

Amino acids pool

The amount of free amino acids distributed throughout the body is called amino acid pool. Plasma level for most amino acids varies widely throughout the day. It ranges between 4–8 mg/dl.

It tends to increase in the fed state and tends to decrease in the post absorptive state.

Sources of amino acid pool

1. Dietary protein
2. Breakdown of tissue proteins
3. Biosynthesis of nonessential amino acids

Fate of amino acid pool

1. Biosynthesis of structural proteins e.g. tissue proteins
2. Biosynthesis of functional proteins e.g. haemoglobin, myoglobin, protein hormones and enzymes
- 3- Biosynthesis of small peptides of biological importance e.g. glutathione, endorphins and enkephalins
- 4- Biosynthesis of non protein nitrogenous compounds (NPN) as urea, uric acid, creatine, creatinine and ammonia
- 5- Catabolism of amino acids to give ammonia and α -keto acids.

Ammonia is transformed mainly into urea

The α -keto acids that remain after removal of ammonia from amino acids are called the carbon skeleton.

Catabolic pathways of amino acids

1. Transamination
2. Deamination
3. Transamidination
4. Transamidation
5. Decarboxylation

1- Transamination

Transamination means transfer of amino group from α -amino acid to α -keto acid with formation of a new α -amino acid and a new α -keto acid.

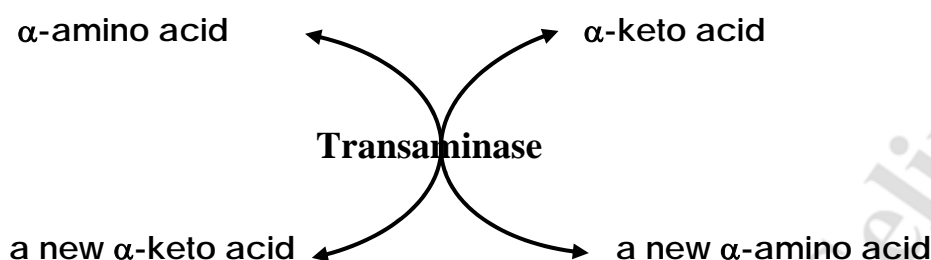
The liver is the main site for transamination.

All amino acids can be transaminated except lysine, threonine, proline and hydroxy proline.

All transamination reactions are reversible.

It is catalyzed by aminotransferases (transaminases).

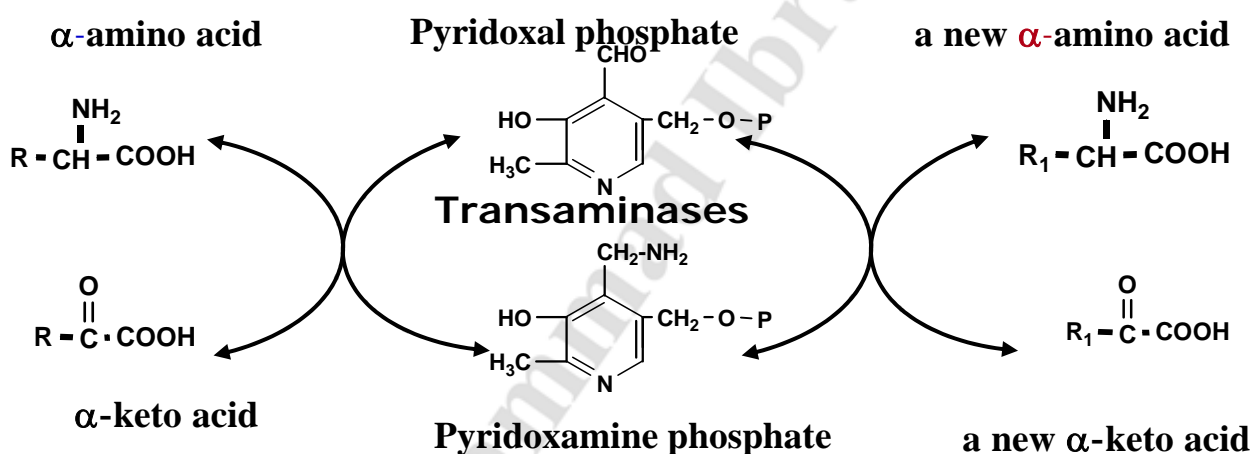
It needs pyridoxal phosphate as a coenzyme.



