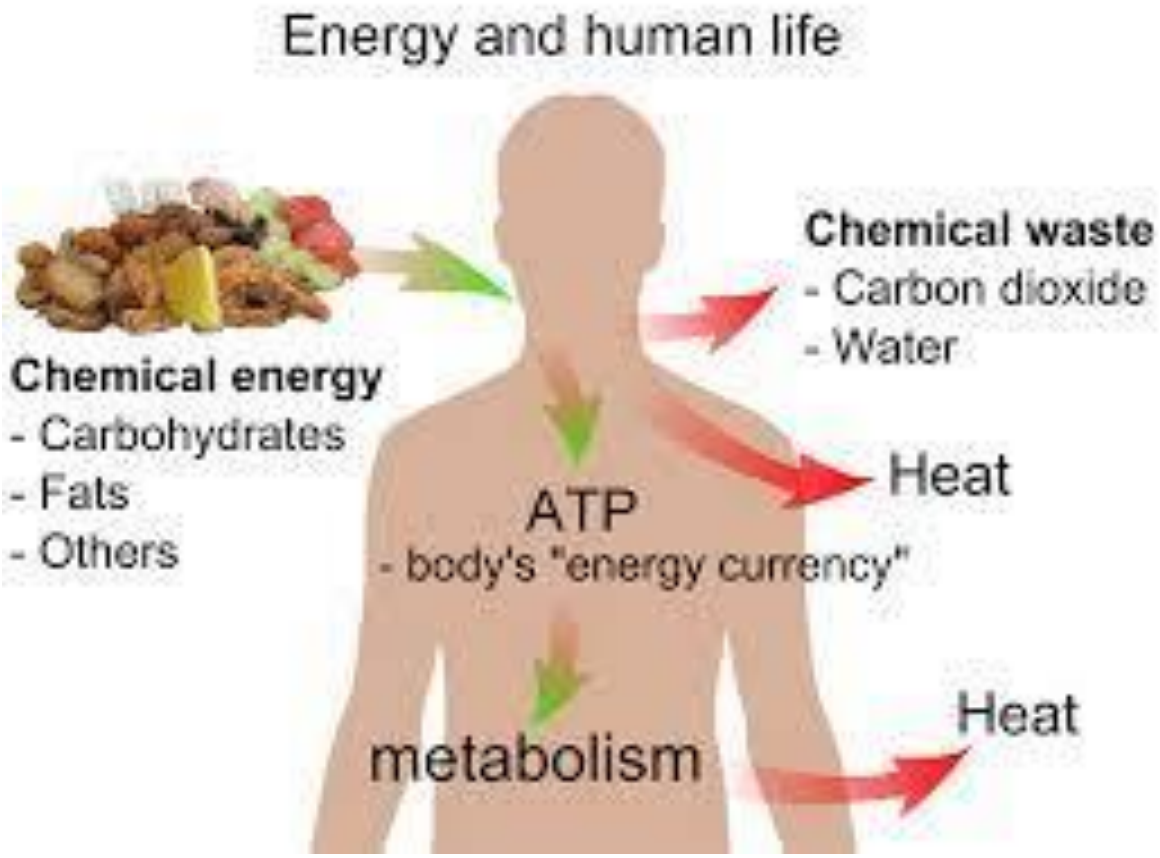
Lecture :1 **Dr. Wasan Khairallah Ali**

Metabolism

Nutrition is the key to 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 : is the set of life-sustaining chemical reactions in organisms. The three main purposes of metabolism are:

