Plasma Enzymes

Blood plasma contains many enzymes, which are classified into functional and non-functional plasma enzymes.

Differences between functional and non-functional plasma enzymes :-

	Functional plasma enzymes	Non-functional plasma enzymes
Concentration in plasma	Present in plasma in higher concentrations in comparison to tissues	Normally, present in plasma in very low concentrations in comparison to tissues
Function	Have known functions	No known functions
The substrates	Their substrates are always present in the blood	Their substrates are absent from the blood
Site of synthesis	Liver	Different organs e.g. liver, heart, brain and skeletal muscles
Effect of diseases	Decrease in liver diseases	Different enzymes increase in different organ diseases
Examples	Clotting factors e.g. prothrombin, Lipoprotein lipase and pseudo-choline esterase	ALT, AST, CK, LDH, alkaline phosphatase, acid phosphatase and amylase,

Sources of non-functional plasma enzymes :

1. Increase in the rate of enzyme synthesis) e.g. bilirubin increases the rate of synthesis of alkaline phosphatase in obstructive liver diseases.
2. Obstruction of normal pathway e.g. obstruction of bile ducts increases alkaline phosphatase.
3. Increased permeability of cell membrane as in tissue hypoxia.
4. Cell damage with the release of its content of enzymes into the blood e.g. myocardial infarction and viral hepatitis.

Medical importance of non-functional plasma enzymes :

Measurement of non-functional plasma enzymes is important for:

1. Diagnosis of diseases as diseases of different organs cause elevation of different plasma enzymes.
2. Prognosis of the disease; we can follow up the effect of treatment by measuring plasma enzymes before and after treatment.

Examples of medically important non-functional plasma enzymes :

1. Amylase and lipase enzymes increase in diseases of the pancreas as acute pancreatitis.
2. Creatine kinase (CK) enzyme increases in heart, brain and skeletal muscle diseases.
3. Lactate dehydrogenase (LDH) enzyme increases in heart, liver and blood diseases.
4. Alanine transaminase (ALT) enzyme, it is also called serum glutamic pyruvic transaminase (SGPT). It increases in liver and heart diseases.
5. Aspartate transaminase (AST) enzyme, it is also called serum glutamic oxalacetic transaminase (SGOT). It increases in liver and heart diseases.
6. Acid phosphatase enzyme increases in cancer prostate.
7. Alkaline phosphatase enzyme increases in obstructive liver diseases, bone diseases and hyperparathyroidism.

Classification of Enzymes

Enzymes are classified according to the type of reaction they catalyze into six groups:

1. Oxido-reductases

These are enzymes that catalyze oxidation-reduction reactions.
Oxido-reductases are further classified into five subgroups:

A- Oxidases

These are enzymes that catalyze direct transfer of hydrogen to oxygen and form water e.g. cytochrome oxidase and ascorbic acid oxidase.

B- Aerobic Dehydrogenases

These are enzymes that catalyze direct transfer of hydrogen to oxygen and form hydrogen peroxide (H_2O_2) e.g. L-amino oxidase and D-amino acid oxidase.

C- Anaerobic dehydrogenases

These are enzymes cannot transfer hydrogen directly to oxygen but hydrogen is indirectly transferred to oxygen through many hydrogen carriers e.g. glucose-6-phosphate dehydrogenase and succinate dehydrogenase.

D- Hydroperoxidase

These enzymes use hydrogen peroxide (H_2O_2) as substrate changing it into water (H_2O) e.g. peroxidases and catalases

E- Oxygenases

These enzymes catalyze direct incorporation of oxygen into substrate. e.g.
i- Dioxygenases (True oxygenases): These enzymes catalyze incorporation (introduction) of two oxygen atoms into substrate e.g. tryptophan pyrrolase enzyme.
ii- Monooxygenases (pseudo-oxygenases or hydroxylases): These enzymes incorporate one oxygen atom into substrate e.g. phenylalanine hydroxylase.