Role of pyridoxal phosphate in transamination

Pyridoxal phosphate acts as an intermediate carrier for amino group

Pyridoxal phosphate accepts the amino group from amino acid to form pyridoxamine phosphate, which in turn gives the amino group to α -keto acid

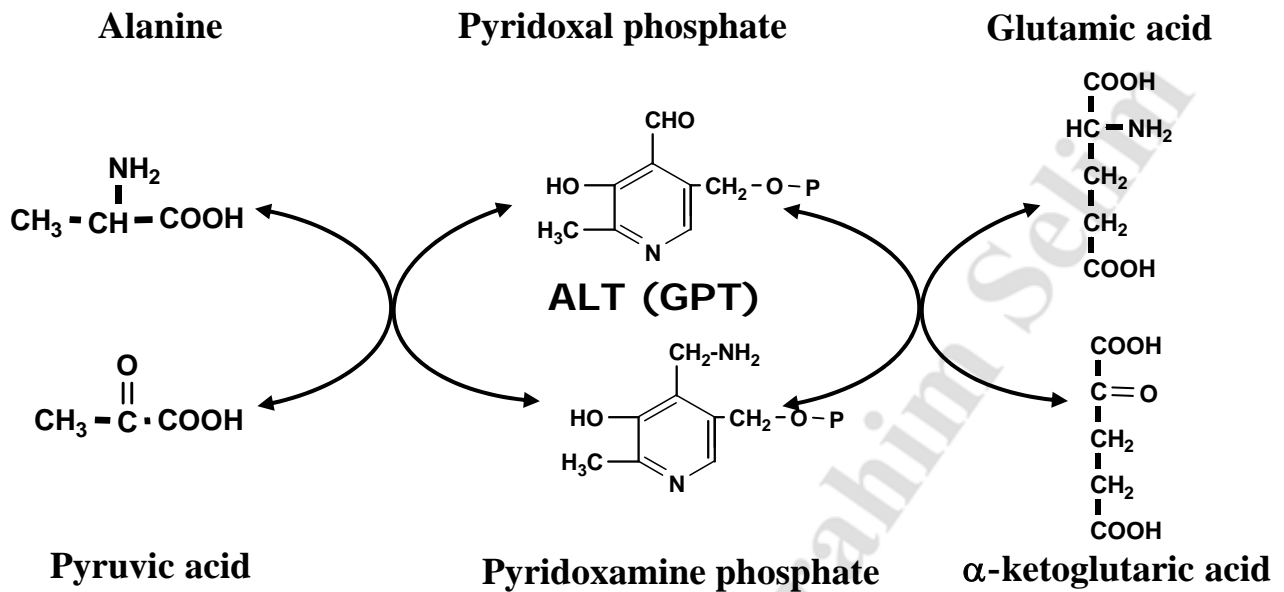


Examples of transaminases

- A. Alanine transaminase
- B. Aspartate transaminase
- C. Glutamate transaminase