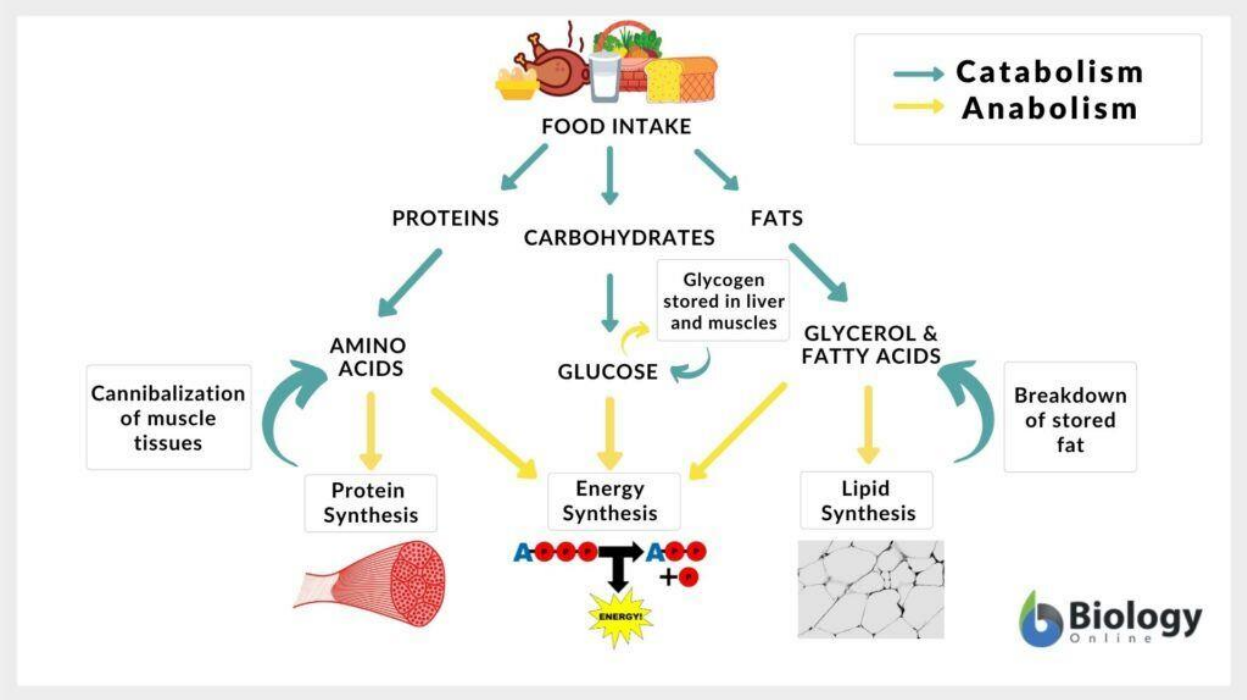
1-The conversion of the energy in food to energy available to run cellular processes;

2- The conversion of food to building blocks for proteins, lipids, nucleic acids, and some carbohydrates; and the elimination of metabolic wastes. These enzyme-catalyzed reactions allow organisms to grow and reproduce, maintain their structures, and respond to their environments.

3-The word metabolism can also refer to the sum of all chemical reactions that occur in living organisms, including digestion and the transportation of substances into and between different cells, in which case the above described set of reactions within the cells is called intermediary (or intermediate) metabolism.

Metabolic reactions may be categorized as catabolic – the breaking down of compounds (for example, of glucose to pyruvate by cellular respiration); or anabolic – the building up (synthesis) of compounds (such as proteins, carbohydrates, lipids, and nucleic acids). Usually, catabolism releases energy, and anabolism consumes energy.

The chemical reactions of metabolism are organized into metabolic pathways. These allow the basic chemicals from nutrition to be transformed through a series of steps into another chemical, by a sequence of enzymes.



How Does Metabolism Work?

After we eat food, the digestive system uses enzymes to:

1 -break proteins down into amino acids

2 - Turn fats into fatty acids

3- Turn carbohydrates into simple sugars (for example, glucose)

The body can use sugar, amino acids, and fatty acids as energy sources when needed. These compounds are absorbed into the blood, which carries them to the cells.

After they enter the cells, other enzymes act to speed up or regulate the chemical reactions involved with "metabolizing" these compounds. During these processes, the energy from these compounds can be released for use by the body or stored in body tissues, especially the liver, muscles, and body fat.

