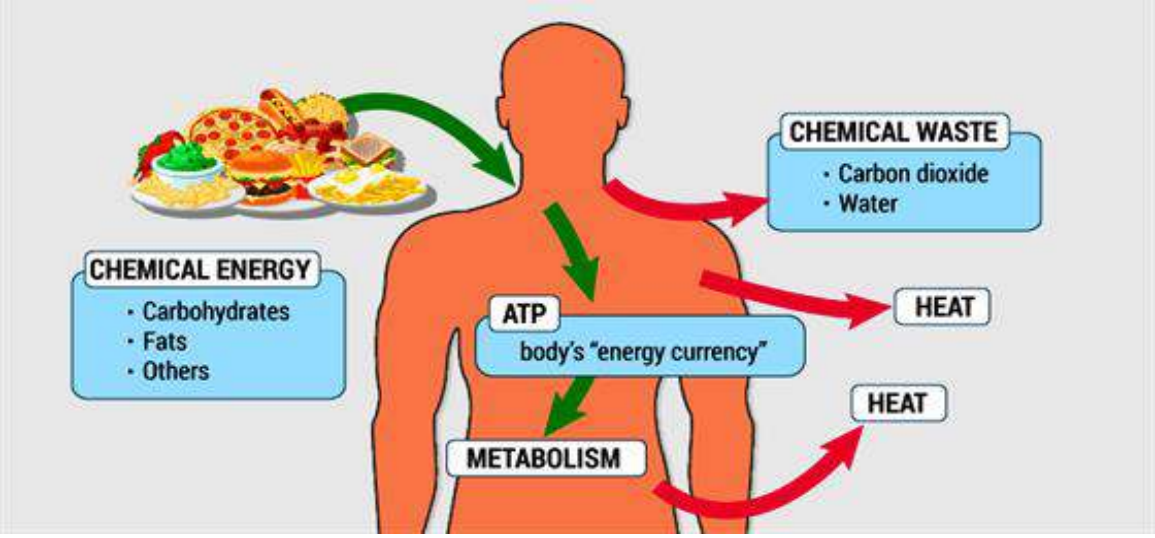
Metabolism

Metabolism:- is the set of chemical reactions that take place within each cell of a living organism . these processes allow organisms to grow and reproduce , maintain their structures and respond to their environment.

The main purposes of metabolism are:-

1. conversion of energy in the food to available energy for run cellular processes.
2. conversion of the food to building blocks for proteins, lipids, nucleic acids, and some carbohydrates.
3. elimination of metabolic wastes as a waste product.

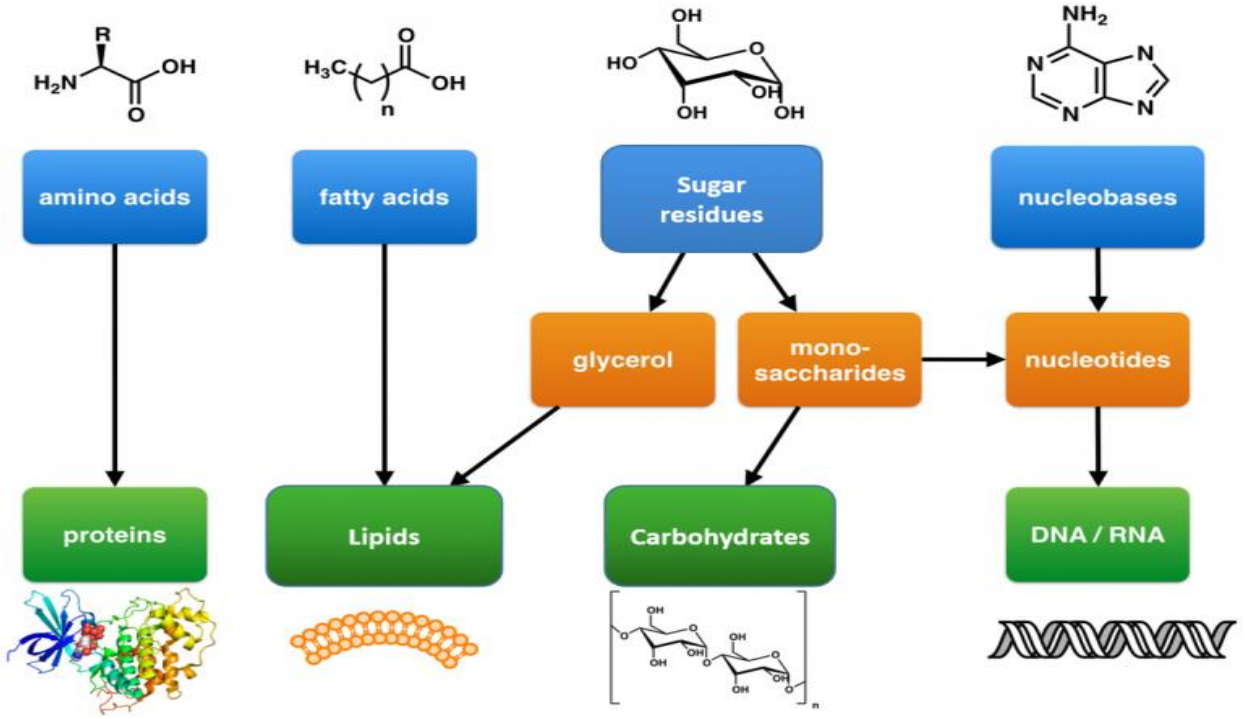


The chemical reactions of metabolism are organized into metabolic pathways, in which one chemical is transformed through a series of steps into another chemical, each step being facilitated by a specific enzyme. Enzymes are crucial to metabolism because they allow organisms to drive desirable reactions that require energy and will not occur by themselves, by coupling them to spontaneous reactions that release energy. Enzymes act as catalysts – they allow a reaction to proceed more rapidly – and they also allow the regulation of the rate of a metabolic reaction, for example in response to changes in the cell's environment or to signals from other cells.

Metabolism

metabolism start by the digestion of nutrients obtained from diet where:- the complex molecules of carbohydrate , proteins and lipids obtained from diet are converted into simple molecule (glucose ,amino acid and fatty acids respectively) then absorbed in to intestine from which the simple molecules moves through the hepatic part vein to the liver which is the factory responsible for more than 90% of the metabolic processes

Most of the structures that make up animals, plants and microbes are made from four basic classes of molecules: amino acids, carbohydrates, nucleic acid and lipids (often called fats) .As these molecules are vital for life, metabolic reactions either focus on making these molecules during the construction of cells and tissues, or on breaking them down and using them to obtain energy, by their digestion. These biochemicals can be joined to make polymers such as DNA and proteins, essential macromolecules of life.



The Molecular building blocks of life are made from organic compounds.