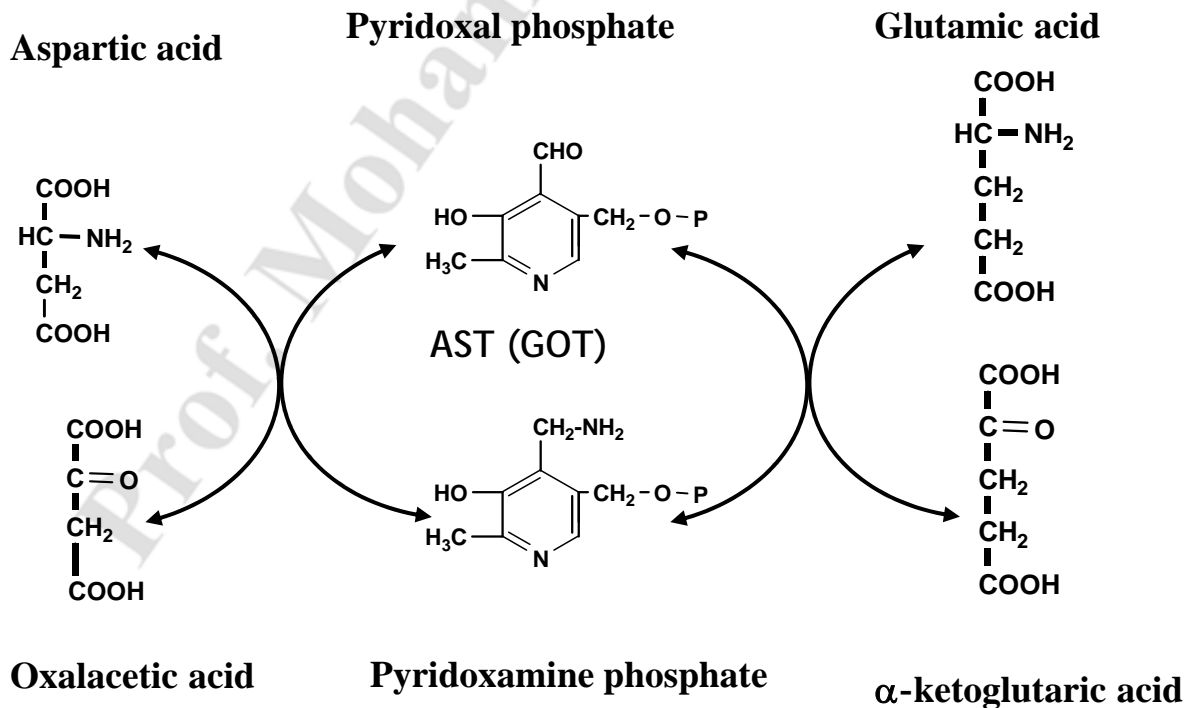
A. Alanine transaminase (ALT)

- It is also called glutamic pyruvic transaminase (GPT).
- It catalyzes the transfer of amino group from glutamic acid to pyruvic acid to form alanine and α -ketoglutaric acid.
- It also catalyzes the reverse reaction.
- It needs pyridoxal phosphate as a coenzyme.
- It is present in the cytoplasm of liver cells.



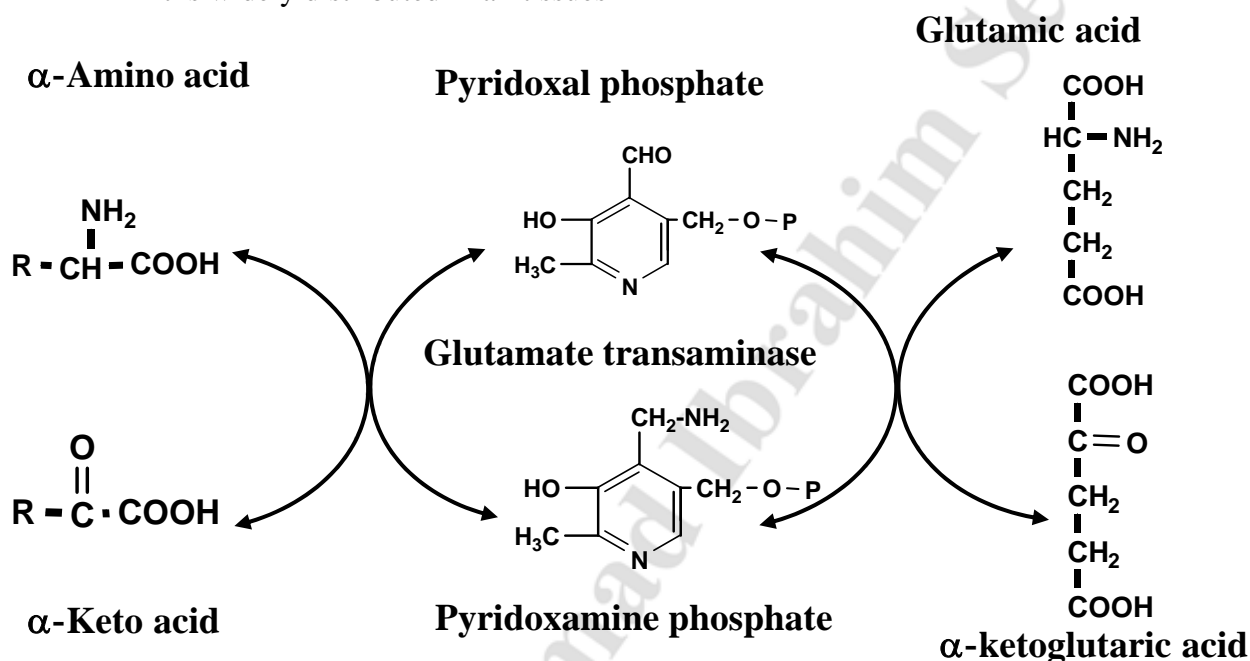
B. Aspartate transaminase (AST)

- It is also called glutamic oxalacetic transaminase (GOT)
- It catalyzes the transfer of amino group from glutamic acid to oxalacetic acid to form aspartic acid and α -ketoglutaric acid
- It also catalyzes the reverse reaction
- It needs pyridoxal phosphate as a coenzyme
- It is present in liver, heart and skeletal muscle cells.
- It is present in both cytoplasm and mitochondria



C. Glutamate transaminase

- It catalyzes the transfer of amino group from any amino acid (except lysine, threonine, proline and hydroxy proline) to α -ketoglutaric acid to form glutamic acid and the corresponding α -keto acid
- It also catalyzes the reverse reaction
- It needs pyridoxal phosphate as a coenzyme
- It is widely distributed in all tissues



Clinical significance of serum transaminases

Transaminases are intracellular enzymes.

Their levels in blood plasma are low under normal conditions.

ALT (GPT) is present mainly in the cytoplasm of liver cells.

AST (GOT) is present in both cytoplasm and mitochondria in liver, heart and skeletal muscles.

Any damage to these organs will increase the level of transaminases in blood

In liver diseases, there is an increase in both serum ALT (SGPT) and AST (SGOT) levels.

In acute liver diseases, e.g. acute viral hepatitis, the increase is more in SGPT

In chronic liver diseases, e.g. liver cirrhosis the increase is more in SGOT.

In heart diseases, e.g. myocardial infarction, there is an increase in SGOT only.

In skeletal muscle diseases, e.g. myasthenia gravis, there is an increase in SGOT only.

3- Deamination

Deamination means the removal of amino group from α -amino acid in the form of ammonia with formation of α -keto acid

The liver and kidney are the main sites for deamination

Deamination may be oxidative or non-oxidative

A. Oxidative deamination

It is catalyzed by one of the following enzymes:

- 1- L-amino acid oxidases
- 2- D-amino acid oxidases
- 3- Glutamate dehydrogenase

B. Non-oxidative deamination

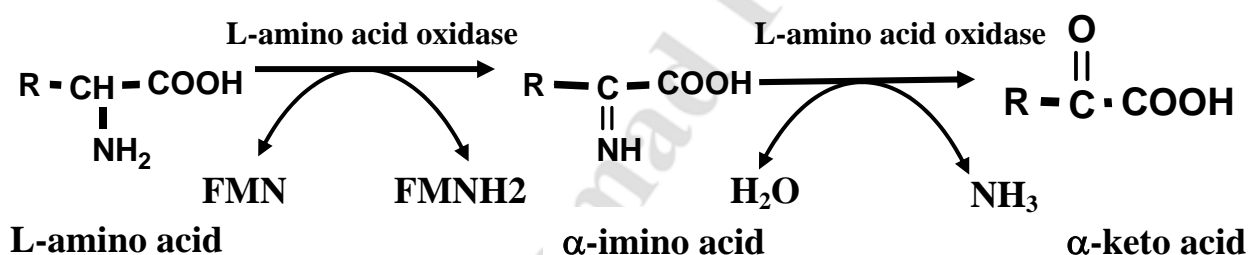
It is catalyzed by one of the following enzymes:

- 1- Dehydratases
- 2- Desulfhydrases

A. Oxidative deamination

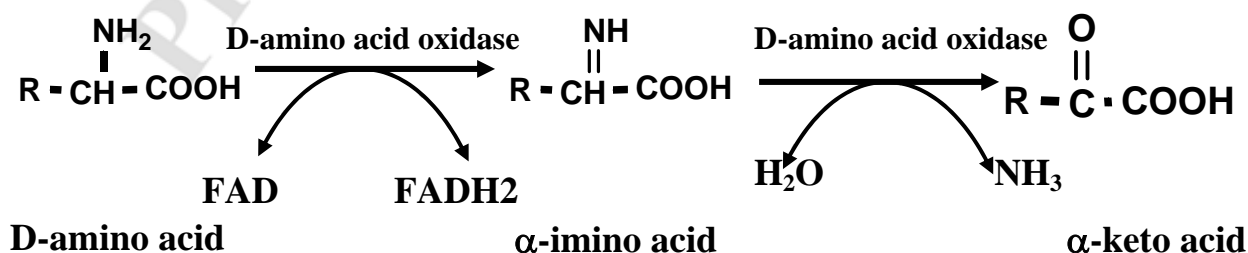
1- L amino acid oxidase

- This enzyme is present in the liver and kidney. Its activity is low.
- It is an aerobic dehydrogenase that needs FMN as a coenzyme.
- It deaminates most of the naturally occurring L-amino acids



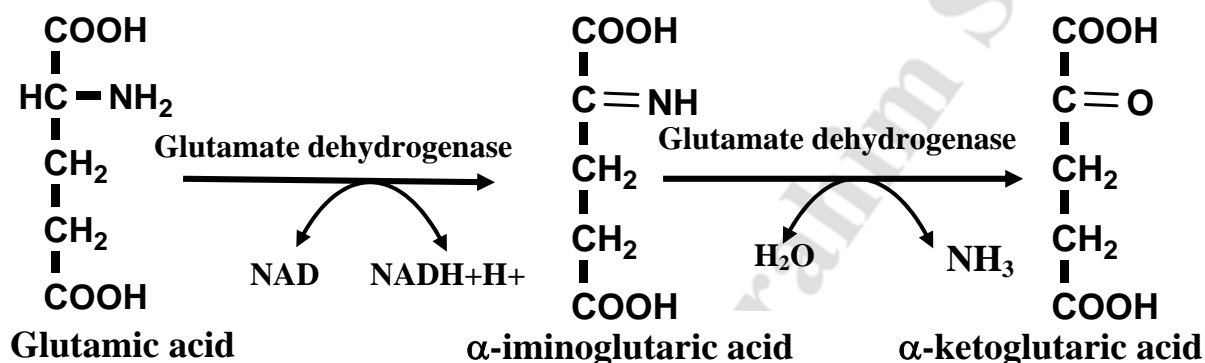
2- D amino acid oxidase

- D- amino acids are present in plants and bacterial cell wall.
- They are not used in protein biosynthesis in humans and animals.
- D-amino acids are deaminated by D-amino acid oxidase resulting in ammonia and α -keto acids.
- D-amino acid oxidase is present in the liver.
- It is an aerobic dehydrogenase.
- It needs FAD as a coenzyme.



3-Glutamate dehydrogenase

- This enzyme is present in most tissues
- It is present both in cytoplasm and mitochondria
- Its activity is high
- It is an anaerobic dehydrogenase
- It needs NAD or NADP as a coenzyme
- It deaminates glutamic acid resulting in α -ketoglutaric acid and ammonia

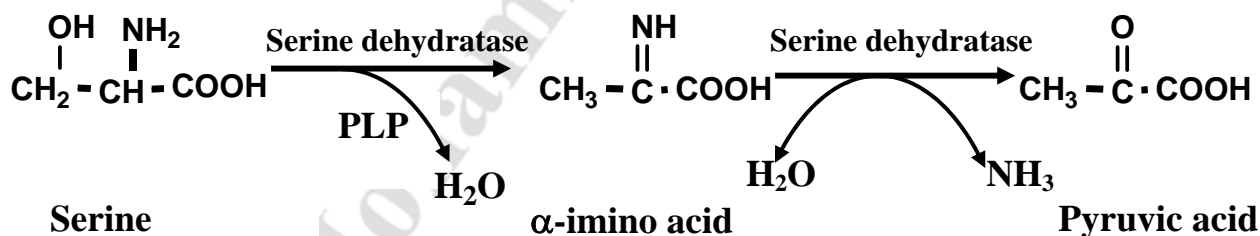


B. Non-oxidative deamination

1-Dehydratase

This enzyme deaminates amino acids containing hydroxyl group e.g. serine, homoserine and threonine.

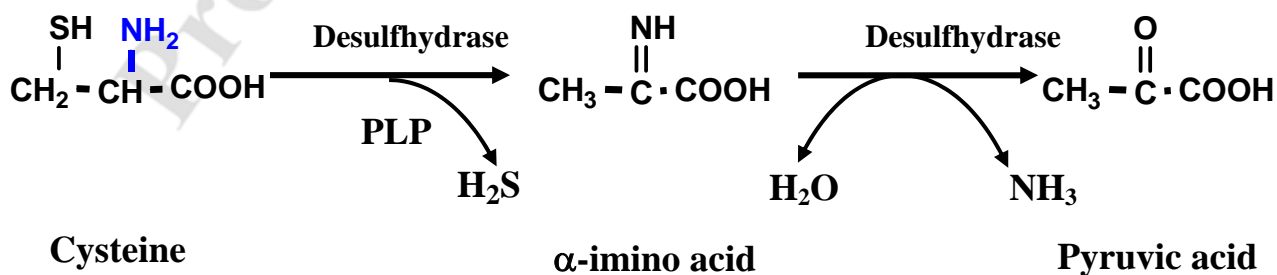
It needs pyridoxal phosphate as coenzyme.



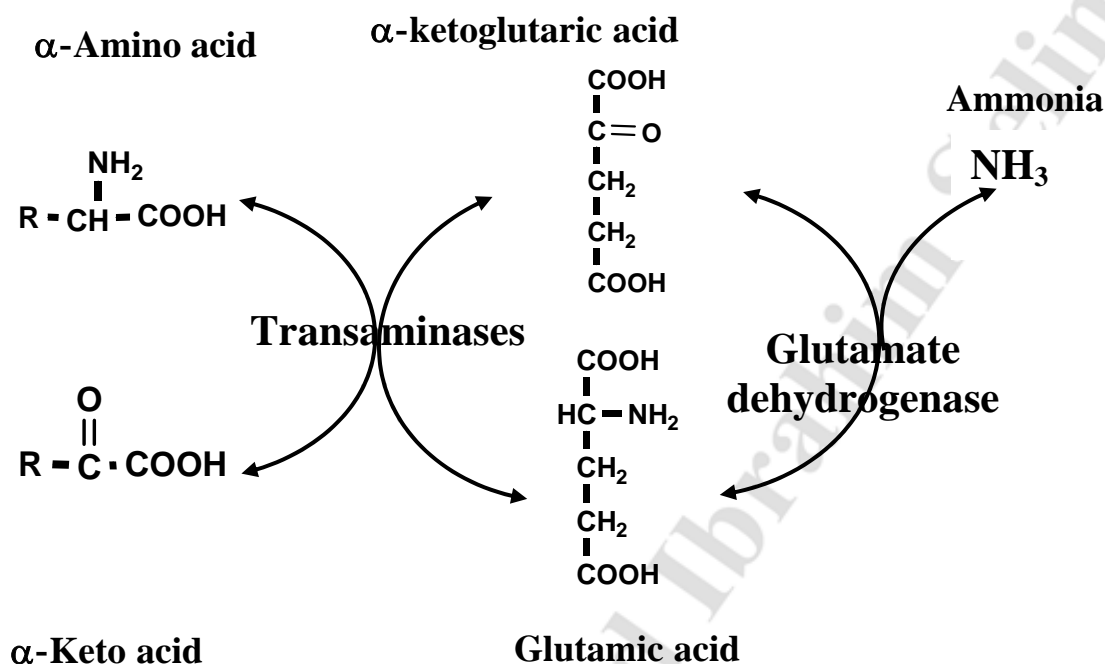
2-Desulhydrase

This enzyme deaminates sulphur containing amino acids e.g. cysteine and cystine.

It needs pyridoxal phosphate as a coenzyme.



Most of the naturally occurring α -amino acids are catabolized by transamination with α -ketoglutaric acid followed by deamination of the produced glutamic acid, a condition called transdeamination