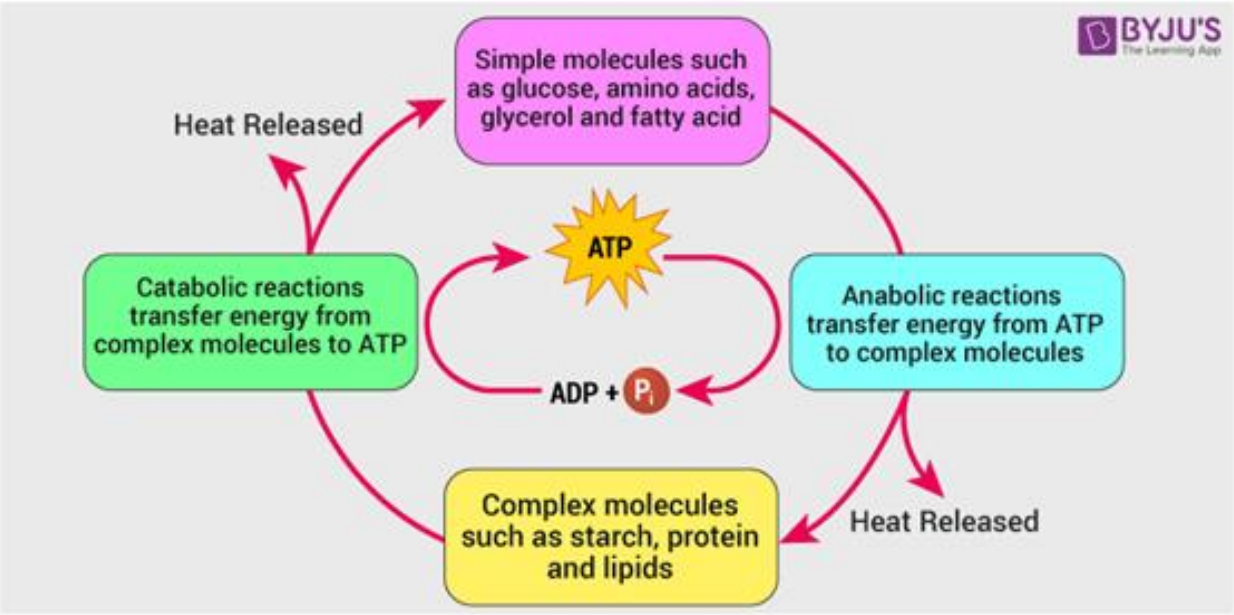
Enzymes are crucial to metabolism because they allow organisms to drive desirable reactions that require energy. These reactions also are coupled with those that release energy. As enzymes act as catalysts they allow these reactions to proceed quickly and efficiently. Enzymes also allow the regulation of metabolic pathways in response to changes in the cell's environment or signals from other cells.

metabolism, the sum of the chemical reactions that take place within each cell of a living organism and that provide energy for vital processes and for synthesizing new organic material.

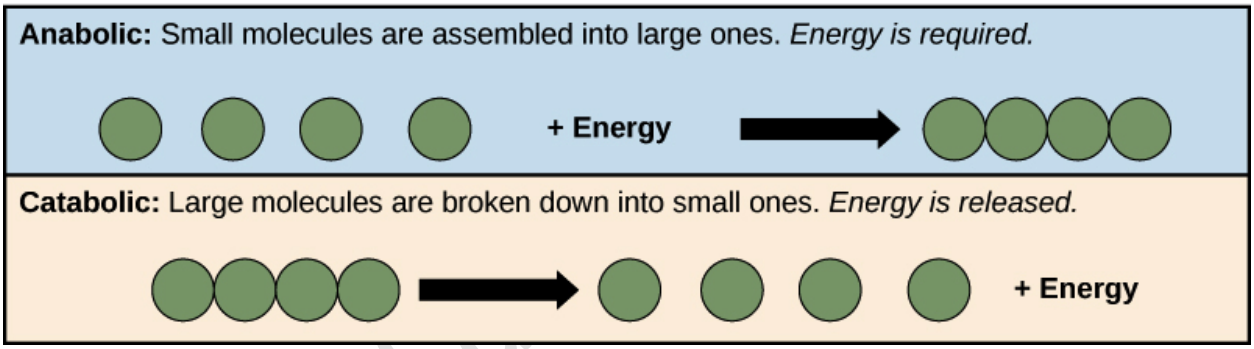
Metabolic Process

There are three types of metabolic process:

- Catabolism
- Anabolism
- Amphibolic



Metabolic pathways



1-Catabolism – This process is mainly involved in breaking down larger organic molecules into smaller molecules. This metabolic process releases energy.

