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Deptt. of Home Science

[CCS University Campus]

Course :- Food and Nutrition - Sem IInd

Subject :- Nutritional Biochemistry

Code :- V-2120

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Unit - IVth (a)

Protein Metabolism

* Transamination

- Transamination involves inter-conversion of a pair of α-amino acid and a pair of α-Keto acid.
- The $-NH_2$ group of amino acid transfer to $>C=O$ group of α-Keto acid.
- The reaction is catalysed by transaminases or amino transferases.
- Pyridoxal phosphate (B_6-PO_4) is the co-enzyme essential for the transaminase activity.
- It is a reversible process. This reversibility allow transaminases to function in amino acid catabolism and biosynthesis.

- These reactions are carried out mainly in liver, kidney, heart and brain.

- Amino acid works as donor for these type of reactions.

- Only 3 Keto acid can take part in Transamination reaction.

i) α-Keto glutarate
ii) Oxalo-acetate
iii) Pyruvate.

- Two specific Transaminase enzyme present in human body are :-

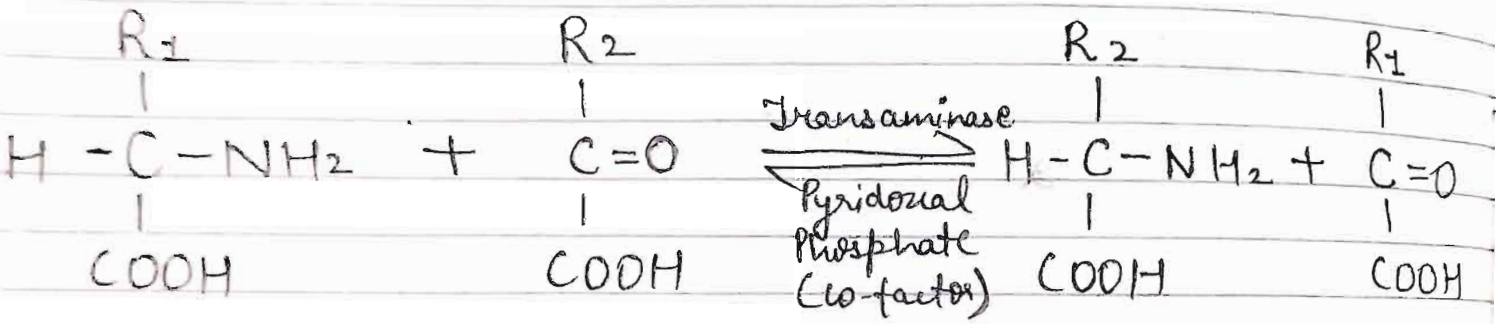
i) SGOT [Serum Glutamate Oxaloace-tate Transaminase]

ii) SGPT [Serum Glutamate Pyruvate Transaminase]

Alanine

Pyruvic Acid

Transamination



Amino Acid (Donor)	Ketoacid (Recipient)	New Amino Acid	New Keto-Acid

Deamination

- In deamination reaction, Nitrogen present in Amino Acid is released in the form of Ammonia.

- NH_2 group present in Amino acid replaced by a Keto-acid group.

