DIGESTION AND ABSORPTION OF CARBOHYDRATES WITH CLINICAL CORRELATIONS

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Objectives:

1. To illustrate the action of salivary $\alpha$-amylase
2. To illustrate the action of pancreatic $\alpha$-amylase
3. To differentiate between salivary and pancreatic $\alpha$-amylase
4. To describe the process of digestion of carbohydrate in the mouth, stomach and duodenum
5. To define disaccharidases
6. To describe the mechanism of absorption of glucose and other monosaccharides and their transport across the intestinal epithelium
7. To describe lactose intolerance and classify it according to its sources and etiology

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Digestion of carbohydrates starts in the mouth upon contact with saliva during mastication.

Saliva contains a carbohydrate splitting enzyme called salivary amylase, which digests starch into small segments of α-dextrins and into individual soluble sugars.
Action of salivary α-amylase:

It requires Cl⁻ ion for activation with an optimum pH of 6.7 (6.6 - 6.8). The enzyme hydrolyse α-1→4 glycosidic linkage deep inside the polysaccharide molecule.
Digestion in the stomach:

Sucrose + HCl → Fructose + Glucose

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Digestion in the duodinum:

1. Food bolus reaches the duodinum from the stomach where it meets the pancreatic juice.

2. Pancreatic juice contains a carbohydrate splitting enzyme, pancreatic amylase similar to salivary amylase.

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Action of pancreatic α-amylase:

- It is α-amylase and requires Cl- ion for activation with an optimum pH of 7.1.

- The enzyme hydrolyses an α-1\(\rightarrow\) 4 glycosidic linkage deep inside the polysaccharide molecule.

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Note: pancreatic $\alpha$-amylase is an isoenzyme of salivary $\alpha$-amylase, differ only in the optimum pH of action.
What are disaccharidases?
- **Maltase** cleaves maltose into two molecules of glucose
- **Lactase** cleaves lactose into a glucose and a galactose
- **Sucrase** cleaves sucrose into a glucose and a fructose
Absorption of Glucose and other Monosaccharides:

Transport across the Intestinal Epithelium

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Interstitial fluid and blood → epithelial cells of small intestine

**Glucose permease**

**Na-K ATPase**

**Na-glucose symport**

Lumen of small intestine

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Fructose is not co-transported with sodium. Rather it enters the enterocyte by another hexose transporter (GLUT5).
**Lactose intolerance**: is the inability to hydrolyze lactose in the upper small intestine. The consequences of that are inability to absorb lactose and bacterial fermentation of ingested lactose in the lower small intestine will occur. Bacterial fermentation results in the production of gas (distension of gut and flatulence) and osmotically active solutes that draw water into the intestinal lumen (diarrhea).
Symptoms of lactose intolerance

Normal digestion:
- Lactose
- Glucose
- Lactase
- Galactose
- Normal stools

Lactose intolerance:
- Lactose
- Small intestine
- Bacterial fermentation
  - Gases
  - Lactic acid
  - Loose, watery stools
- Large intestine
- Water
- Abdominal distension and pain
- Possible nappy rash

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Causes

Congenital

In congenital lactose intolerance, there is a complete absence or deficiency of lactose enzyme. Thus the child develops intolerances immediately after birth.

It is diagnosed in early infancy

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Acquired during life time

Primary

Secondary

Lactose Intolerance
Conclusions:

- Salivary $\alpha$-amylase enzyme hydrolyse $\alpha-1\,4$ glycosidic linkage
- Pancreatic $\alpha$-amylase enzyme hydrolyse $\alpha-1\,4$ glycosidic linkage
- Pancreatic $\alpha$-amylase is an isoenzyme of salivary $\alpha$-amylase, differ only in the optimum pH of action
- Digestion of carbohydrate in the
  - mouth: action of Salivary $\alpha$-amylase
  - stomach: Sucrose $\overset{HCl}{\rightarrow}$ Fructose + Glucose
  - duodenum: action of Pancreatic $\alpha$-amylase

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Brush border enzymes (hydrolases),

The transporter that carries glucose and galactose into the enterocyte is the sodium-dependent hexose transporter, known more formally as SG LUT-1. However fructose is not co-transported with sodium. Rather it enters the enterocyte by another hexose transporter (G LUT5).

Lactose intolerance: is the inability to hydrolyze lactose. It might be congenital or acquired.
Any questions: