



AMINO ACID METABOLISM

CONTENTS

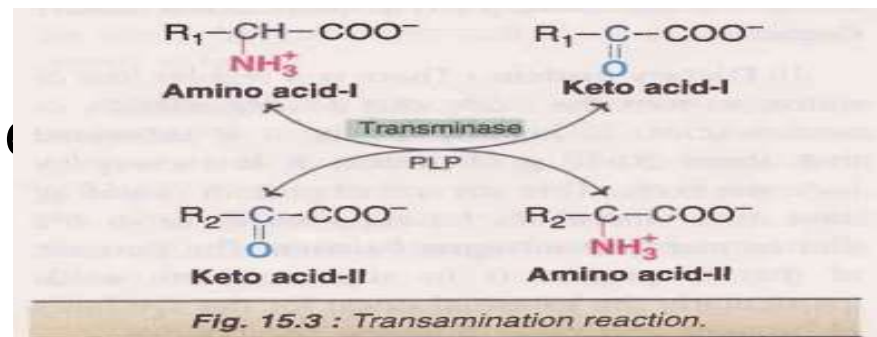
- General reactions of amino acid metabolism: Transamination , deamination & decarboxylation
- Urea cycle and its disorders
- Catabolism of phenylalanine and tyrosine and their metabolic disorders (Phenylketonuria, Albinism, alcaptonuria, tyrosinemia)
- Synthesis and significance of biological substances; 5-HT, melatonin, dopamine, noradrenaline, adrenaline
- Catabolism of heme
- Hyperbilirubinemia and jaundice

Metabolism of amino acid

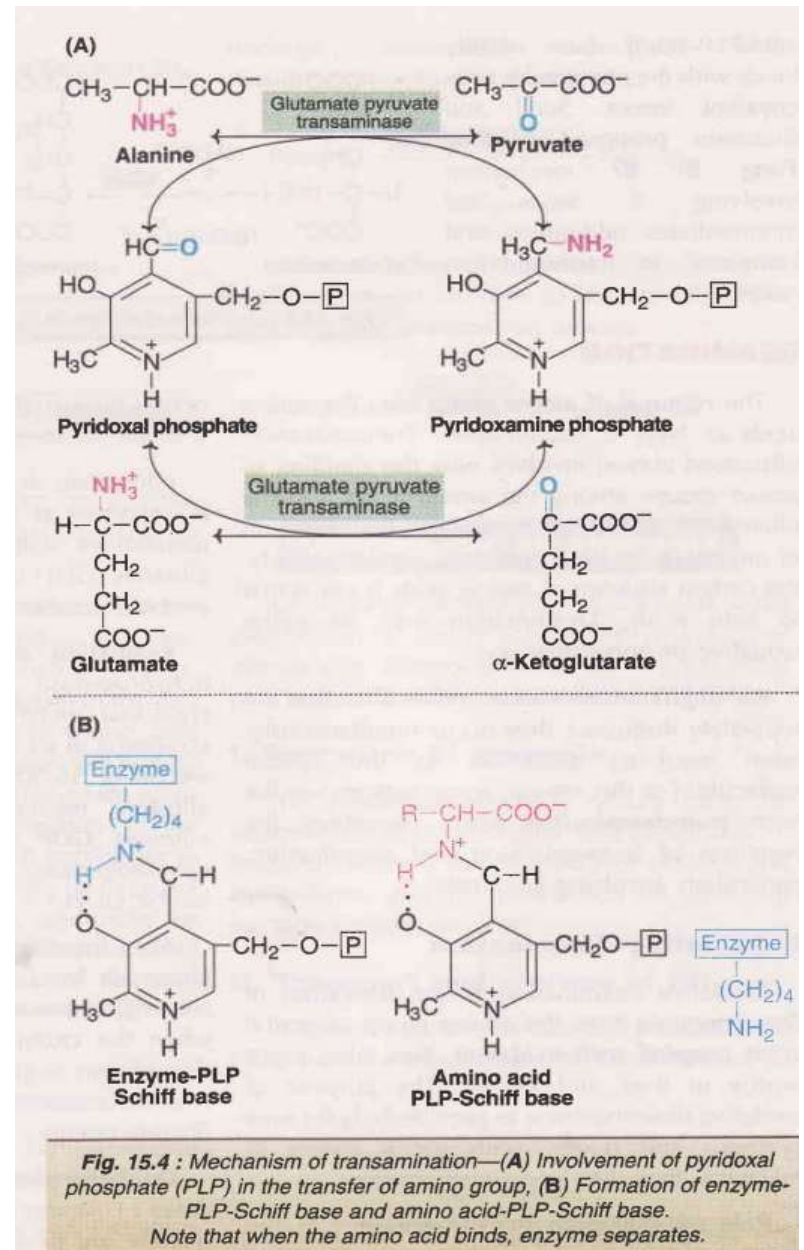
- The amino group of the amino acids is utilized for the formation of **urea** which is an excretory end product of protein metabolism.
- The carbon skeleton of the **amino acids** is first converted to **keto acids** (by transamination) which meet one or more of the following fates.
 1. Utilized to generate energy.
 2. Used for the synthesis of glucose.
 3. Diverted for the formation of fat or ketone bodies.
 4. Involved in the production of non-essential amino acids.

