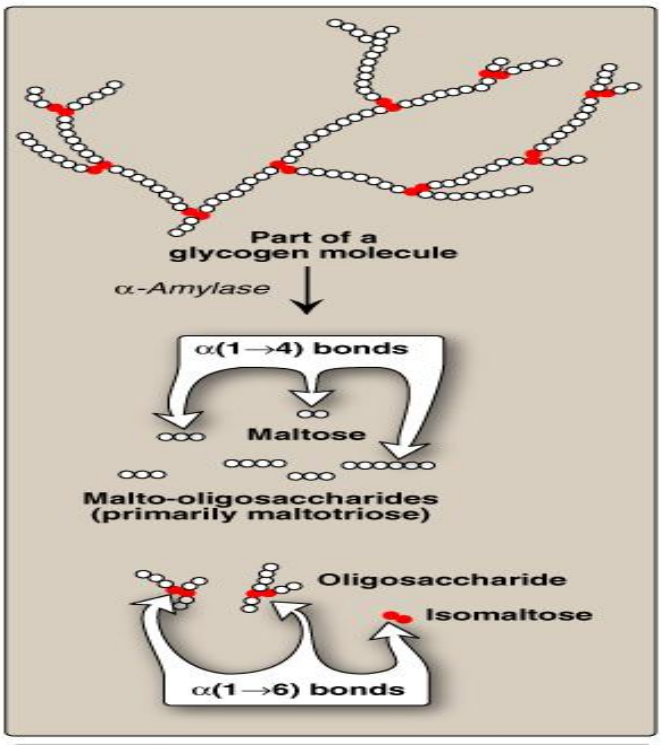
Contains β (1→4) bonds

2. Oligosaccharides
3. Disaccharides:
   Sucrose, Lactose, Maltose
4. Monosaccharides: Little amounts
   Glucose, Galactose, Fructose

Cellulose is non-digestible in humans because they lack enzymes with the ability to break β (1→4) bonds

Enzymes for Digestion of Dietary Carbohydrates:

- α-Amylase (Both salivary & pancreatic):
  Substrate: Polysaccharides
  Pancreatic are more potent because salivary are inactivated in the stomach by acidity
- Disaccharidases (Intestinal):
  Substrate: Disaccharides
- Isomaltase & α(1,6) glucosidase (Intestinal):
  Substrate: Branch points of oligo- and di-saccharides (isomaltose = maltose where glucose are attached by a 1→6 bond, instead of 1→4)



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
Trisaccharides: maltotriose

Notes:

- No dietary carbohydrate digestion occurs in the stomach (the high acidity of the stomach inactivates the salivary α–amylase).
- Pancreatic α–amylase continues the process of starch & glycogen digestion in the small intestine (Secreted by pancreas but works in small intestine)

Serum level of α-Amylases:

Normal level in serum: 25 -125 U/L
Fiound intracellularly
The clinical significance of rising circulating levels of α-amylase activity:

Diagnosis of acute pancreatitis
(damage of pancreatic cells → release & activation of the intracellular enzymes into the blood)

-Its level starts to rise within few hours
-Reaches a peak within 12- 72 hours
-Then returns to normal within few days because it is a self-limiting disease (when no complications occur)

note: α amylase and lipase are diagnostic enzymes

Final digestion of carbohydrates by intestinal enzymes in the small intestine:

Enzymes:

Secreted by & remain associated with the luminal side of the brush border membranes of the intestinal mucosal cells

Location of their action:

The mucosal lining of the jejunum
They include:

- Disaccharidases
- α(1,6) Glucosidase (for branched oligosaccharides)

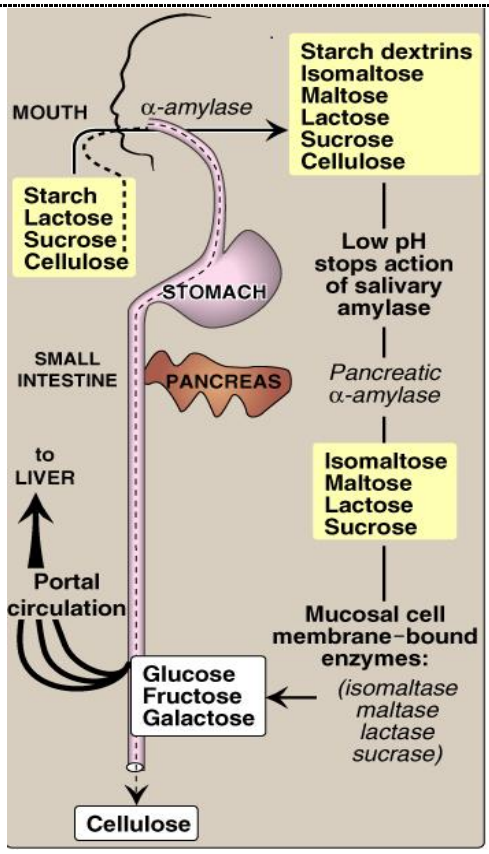
Intestinal disaccharidases:

Enzyme: Isomaltase
Substance: Isomaltose
Product: 2 Glucose

Enzyme: Sucrase
Substance: sucrose
Product: Glucose & fructose

Enzyme: Maltase
Substance: maltose
Product: 2 Glucose

Enzyme: Lactase (β-galactosidase)
Substance: lactose
Product: Glucose & galactose