* Deamination reaction is of 2 types –

i) Oxidative Deamination

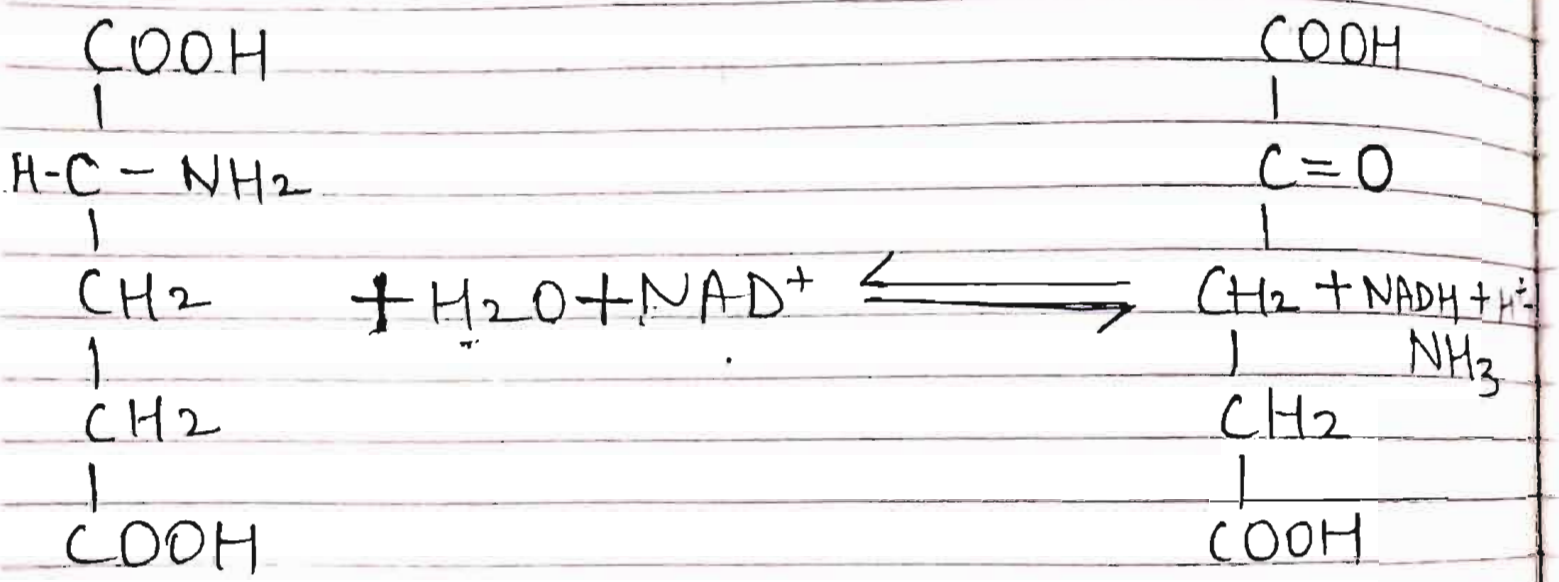
ii) Non-oxidative deamination

I] OXIDATIVE DEAMINATION

- Occurs in the presence of O_2.
- NH_3 is released.
- Deaminated acid is formed.
- Flavin oxidase is the enzyme require for Oxidative deamination
- Flavin protein is used as co-factor

Deamination

i) Oxidative Deamination



Glutamic Acid

α-Keto glutaric Acid

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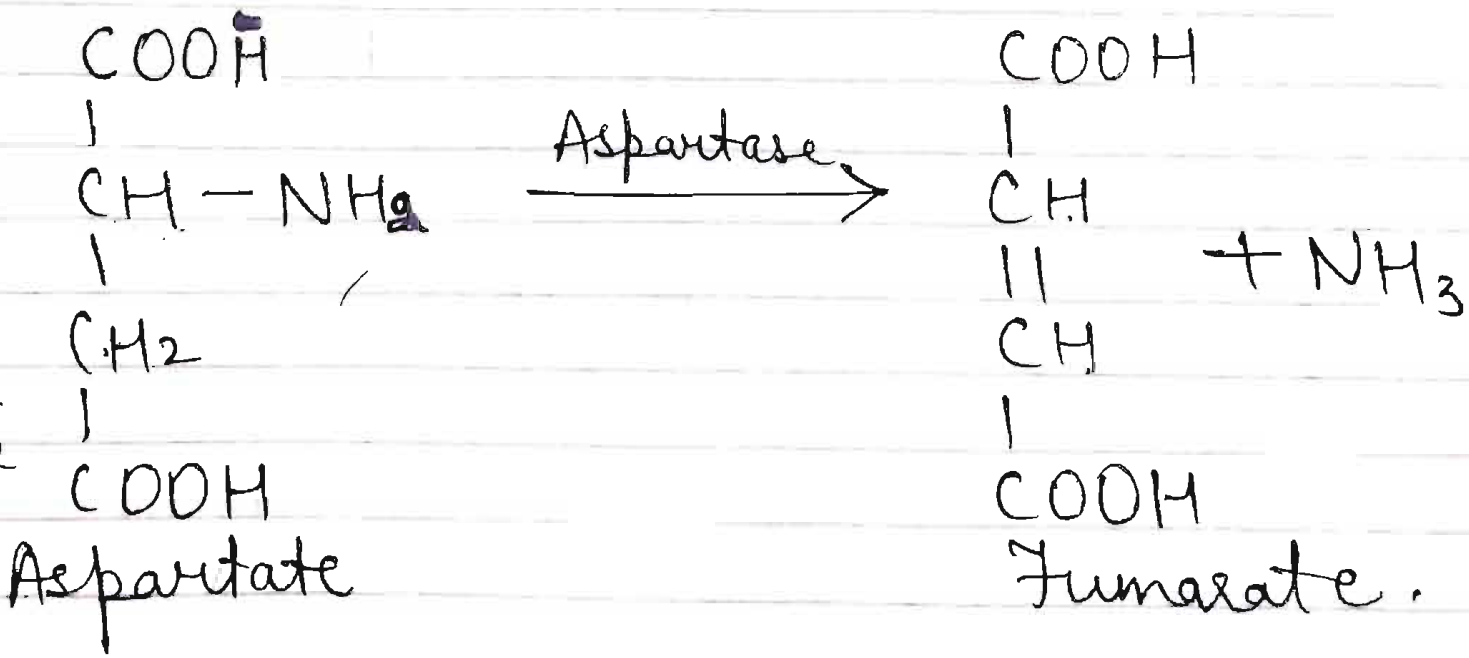
II) NON-OXIDATIVE DEAMINATION