Catabolism is a degradative phase of metabolism in which large molecules are converted into smaller and simpler molecules, which involves two types of reactions. **First**, hydrolysis reactions, in which catabolism is the breaking apart of molecules into smaller molecules to release energy. Examples of catabolic reactions are digestion and cellular respiration, where sugars and fats are broken down for energy. Breaking down a protein into amino acids, or a triglyceride into fatty acids, or a disaccharide into monosaccharides are all hydrolysis or catabolic reactions. **Second,** oxidation reactions involve the removal of hydrogens and electrons from an organic molecule.

Stages of Catabolism

Catabolism can be broken down into 3 main stages. The three stages are as explained as follows:

Stage 1 – Stage of Digestion

The large organic molecules of organic chemistry like proteins, lipids, and polysaccharides are digested into their smaller components outside cells. This stage acts on starch, cellulose or proteins that cannot be directly absorbed by the cells.

Stage 2 – Release of energy

Once the molecules are broken down, these molecules are taken up by cells and converted to yet smaller molecules, usually acetyl coenzyme A, which releases some energy.

Stage 3 – Energy Stored

The released energy is stored by reducing the coenzyme nicotinamide adenine dinucleotide into NADH.

2-Anabolism – This process is mainly involved in building up or synthesizing compounds from simpler substances required by the cells. This metabolic process requires and stores energy.

