ALAYEN IRAQI
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COLLAGE OF DENTISTRY

الفرع العلمي: العلوم الأساسية

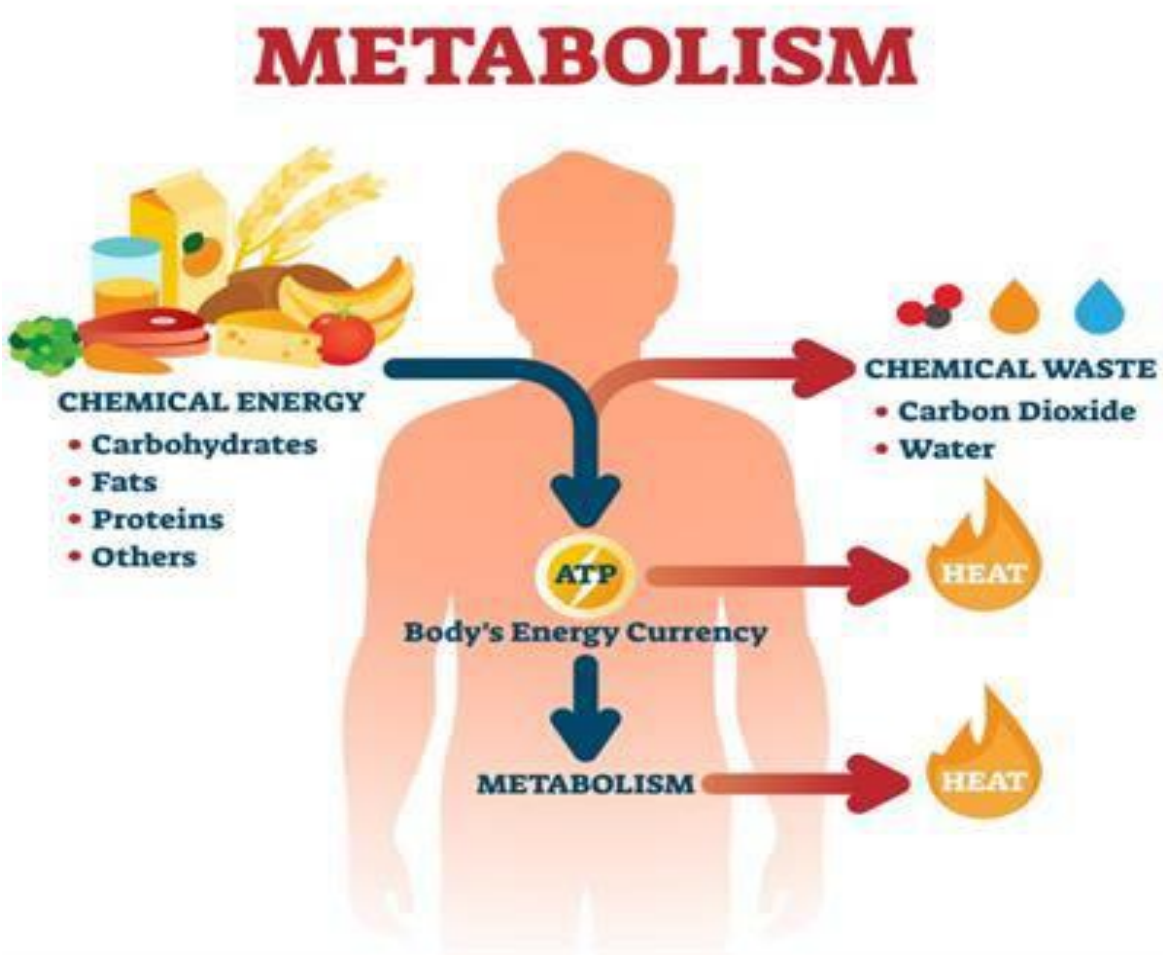
المادة: Biochemistry

المحاضرة: (Metabolism)

