METABOLISM

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ARKAN ACADEMY

Carbohydrates

- Sugars consist of a carbon skeleton with a *carbonyl* group and *many hydroxyl*-groups
  - If the carbonyl located **peripherally**, the sugar is considered as an **aldose**
  - If the carbonyl located in the **middle**, the sugar is considered as a **ketose**
    - ✓ Most ketoses end with -ulose

The majority of sugars are aldoses

- *Monosaccharide:* A single sugar, such as:
  - Triose (3C): Glyceraldehyde
  - Tetrose (4C): Erythrose
  - Pentose (5C): Ribose
  - Hexose (6C): Glucose, Galactose, mannose, Fructose
  - Heptose (7C): Sedoheptulose
  - Nonose (9C): Neuraminic acid

Glucose (aldose): 3
Galactose (aldose): 3,4
Mannose (aldose): 3,2
Fructose (ketose)

- Isomers: molecules with the same molecular formula but different structures, and they include:
  - ***Constitutional isomers:*** Difference in the position of the carbonyl group (***ketose, aldose***)
  - ***Stereoisomers:*** difference in the orientation of the OH group on the chiral carbons
    - ✓ *Enantiomers: all* the chiral carbons are reflected (*mirror* image)
    - ✓ *Diastereomers: 1 or more* chiral carbons are reflected (not mirror image)
    - ✓ *Epimer: 1* chiral carbon is reflected (not mirror image)
  - ***Anomer:*** Isomers depend on the orientation of the anomeric carbon (carbon of the carbonyl)
    - ✓ *Down*ward OH on the anomeric carbon, *alpha* isomer
    - ✓ *Up*ward OH on the anomeric carbon, *beta* isomer

- *Disaccharides:* 2 sugars joined by a glycosidic bond via dehydration reaction, such as:
  - *Maltose* consists of ***2 glucose*** molecules (homodimer)
  - *Lactose* consists of ***galactose*** and ***glucose*** molecules (heterodimer)

- Glycosidic bond is cleaved by **glycosidase** enzyme via hydrolysis, such as:
  - *Amylase:* hydrolyzes *α 1-4* glycosidic linkage and it is specific to *starch*
    - ✓ Produced in the saliva and pancreas
    - ✓ It breaks starch into smaller oligo- or disaccharides which are digested into monosaccharides by ***mucosal cell membrane enzymes***
    - ✓ Amylase is ***not active in the stomach*** due to acidity

Cellulose is not broken down inside our bodies

  - *Isomaltase* break the *α 1-6* bond of isomaltose
  - *Maltase* breaks the *α 1-4* bond of maltose
  - *Sucrase* breaks the *α 1-2* bond of sucrose

Exoglycosidase (Glucoamylase) breaks the *α 1-4* and *α 1-6* bonds

- *Lactase* breaks the *β 1-4* bond of lactose
- *Trehalase* breaks the *α 1-1* bond of trehalose

Sucrase-isomaltase complexes

- Complexes encoded in 1 gene forming ***1 polypeptide*** having ***2 hydrolytic*** activities involving a *maltase* with another *glycosidase* including *sucrase-maltase* activity and *isomaltase-maltase* activity
  - Inserted in the apical surface of the intestines and toward the lumen
  - It is a glycoprotein which is modified pre-translationally

- Clinical Notes:
  - *Sucrase-isomaltase deficiency* can be due to genetic mutations, intestinal diseases (such as Celiac and Crohn's diseases), malnutrition, injury of the mucosa (by drugs) and severe diarrhea
  - *Lactase deficiency:* Mostly genetic and causes diarrhea and blotting (gases due to normal flora)
    - ✓ Half of the world population
    - ✓ Lactase reaches its maximum activity at the **first month** of birth and its activity decreases until reaching the adults level at 5-7 years (10% of the max)

- Absorption of Sugars
  - Na^+ - independent facilitated diffusion: In the apical and basal membrane of the intestinal cells
    - ✓ Down the concentration gradient (no energy needed)
    - ✓ Involve glucose transporters (***GLUT 1-14***) which transport most monosaccharides from the lumen of the intestine into the cells then into the circulation and vice versa (***Bidirectional***)
    - ✓ *GLUT 1:* High affinity glucose transporter in the barriers
    - ✓ *GLUT 2:* High capacity, low affinity transporter for *glucose, galactose, fructose*
      - It performs glucose sensor in the pancreas
    - ✓ *GLUT 3:* In the central nervous system
    - ✓ *GLUT 4:* Stimulates the movement of glucose to intestines and adipose tissue (***Insulin sensitive***)
    - ✓ *GLUT 5 (Fructose): Fructose* transporter (in sperms)
    - ✓ *GLUT 7:* In the endoplasmic reticulum
  - Na^+ monosaccharide cotransporter system (SGLT): In the *apical* surface of the intestinal cells
    - ✓ Against the concentration gradient (requires energy, active transport)
    - ✓ It also presents in the *proximal kidney tubules* to prevent the loss of sugars in the urine