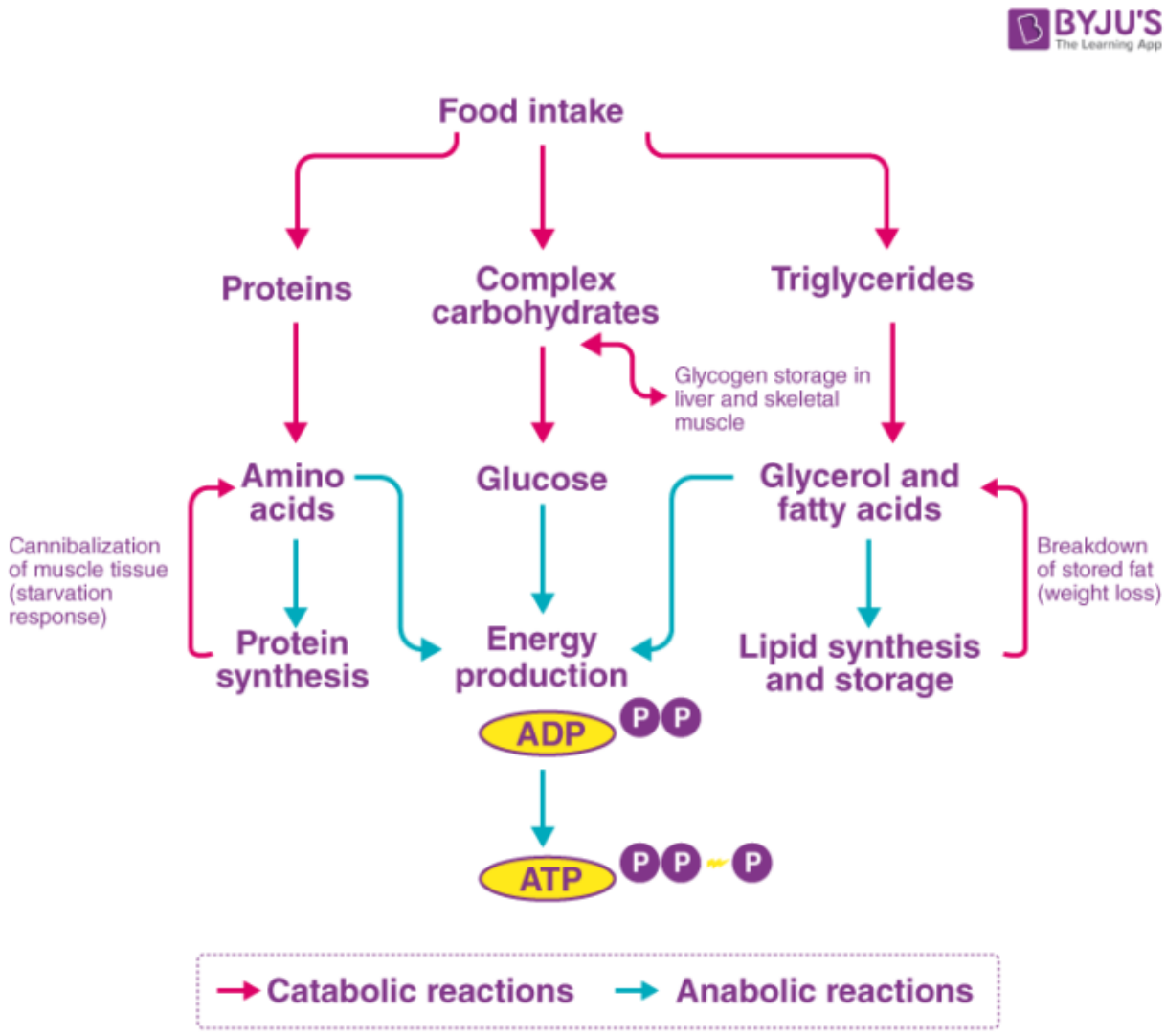
Anabolism is the biosynthesis phase of metabolism in which smaller simple precursors are converted to large and complex molecules of the cell. Anabolism has two classes of reactions. The first are dehydration synthesis reactions; these involve the joining of smaller molecules together to form larger, more complex molecules. These include the formation of carbohydrates, proteins, lipids and nucleic acids. The second are reduction reactions, in which hydrogens and electrons are added to a molecule. Whenever that is done, molecules gain energy.

3-Amphibolic : The term is used to describe a biochemical pathway that involves both catabolism and anabolism. The term amphibolic was proposed by B. Davis in 1961 to emphasise the dual metabolic role of such pathways.These pathways are considered to be central metabolic pathways which provide, from catabolic

sequences, the intermediates which form the substrate of the metabolic processes.