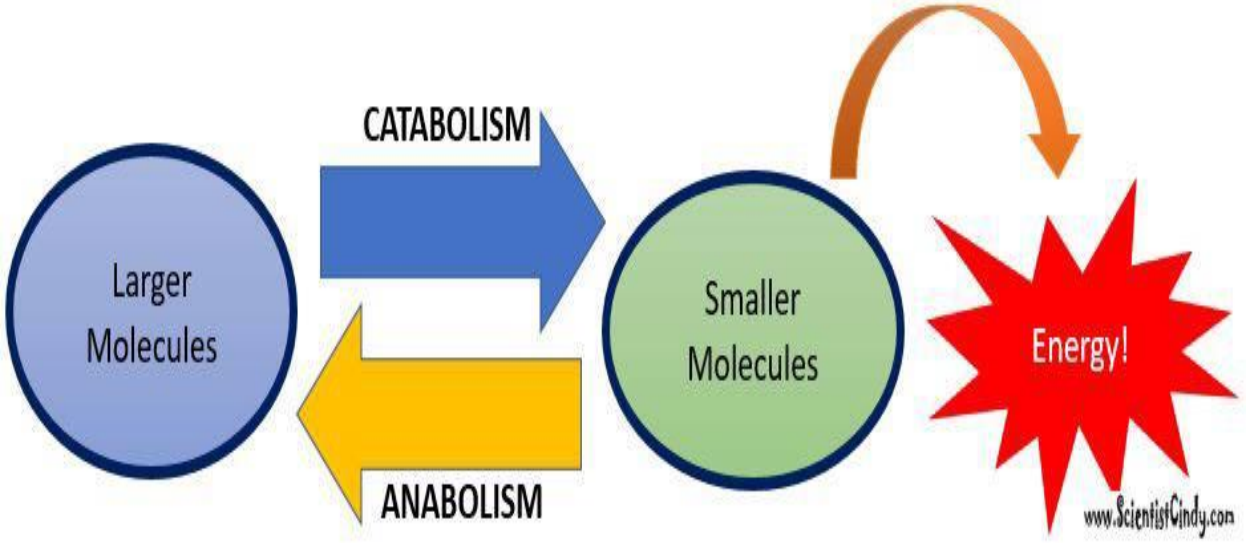
اسم تدريسي المادة: م.م شاكر غليون

Metabolism

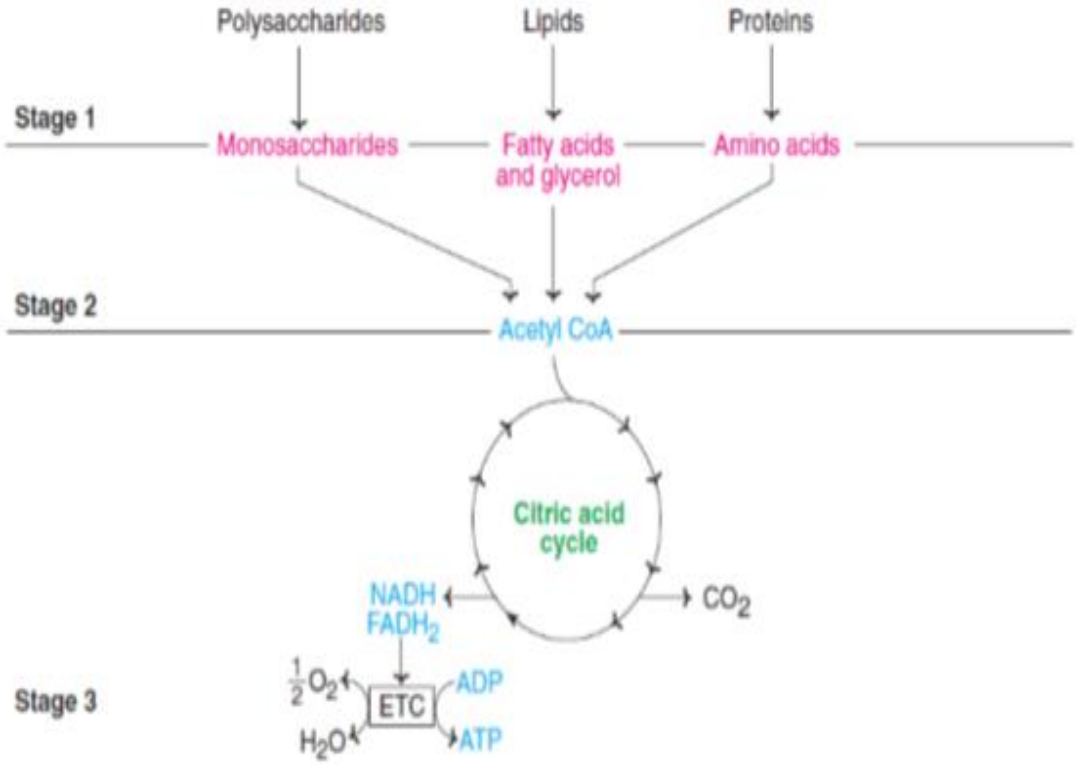
Metabolism is the chemical reactions in the body's cells that change food into energy. Our bodies need this energy to do everything from moving to thinking to growing. Specific proteins in the body control the chemical reactions of metabolism



METABOLISM



1. **Anabolism**: The biosynthetic reactions involving The formation of complex molecules from simple precursors.
2. **Catabolism**: The degradative processes concerned with the breakdown of complex molecules to simpler ones, with a concomitantrelease of energy.