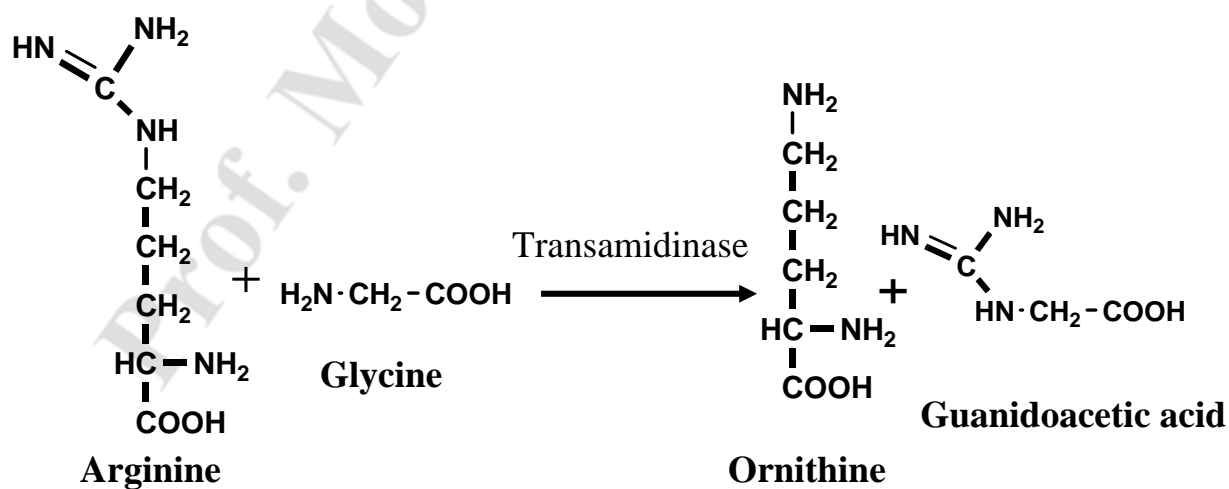


3-Transamidination

Transamidination means the transfer of amidine group from a donor molecule to an acceptor molecule

It is catalyzed by transamidinase enzyme

An example of transamidination reaction is the transfer of amidine group from arginine (donor) to glycine (acceptor) in creatine biosynthesis



4-Transamidation

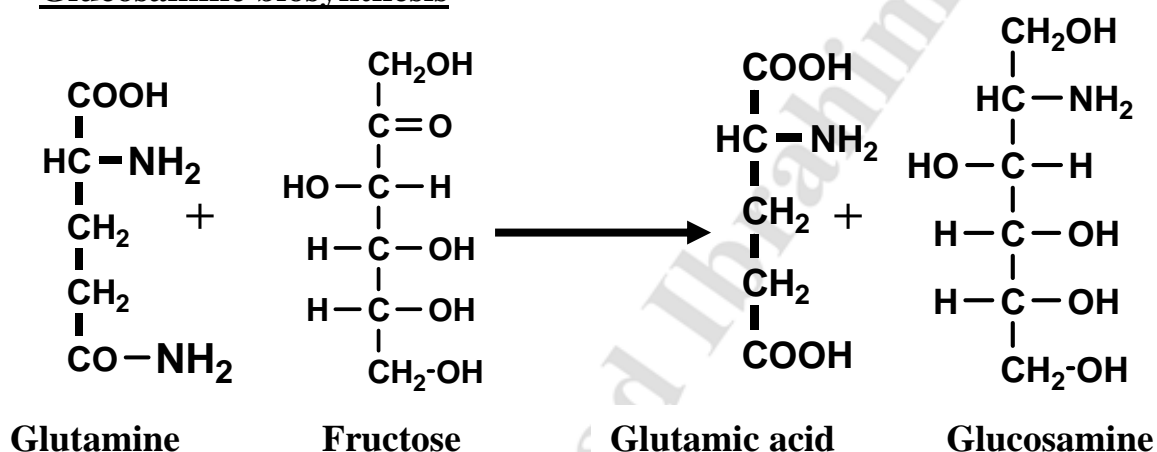
Transamidation means transfer of amide group nitrogen from a donor molecule to an acceptor molecule

It is catalyzed by transamidase enzyme

Examples of transamidation reaction include:

- 1- Transfer of amide nitrogen from glutamine (donor) to fructose (acceptor) to form glucosamine
- 2- Amide group nitrogen of glutamine is the source of N3 and N9 in purine bases

Glucosamine biosynthesis



5-Decarboxylation

Decarboxylation means removal of CO₂ from amino acid with formation of corresponding amines

It is catalyzed by decarboxylase enzyme

It needs pyridoxal phosphate as a coenzyme

Examples of decarboxylation reaction include:

1. Decarboxylation of histidine to form histamine
2. Decarboxylation of tyrosine to form tyramine