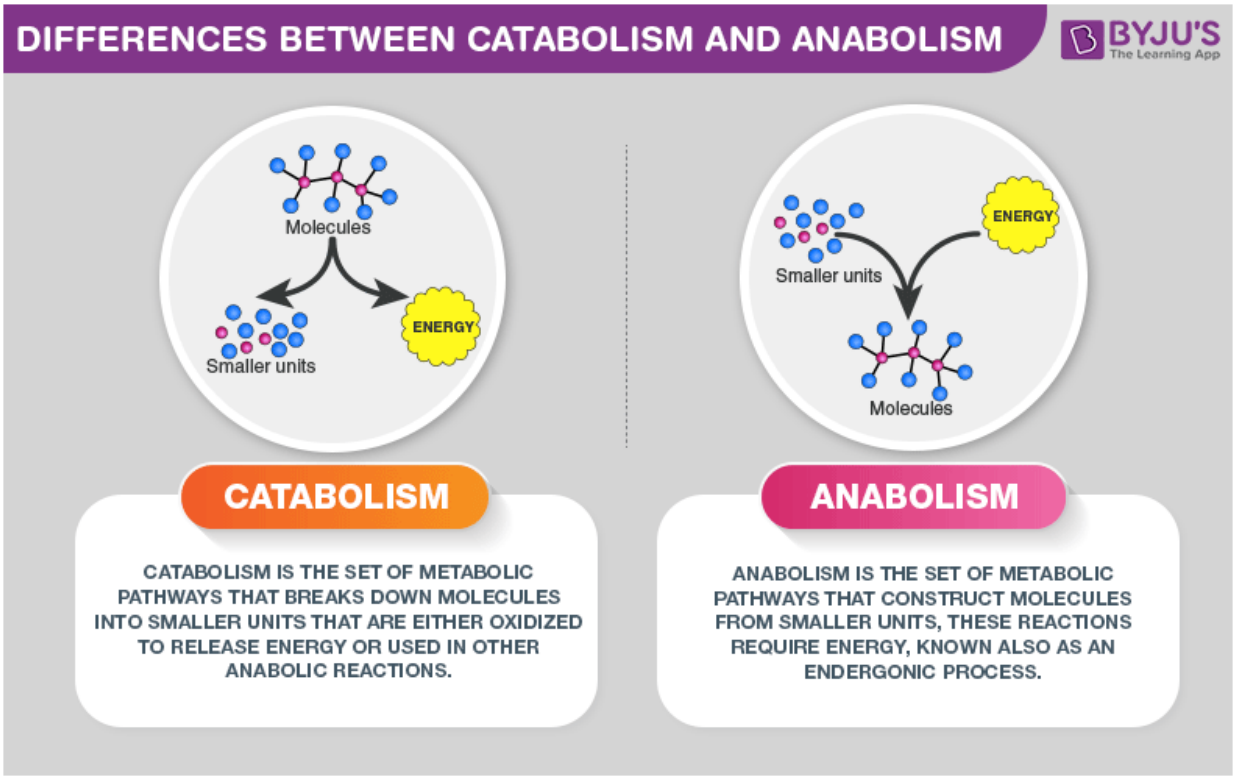
All the reactions associated with synthesis of biomolecule converge into the following pathway, glycolysis, the Krebs cycle and the electron transport chain, exist as an amphibolic pathway, meaning that they can function anabolically as well as catabolically.

This process provides the chemical energy necessary for the maintenance and growth of cells. Some examples of the catabolic processes include glycolysis, the citric acid cycle, the breakdown of muscle protein in order to use the amino acids as substrates for gluconeogenesis, the breakdown of fat in adipose tissue to fatty acids, and oxidative deamination of neurotransmitters by monoamine oxidase.



Differences Between Catabolism and Anabolism

The concept of anabolism and catabolism have been adopted in the fitness industry as well. They are employed to achieve two different goals. The anabolic workout focuses on building muscle mass whereas, catabolic workout focuses on shedding weight and burning more calories. The major differences between catabolism and anabolism are summarized below.



Difference Between Catabolism and Anabolism	
Catabolism	**Anabolism**
Catabolism breaks down big complex molecules into smaller, easier to absorb molecules.	Anabolism builds molecules required for the body's functionality.
The process of catabolism releases energy.	Anabolic processes require energy.
Hormones involved in the processes are adrenaline, cytokine, glucagon, and cortisol.	Hormones involved in the process are estrogen, testosterone, growth hormones and insulin.
Examples of catabolic processes are proteins becoming amino acids, glycogen breaking down into glucose and triglycerides breaking up into fatty acids.	Examples include the formation of polypeptides from amino acids, glucose forming glycogen and fatty acids forming triglycerides.
In catabolism, potential energy is changed into kinetic energy.	In anabolism, kinetic energy is converted into potential energy.
It is required to perform different activities in living entities.	It is required for maintenance, growth, and storage.

Difference between anabolism and catabolism		
Criteria	**Anabolism**	**Catabolism**
Process	Synthesis process (Constructive)	Breakdown process (Destructive)
ATP requirement	Required	Released
Energy-wise	Endergonic	Exergonic
Oxygen utilization	No	Yes
Important role in	Growth and development, bone mineralization, etc	Digestion, respiration, etc.