Transamination

- The transfer of an amino (- NH₂) group from an amino acid to a keto acid.
- It involves the interconversion of a pair of amino acids and a pair of keto acids, catalysed by a group of enzymes called **transaminases**.
- All transaminases require pyridoxal phosphate (PLP), a coenzyme derived from vitamin B6.
- **Aspartate transaminase** and **Alanine transaminase**-make a significant contribution for transamination.
- Only transfer of amino group occurs (free NH₃ is not liberated).
- Transamination is reversible

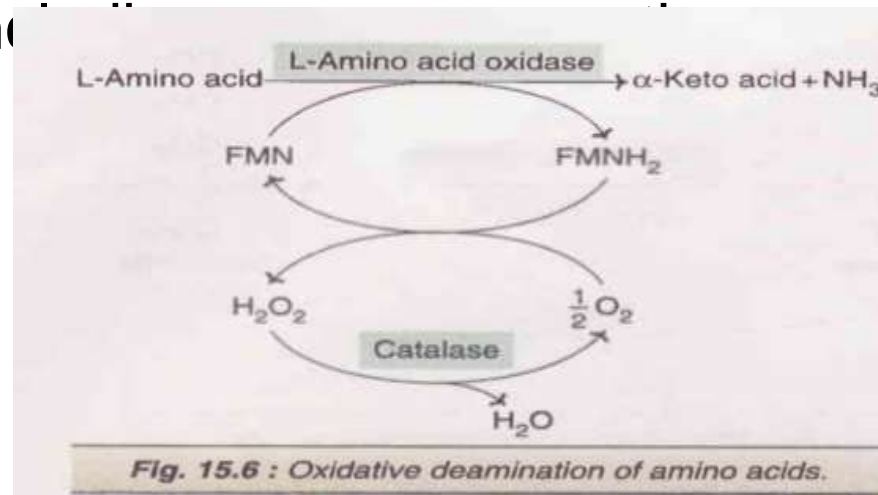


- Transamination is very important for the redistribution of amino groups and production of non essential amino acids, as per the requirement of the cell.
- Transamination diverts the excess amino acids towards energy generation.
- The amino acids undergo transamination to finally concentrate nitrogen in glutamate.
- All amino acids except lysine, threonine, proline and hydroxyproline participate in transamination.
- Transamination is not restricted to α -amino groups only.
- Serum transaminases are important for diagnostic and



Deamination

- The **removal of amino group from the amino acids as NH_3** is deamination.
- Deamination may be either oxidative or non-oxidative.
- Oxidative deamination is the liberation of free ammonia from the amino group of amino acids coupled with oxidation.
- This takes place mostly in **liver and kidney**.
- The purpose of oxidative deamination is to provide NH_3 for urea synthesis and α -keto acids for a variety of reactions, including the citric acid cycle.



Non-oxidative deamination:

- Some of the amino acids can be deaminated to liberate NH_3 without undergoing oxidation

Amino acid dehydrases:

- Serine, threonine and homoserine are the hydroxy amino acids undergo non-oxidative deamination.

Amino acid desulfhydrases:

- The sulfur amino acids (cysteine and homocysteine) undergo deamination coupled with desulfhydration to give keto acids.

Deamination of histidine :

- The enzyme histidase acts on histidine to liberate NH_3

Decarboxylation

- The decarboxylation of amino acids or their derivatives results in the formation of **amines**.
- This is carried out by a group of enzymes called **decarboxylases**.

- **Examples:**

- Tryptophan \longrightarrow Hydroxytryptamine.



