Metabolism

Metabolism - the sum of all chemical processes carried out by living cells

Microbial metabolism : all chemical changes occurring in a microbe during its growth and development for healthy and stable maintenance occurring for activities such as :

- Movement
- Growth
- Synthesis
- Foodstuff
- Reproduction

Catabolism - the chemical reactions that break larger molecules into smaller molecules. It is usually an exergonic process.

Anabolism - the chemical reactions that form larger molecules from smaller molecules. It is usually an endergonic process.

Autotroph - an organism that obtains its energy from sunlight or inorganic chemicals. Plants, photosynthetic protists, and photosynthetic prokaryotes are autotrophs.

Heterotroph - an organism that obtains its energy by consuming and degrading organic molecules. Some eat other organisms, some parasitize, and some degrade the remains of once living organisms. Animals, Fungi, many protests and most prokaryotes are heterotrophs.

Glucose is the preferred energy source of all organisms and it is the principal product of photosynthesis. Glucose breakdown can be aerobic (using oxygen) or anaerobic (without oxygen). Anaerobic metabolism of glucose is also known as **anaerobic glycolysis** or **fermentation**.
Aerobic metabolism of glucose is known as **glycolysis and respiration**.

Complete aerobic metabolism of glucose produces water and carbon dioxide as products.

$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$

Energy is released in this process. The overall ΔG of glucose breakdown in cells is -720 kcal/mole. Normally about 32% of the energy released is captured through the formation of ATP. The remainder is released as heat

All microbial metabolisms can be arranged according to three principles:

1. How the organism obtains carbon for synthesizing cell mass:

- **autotrophic** – carbon is obtained from carbon dioxide (CO_2)
- **heterotrophic** – carbon is obtained from organic compounds
- **mixotrophic** – carbon is obtained from both organic compounds and by fixing carbon dioxide

2. How the organism obtains reducing equivalents used either in energy conservation or in biosynthetic reactions:

- **lithotrophic** – reducing equivalents are obtained from inorganic compounds
- **organotrophic** – reducing equivalents are obtained from organic compounds

3. How the organism obtains energy for living and growing:

- **chemotrophic** – energy is obtained from external chemical compounds
- **phototrophic** – energy is obtained from light

- **Respiration**

  Respiration is a type of heterotrophic metabolism that uses oxygen and in which 38 moles of ATP are derived from the oxidation of 1 mole of glucose, yielding 380,000 cal. (An additional 308,000 cal is lost as heat.)

- **Fermentation**

  In fermentation, another type of heterotrophic metabolism, an organic compound rather than oxygen is the terminal electron (or hydrogen) acceptor. Less energy is generated from this incomplete form of glucose oxidation, but the process supports anaerobic growth.

Metabolism

- **Krebs Cycle**

The Krebs cycle is the oxidative process in respiration by which pyruvate (via acetyl coenzyme A) is completely decarboxylated to CO_2. The pathway yields 15 moles of ATP (150,000 calories).

- **Glyoxylate Cycle**

The glyoxylate cycle, which occurs in some bacteria, is a modification of the Krebs cycle. Acetyl coenzyme A is generated directly from oxidation of fatty acids or other lipid compounds.

Acetyl CoA Formation

- Pyruvic acid is decarboxylated by the removal of CO_2 into a two carbon acetyl group
- Occurs in the mitochondria of the cell

Electron Transport

- Involves electron carrier molecules that will release energy in a controlled way
- This energy is used to generate ATP
- Occurs inner mitochondrial membrane
- Chemiosmosis

Glucose Anabolism

- Glycogenesis - conversion of glucose to glycogen; stimulated by insulin
- Glycogenolysis - hydrolysis of glycogen to form glucose; stimulated by glucagon
- Gluconeogenesis - synthesis of glucose from non-carbohydrates such as fats and amino acids

Lipid Catabolism - Lipolysis

- Hydrolysis of triglycerides into glycerol and fatty acids

Glycerol converted to G 3-P and then into pyruvic acid, then into the Kreb's cycle

Metabolism

- Beta -oxidation of fatty acids occurs forming two-carbon fragments which is then attached to coenzyme A, forming acetyl CoA

Protein Metabolism

- Proteins are converted into substances than can enter the Kreb's cycle by
- deamination - loss of (NH_2) from amino group
- decarboxylation - loss of CO_2 molecule
- dehydrogenation - loss of hydrogen atom
- Protein synthesis involves transcription and translation