The three stages of catabolism (ETC–Electron transport chain).

1. Conversion of complex molecules into their building blocks: Polysaccharides are broken down to monosaccharides, lipids to free fatty acids and glycerol, proteins to amino acids.

2. Formation of simple intermediates: The building blocks produced in stage (1) degraded to simple intermediates such as pyruvate and acetyl CoA. These intermediates are not readily identifiable as carbohydrates, lipids or proteins. A small quantity of energy (as ATP) captured in stage

3. Final oxidation of acetyl CoA: Acetyl CoA completely oxidized to CO2, liberating NADH and FADH2 that finally oxidized to release large quantity of energy (as ATP). Krebs cycle (or citric acid cycle) is the common metabolic pathway involved in the final oxidation of all energy-rich molecules. This pathway accepts the Carbon compounds (pyruvate, succinate etc.) derived from carbohydrates, lipids or proteins.

Types of metabolic reactions

The biochemical reactions are mainly of four types:

1. Oxidation-reduction.
2. Group transfer.
3. Rearrangement and isomerization.
4. Make and break of carbon-carbon bonds.

… Specific enzymes catalyze these reactions.

Metabolism of Carbohydrates

Major pathways of carbohydrate metabolism

The important pathways of carbohydrate metabolism listed:

1. **Glycolysis**: The oxidation of glucose to pyruvate and lactate.
2. **Citric acid cycle (Krebs cycle or tricarboxylic acid cycle):** The oxidation of acetyl CoA to CO2. Krebs cycle is the final common oxidative pathway for carbohydrates, fats or amino acids, through acetyl CoA.

3. **Gluconeogenesis**: The synthesis of glucose from non-carbohydrate precursors (e.g. amino acids, glycerol etc.).

4. **Glycogenesis**: The formation of glycogen from glucose.

5. **Glycogenolysis**: The breakdown of glycogen to glucose.
6. **Hexose monophosphate shunt (pentose phosphate pathway or direct oxidative pathway)**: This pathway is an alternative to glycolysis and TCA cycle for the oxidation of glucose (directly to carbon dioxide and water).

7. **Uronic acid pathway**: Glucose converted to glucuronic acid, pentoses and, in some animals, to ascorbic acid (not in man). This pathway is also an alternative oxidative pathway for glucose.
8. **Galactose metabolism**: The pathways concerned with the conversion of galactose to glucose and the synthesis of lactose.
9. **Fructose metabolism**: The oxidation of fructose to pyruvate and the relation between fructose and glucose metabolism.

10. **Amino sugar and mucopolysaccharide metabolism**: The synthesis of amino sugars and other sugars for the formation of mucopolysaccharides and glycoproteins.

Entry of glucose into cells:

Glucose concentration is very low in the cells compared to plasma (for human's < 100 mg/dl). However, glucose does not enter the cells by simple diffusion. Two specific transport systems recognized for the entry of glucose into the cells.

1. Insulin-independent transport system of glucose: This is a carrier-mediated uptake of glucose, which is not dependent on the hormone Insulin. This is operative in hepatocytes, erythrocytes and brain.

2. Insulin-dependent transport system: This occurs in muscle and adipose tissue.

Glucose transporters:

In recent years, at least six glucose transporters (GLUT-1 to GLUT-5 and GLUT-7) in the cell membranes were been identified. They exhibit tissue specificity. For instance, GLUT-1 is abundant in erythrocytes whereas GLUT-4 is abundant in skeletal muscle and adipose tissue. Insulin increases the number and promotes the activity of GLUT-4 in skeletal muscle and adipose tissue. In type 2 diabetes mellitus, insulin resistance observed in these tissues. This is due to the reduction in the quantity of GLUT-4 in insulin deficiency.

GLUT Isoform	K_m (substrate) mM	Tissue & Characteristics
GLUT-1	5 (glucose)	Resting glucose uptake in most cells, including muscle
GLUT-2	10-15 (glucose, [galactose & fructose])	Liver, pancreas β cells, kidney, enterocytes
GLUT-3	1-2 (glucose)	Mainly brain (note low K_m), also found at low levels in other tissues
GLUT-4	3-5 (glucose)	Insulin-sensitive tissues – Skeletal muscle, adipose tissue
GLUT-5	6 (fructose)	Jejunum

Fig (3) Glucose transporters

Thank You