Past Papers

1. The fructose-specific transporter is:

   A. GLUT 4
   B. GLUT 5
   C. GLUT 7
   D. GLUT 1
   E. SGLT

2. Lactase is a_____ enzyme that is used in digestion of_____bond:

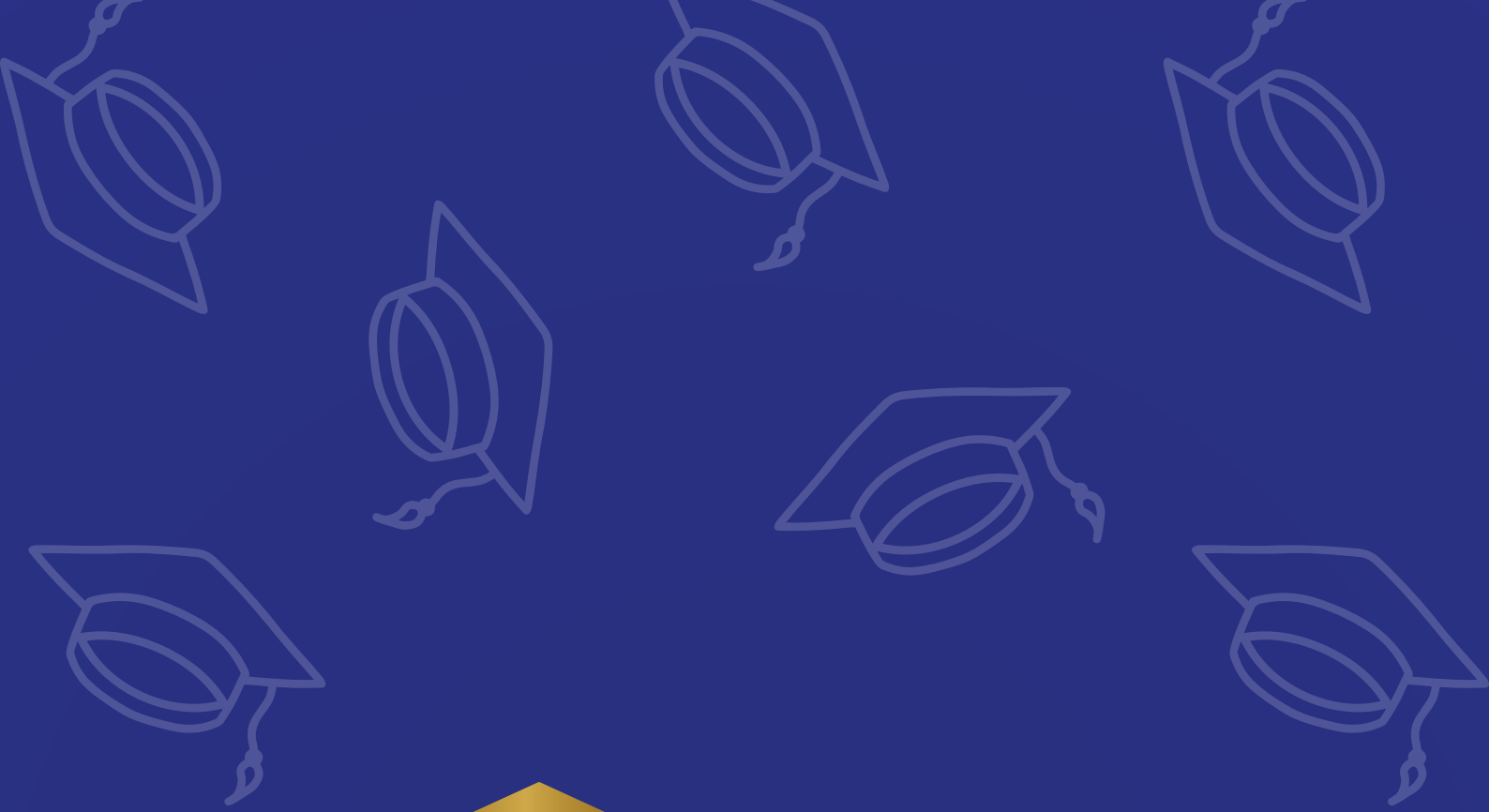
   A. Mucosal cell-membrane bound, alpha 1,6
   B. Mucosal cell-membrane bound, alpha 1,2
   C. Pancreatic, alpha 1,4
   D. Mucosal cell-membrane bound, beta 1,4
   E. Pancreatic, alpha 1,1

3. True about isomaltase-sucrase enzyme:

   A. It's composed of 2 polypeptide chains.
   B. It can metabolize lactose, sucrose and isomaltose.
   C. It is a glycoprotein.
   D. It's cleaved pre-translationally.

4. Which of these transporters is insulin dependent glucose transferase?

   A. Glut 5
   B. Sglt
   C. Glut 4
   D. Glut 3
   E. Glut 7



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