2. Transferases

These are enzymes that catalyze transfer of a chemical group from one compound to another. They include:

A- Transaminases

These are enzymes that catalyze transfer of amino group ($-NH_2$) from amino acid to ?-keto acid producing new amino acid and new keto acid e.g.
i- Alanine transaminase (ALT): It is also called serum glutamic pyruvic transaminase (SGPT).
ii- Aspartate transaminase (AST): It is also called serum glutamic oxalacetic transaminase (SGOT).

B- Acyl transferases

These enzymes catalyze the transfer of acyl (fatty acid) group to compounds. They need Coenzyme-A that acts as a carrier for acyl group e.g. choline acetylase.

C- Methyl transferases

These enzymes transfer methyl group ($-CH_3$) from methyl donor usually active methionine (S-adenosyl methionine) to the substrate e.g. formation of epinephrine (adrenaline) from norepinephrine (noradrenaline).

D- Phosphotransferases

These enzymes catalyze transfer of phosphate group e.g. hexokinase and glucokinase both catalyze transfer of phosphate group from ATP to glucose.

3. Hydrolases

These enzymes catalyze cleavage of their substrates by addition of water.
All the digestive enzymes are hydrolases. Hydrolases include:

A- Enzymes hydrolyzing glycosidic link in carbohydrates

These enzymes catalyze hydrolysis of carbohydrates e.g. maltase, lactase, sucrase and amylase.

B- Lipase: Enzyme that hydrolyzes triglyceride into glycerol and three fatty acids.

C- Proteases: Enzymes that catalyze hydrolysis of proteins (proteolytic enzymes). e.g. pepsin and trypsin

D- Phosphatases:
These enzymes catalyze hydrolysis of phosphoric acid esters e.g..
i- Phosphomonoesterases that catalyze hydrolysis of phosphoric acid monoesters as glucose-6-phosphatase
ii- Phosphodiesterases that catalyze hydrolysis of phosphoric acid diesters e.g. the enzyme that catalyzes the hydrolysis of cAMP (cyclic adenosine monophosphate) to AMP.

4. Lyases (desmolases)

These enzymes catalyze cleavage of substrates or removal of chemical groups by mechanisms other than addition of water i.e. by mechanisms other than hydrolysis.
They include:

A. Aldolase: It is an enzyme that splits aldehyde from alcohol e.g. fructose-1-6-diphosphate aldolase.

B. Dehydratases: These enzymes catalyze removal of water from their substrates e.g. fumarase and carbonic anhydrase

C. Decarboxylases:
These enzymes catalyze the removal of CO_2 from their substrates.
They need pyridoxal phosphate (PLP) as coenzyme e.g. amino acids decarboxylases as histidine decarboxylase, which removes CO_2 from histidine changing it to histamine

D. Phosphorylases: These enzymes catalyze cleavage of their substrates by addition of phosphoric acid e.g. glycogen phosphorylase.

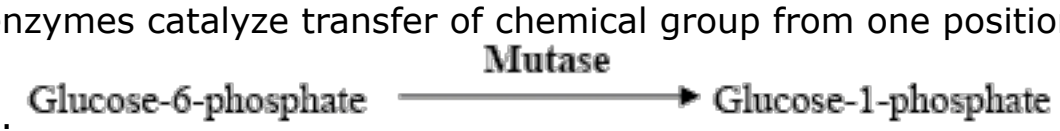
5. Isomerases:

These enzymes catalyze intramolecular rearrangement, so they catalyze conversions between optical, positional and geometric isomers
They include:

A. Aldose-ketose isomerases: These enzymes catalyze interconversion between aldoses and ketoses e.g.

B. Epimerases: These enzymes catalyze interconversion between epimers e.g.

C. Mutases: These enzymes catalyze transfer of chemical group from one position to another in the same compound e.g.



D. Racemases: These enzymes catalyze interconversion between D & L enantiomers e.g.

E. Cis-Trans isomerases: These enzymes catalyze interconversion between cis and trans geometric isomers

6. Ligases:

These enzymes catalyze the binding of two molecules to form one molecule.
They need energy which is derived from ATP e.g. glutamine synthetase