Metabolism

The metabolism is classified into two categories:-

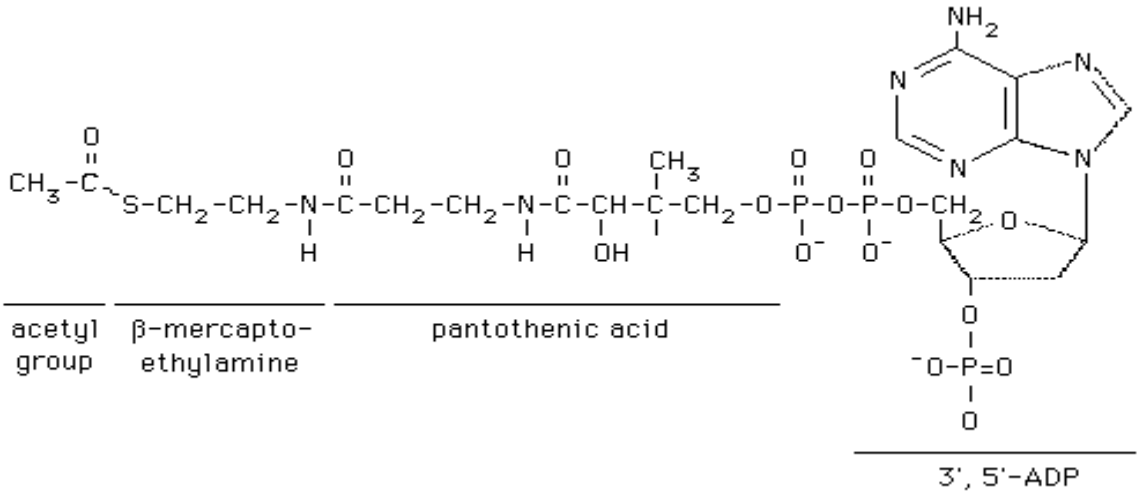
Catabolism:- is the set of metabolic processes that breakdown the large molecules(complex molecules) into small molecules . The purpose of the catabolic reactions is to provide the energy which stored in ATP molecule(Adenosine Tri-phosphate called the bank of energy) and components needed by anabolic reactions which required for life , cell reproduction and build molecules.

The most common set of catabolic reactions in animals can be separated into three main stages:-

In the first stage- large organic molecules, such as proteins, polysaccharides or lipids, are digested into their smaller components outside cells.

In the second stage- these small molecules are taken up by cells and converted to smaller molecules, usually acetyl coenzyme A (acetyl-CoA), which releases some energy.

(acetyl-CoA is a molecule that participates in many biochemical reactions in protein, carbohydrate and lipid metabolism. Its main function is to deliver the acetyl group to the citric acid cycle (Krebs cycle) to be oxidized for energy production. Coenzyme A (CoASH or CoA) consists of a β-mercaptoethylamine group linked to the vitamin pantothenic acid (B5) through an amide linkage and 3'-phosphorylated ADP)



Acetyl coenzyme A, showing its constituents

Metabolism

In the third stage -the acetyl group on the CoA is oxidized to water and carbon dioxide in the citric acid cycle and electron transport chain, releasing the energy of O2 while reducing the coenzyme nicotinamide adenine dinucleotide (NAD+) into NADH.

(Nicotinamide adenine dinucleotide (NAD) is a coenzyme central to metabolism. Found in all living cells, NAD is called a dinucleotide because it consists of two nucleotides joined through their phosphate groups. One nucleotide contains an adenine nucleobase and the other nicotinamide. NAD exists in two forms: an oxidized and reduced form, as NAD+ and NADH (H for hydrogen), respectively.)

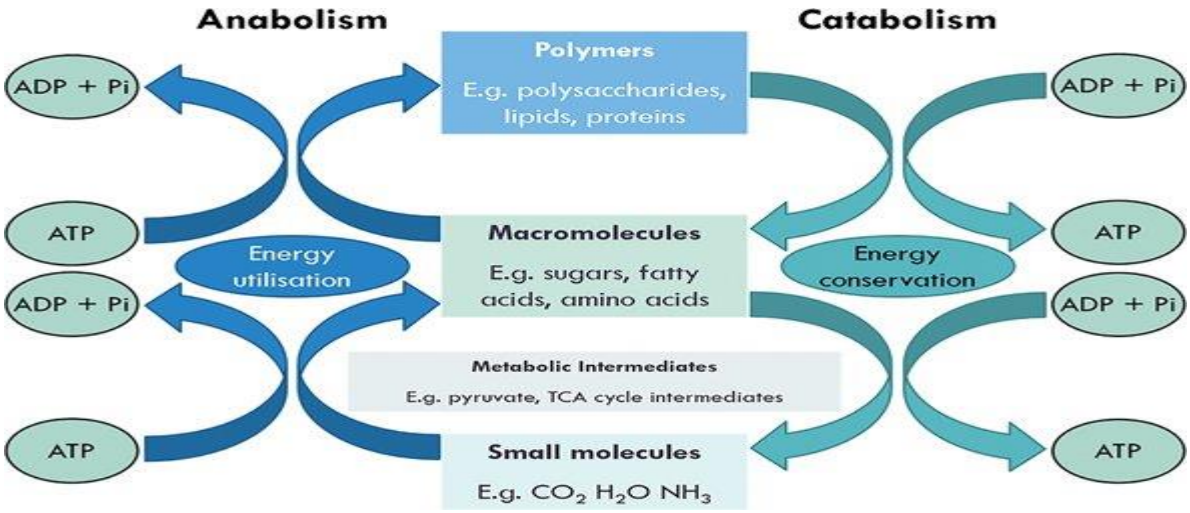
Anabolism:- is the set of metabolic processes where the energy released by catabolism is used to synthesize complex molecules which that make up cellular structures are constructed from smaller and simpler precursors .