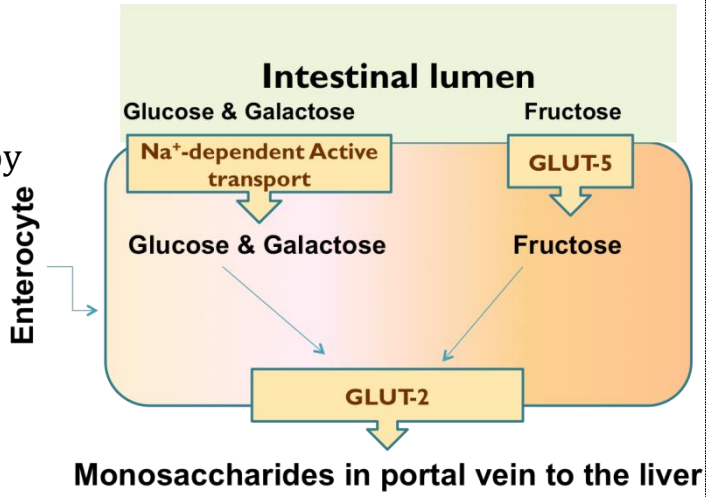
Dietary cellulose cannot be digested due to the absence of enzyme that can cleave β (1-4) bonds. It passes through the GIT largely intact. Despite that, it has several beneficial effects.

Absorption of Monosaccharides by Intestinal Mucosal Cells:

Location: Duodenum & upper jejunum

Insulin is not required for the uptake of glucose by intestinal cells

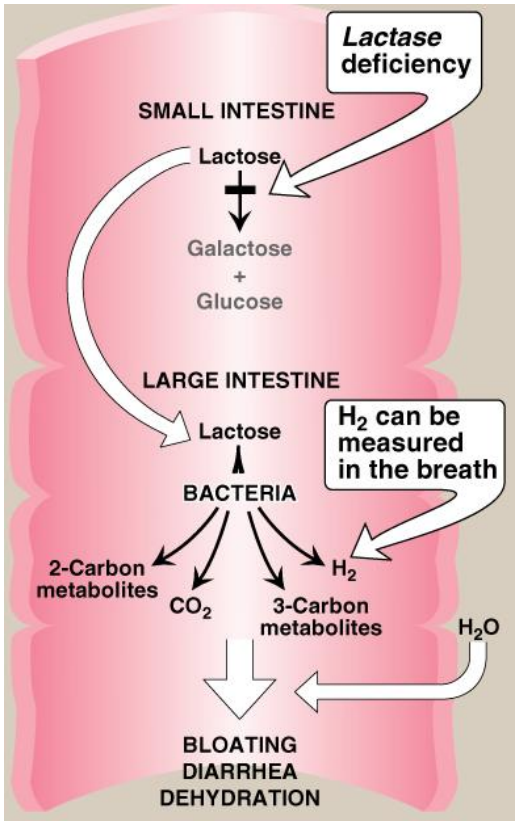
Different monosaccharides have different mechanisms of absorption (both facilitated/passive carrier mediated by GLUT) and active transport (Energy-dependent co-transport or secondary transport).



Abnormal digestion of disaccharides (e.g. of lactose):

Lactose intolerance (Lactase deficiency):

Lactase (β-galactosidase) deficiency → Undigested carbohydrate in large intestine → bacterial fermentation of the undigested compounds in the large intestine → CO_2, H_2 gas production → abdominal cramps, → osmotic diarrhea & distension (flatulence).



Take home message

Digestion of dietary proteins:

- The stomach, the pancreas & the small intestine produce proteolytic enzymes responsible for digestion of dietary proteins.
- The digestion of proteins in the stomach is the result of the action of HCl, pepsin & rennin
- Pancreatic proteases are, like pepsin, synthesized and secreted as inactive zymogens

Digestion of dietary proteins:

- The intestinal digestion of proteins occurs in the small intestine's lumen, on the luminal surface of the small intestine, and is completed intracellularly to produce free amino acids
- In pancreatic insufficiency, the digestion and absorption of fat & protein is incomplete → steatorrhea & appearance of undigested proteins in the feces

Digestion of dietary carbohydrates:

- Salivary α-amylase acts on dietary glycogen & starch in the mouth
- Pancreatic α-amylase continues the process of polysaccharide digestion in small intestine.
- The final digestive processes of carbohydrates into monosaccharides occur at the mucosal lining of the small intestine by disaccharidases & α(1,6) glucosidase
- Dietary cellulose cannot be digested due to the absence of enzyme that can cleave β (1-4) bonds, so it passes through the GIT largely intact. Despite that, it has several beneficial effects.

Digestion of dietary carbohydrates:

- Absorption of the monosaccharides requires specific transporters (GLUTs).
- Lactose intolerance is due to deficiency of lactase enzyme and causes abdominal cramps, diarrhea & flatulence.

Questions:

Trypsinogen is converted into trypsin by:

1- Endopeptidase
2- Exopeptidase
3- Enteropeptidase
4- Pancrease

High concentration of Acid (H+) in the small intestine , will stimulate which ofo the following hormones:

1- CCK
2- Secretin
3- Gastrin
4- Somatostatin

The product of digestion of proteins in the stomach is:

1- Polypeptides
2- Oligopeptides
3- Amino Acids
4- Dipeptides

Oligopeptides are cleaved into amino acids by:

1- Trypsin
2- Intestinal aminopeptidase
3- Bile salt
4- All are wrong

The digestion of Carbohydrates takes place in all of the following except:

1- Mouth
2- Stomach
3- Small intestine
4- None of the above

Patient came to the hospital suffered from a very sharp epigastric pain, and was diagnosed with Acute Pancreatitis. What would you see in the serum of the blood sample?

1- Totally normal
2- Increased a-Amylase
3- Increased coagulation enzyme
4- Decreased Lipase

Answers:

3 2 1 2 2 2

Best wishes from the students:
Khalid Alkhamis & Turki Alotaibi & Hadeel Helmi