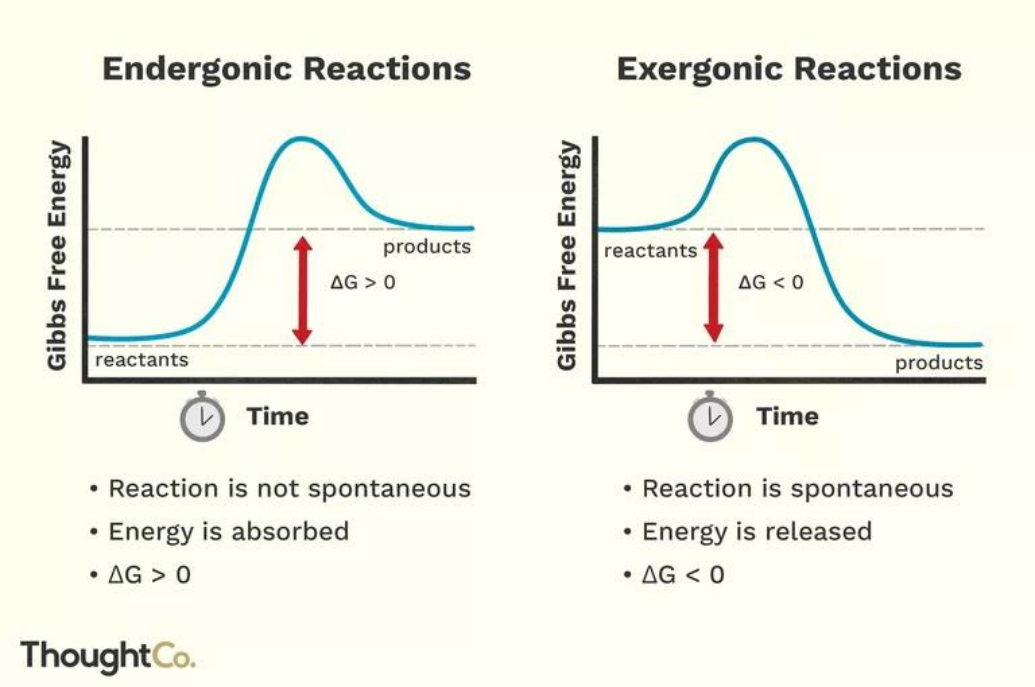
Endergonic and exergonic

Endergonic and exergonic are two types of chemical reactions, or processes, in thermochemistry or physical chemistry. The names describe what happens to energy during the reaction. The classifications are related to endothermic and exothermic reactions, except endergonic and exergonic describe what happens with any form of energy, while endothermic and exothermic relate only to heat or thermal energy.

1-Endergonic reactions require energy input to take simple, low energy reactants and build complex, high energy products. Exergonic reactions release the energy bound up in the reactants and yield simpler, low energy products.

2-Exergonic Reactions

An exergonic reaction may be called a spontaneous reaction or a favorable reaction. Exergonic reactions release energy to the surroundings .The chemical bonds formed from the reaction are stronger than those that were broken in the reactants.



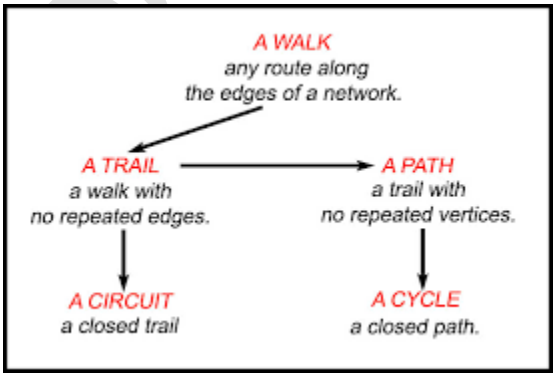
Differentiate between exergonic and endergonic reactions.