Anabolism involves three basic stages .

In the first stage- the production of precursors such as amino acids, monosaccharides and nucleotides ,

In the second stage- activate the precursors by using energy from ATP.

In the third stage- the assembly of these precursors into complex molecules such as proteins, polysaccharides, lipids and nucleic acids.



Metabolism

Carbohydrate metabolism:- **(part one)**

In carbohydrate metabolism we will study, the types of carbohydrate, how they are digested and absorbed, then we will study the cycles of carbohydrate oxidation which generate the energy required for life…. these cycles are:

1. Glycolysis :Glucose oxidation(breakdown of glucose to get energy).
2. Gluconeogenesis:(formation of Glucose form non-carbohydrate sources).
3. Krebs cycle:(release stored energy through the oxidation of acetyl-CoA).
4. Glycogen Metabolism including breaking and formation of glycogen.
5. Pentose phosphate pathway which generate NADH.

A) Types of carbohydrates:

- Monosaccharides
  They are those carbohydrates that cannot be hydrolyzed into simpler carbohydrates.
  They may be classified as trioses (3-carbon sugar), tetroses (4-carbon sugar), pentoses (5-carbon sugar), hexoses (6-carbon sugar);Examples for Hexoses: glucose , fructose , galactose and mannose

- Disaccharides
  are condensation products of two monosaccharide units; Example: maltose , sucrose and lactose

- Oligosaccharides
  are condensation products of 2 to 10 monosaccharides; Example: maltotriose and raffinose

- Polysaccharides
  are condensation products of more than ten monosaccharide units; examples : starches , dextrins and glycogen which may be linear or branched polymers.

B) Carbohydrate digestion:

After eating , digestion begins as follow:

1. In the mouth , salivary amylase , hydrolyze starch partially into a mixture of dextrins and maltose.
2. In the stomach , salivary amylase continues hydrolysis of starch only for few minutes then stop because the pH becomes acidic due to the presence of the HCl in stomach and this is unfavorable condition for the amylase to work.
3. In the intestine , pancreatic amylase , completes the digestion of starch into maltose with little Isomaltose and Maltotriose which are then hydrolyzed in the intestine into Glucose , Fructose and Galactose.
4. Sucrose and the enzymes that complete hydrolysis into Monosaccharides in the mucus layer of the intestine
5. The net result of carbohydrate hydrolyses is glucose, fructose and Galactose

Starch + H2O ===== ***Amylase*** =====> Dixterns + Maltose

Dixterns + H2O ===== ***Amylase*** =====> Maltose + Isomaltose + Maltotriose

Maltotriose + H2O ===== ***Maltase*** =====>Maltose + Glucose

Maltose + H2O ===== ***Maltase*** =====> Glucose + Glucose

Isomaltose + H2O===== ***Isomaltase*** ===> Glucose + Glucose

Sucrose + H2O====== ***Sucrase*** =====>Glucose + Fructose

Lactose + H2O ======***Lactase*** =====>Glucose + Galactose