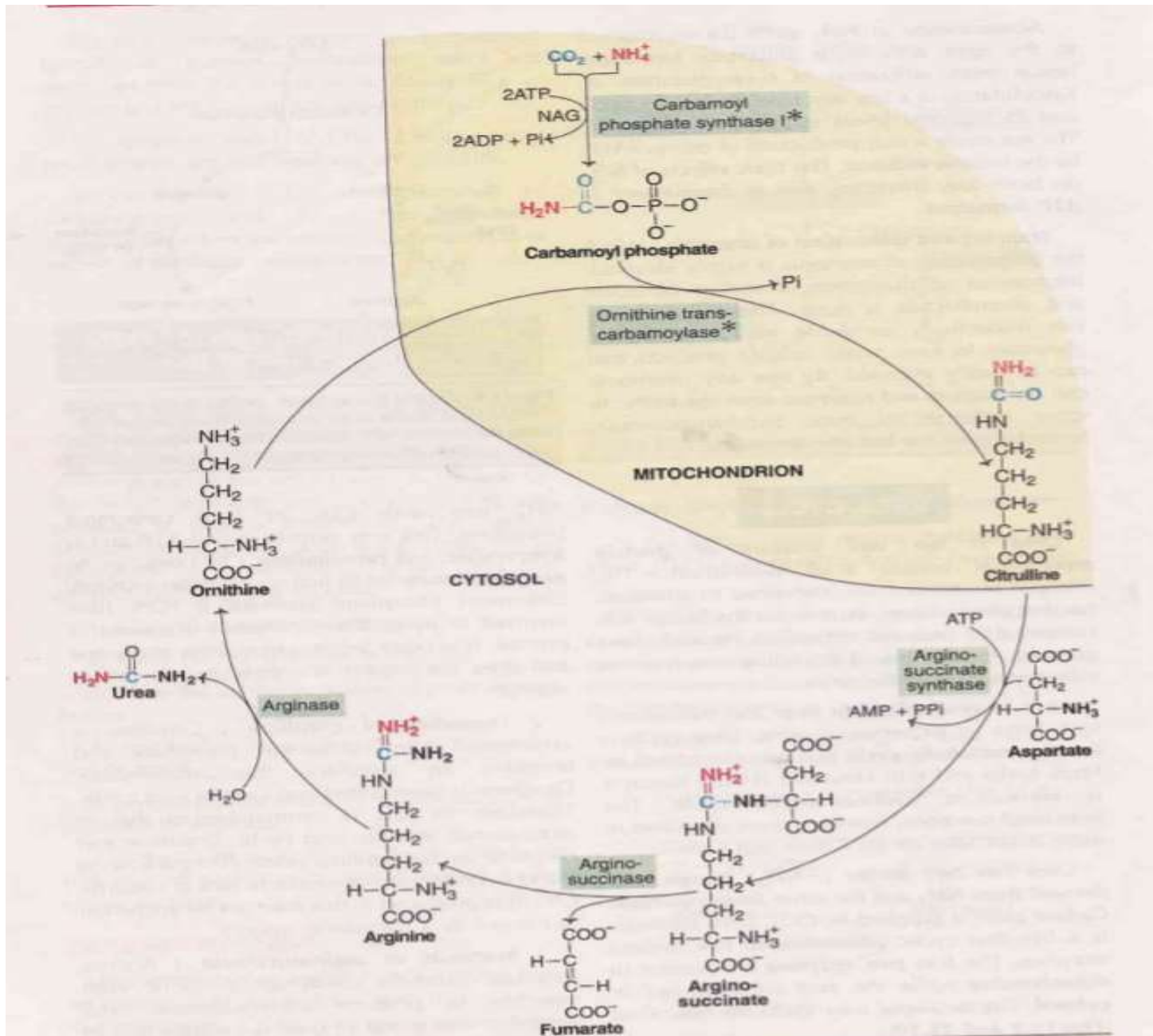
- Histidine $\xrightarrow[\text{CO}_2]{\text{PLP}}$ Histamine

Urea cycle

- Urea is the end product of protein metabolism.
- The nitrogen of amino acids, converted to ammonia, is toxic to the body.
- It is converted to urea and detoxified.
- Urea is synthesized in liver and transported to kidneys for excretion in urine.

Steps involved in urea cycle:

1. Synthesis of carbamoyl phosphate.
2. Formation of citrulline.
3. Synthesis of arginosuccinate.
4. Cleavage of arginosuccinate
5. Formation of urea.



Disorders of urea cycle

- All the disorders invariably lead to a build-up in blood ammonia (hyperammonemia), leading to toxicity.
- The clinical symptoms associated with defect in urea cycle enzymes include vomiting, lethargy, irritability, ataxia and mental retardation.

TABLE 15.1 Metabolic defects in urea cycle

| <i>Defect</i> | <i>Enzyme involved</i> |
|-------------------------|--------------------------------|
| Hyperammonemia type I | Carbamoyl phosphate synthase I |
| Hyperammonemia type II | Ornithine transcarbamoylase |
| Citrullinemia | Arginosuccinate synthase |
| Arginosuccinic aciduria | Arginosuccinase |
| Hyperargininemia | Arginase |