Exergonic reaction	Endergonic reaction
The exergonic reaction is a type of reaction in which free energy is released	Endergonic reactions are the type of reaction in which free energy is absorbed.
Here Gibbs free energy is negative	Here Gibbs free energy is positive
Exergonic reactions indicate that the energy is released in the system	Endergonic reactions indicate that the energy is absorbed by the system.
All the exothermic reactions are exergonic.	All endothermic reactions are endothermic.
Exergonic reactions do not require energy to begin	Endothermic reactions always require energy to begin.
It is a downhill reaction.	It is an uphill reaction
Fatty Acid Catabolism, Glycolysis, cellular respiration	DNA/RNA Synthesis, Protein synthesis, Fatty acid synthesis.

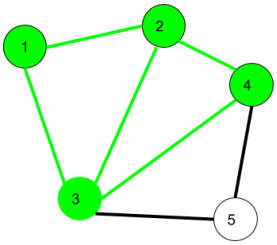
Pathway and cycle

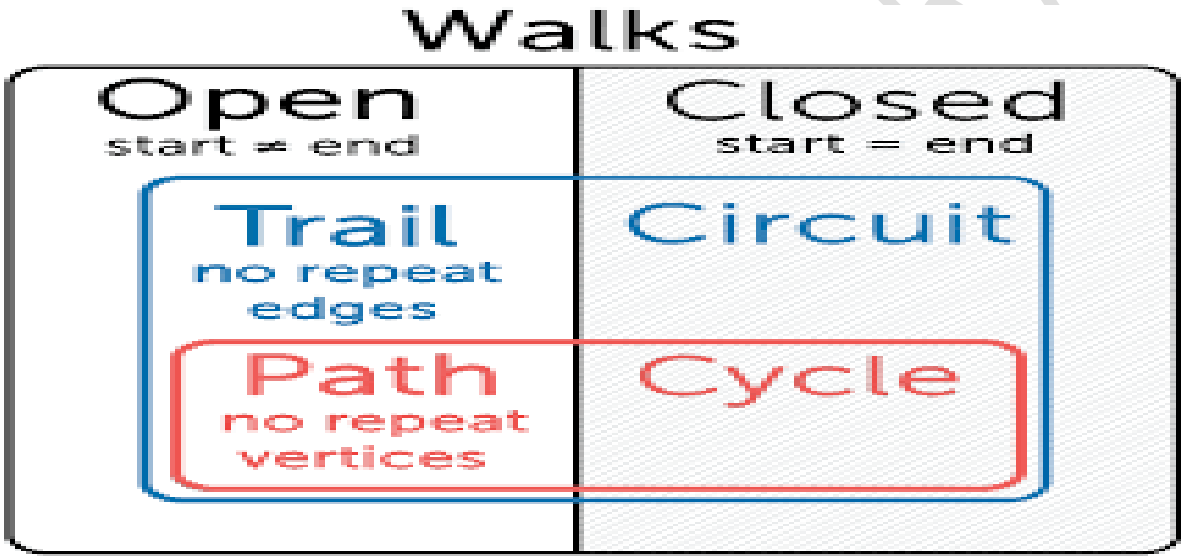
As nouns the difference between pathway and cycle is that pathway is a footpath or other path or track while cycle is an interval of space or time in which one set of events or phenomena is completed.

pathway :(biochemistry) A sequence of biochemical compounds, and the reactions linking them, that describe a process in metabolism or catabolism.



Cycle: A process that returns to its beginning and then repeats itself in the same sequence.





A path is a sequence of vertices with the property that each vertex in the sequence is adjacent to the vertex next to it. A path that does not repeat vertices is called a simple path. A circuit is path that begins and ends at the same vertex. A circuit that doesn't repeat vertices is called a cycle.

Also known as the citric acid cycle, the Krebs cycle or TCA cycle is a chain of reactions occurring in the mitochondria, through which almost all living cells produce energy in aerobic respiration. It uses oxygen and gives out water and carbon dioxide as products

A cycle is a closed path. A path is a walk with no repeated vertices. Circuits refer to the closed trails. Trails refer to a walk where no edge is repeated.

Path: a sequence of vertices, p0, p1, ..., pm, such that each adjacent pair of vertices pi and pi+1 are connected by an edge. Cycle: a simple path with no repeated vertices or edges other than the starting and ending vertices.