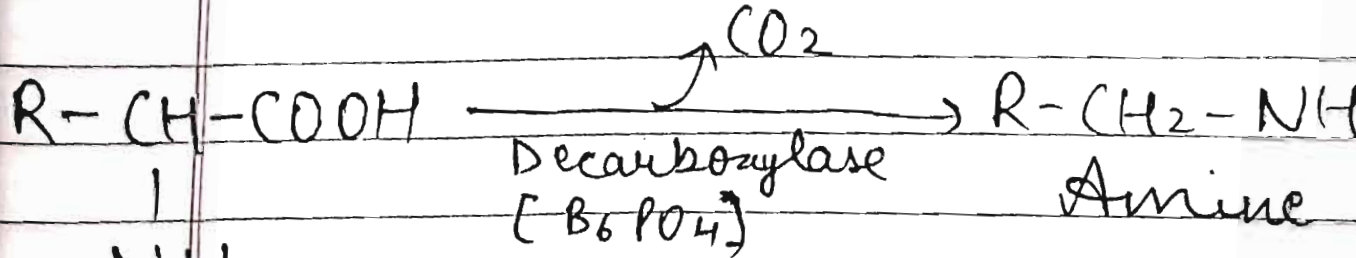
- Occurs in the absence of O_2
- NH_3 is released.
- Hydrolases are used as enzymes.
- NADP is used as co-enzyme.

Non-oxidative Deamination



* Decarboxylation

- It is catalyzed by the enzyme decarboxylase.
- Pyridoxal phosphate [B_6PO_4] is used as co-enzyme.
- CO_2 is released/removed.
- Amine is formed.



4. Reactions of the Urea Cycle

(i) **Carbamoyl phosphate** is formed by the condensation of one mol. of phosphate (derived from ATP) being catalyzed by the enzyme **carbamoyl phosphate synthetase** which is present in liver mitochondria of all ureotelic organisms including humans. In addition to magnesium ion (Mg^{++}), N-acetyl-glutamate (a dicarboxylic acid) is required. Probably, the presence of N-acetyl-glutamate brings about a marked change in the structure of carbamoyl phosphate synthetase which exposes certain sulfahydryl groups and affects the affinity of the enzyme for ATP.

In **bacteria**, glutamine in place of ammonia serves as a substrate for carbamoyl phosphate synthesis.

(ii) Carbamoyl moiety is transferred to ornithine to form citrulline being catalyzed by ornithine transcarbamoylase of liver mitochondria.

(iii) Arginosuccinic acid is formed by the combination of citrulline and aspartic acid in presence of argino succinic acid synthetase and ATP.

(iv) **Arginosuccinic acid** is cleaved to arginine and fumaric acid by **arginosuccinase** which is present in mammalian liver and kidney. The fumarate formed is converted to oxaloacetate via the fumarase and malate dehydrogenase reactions and then transaminated to regenerate aspartate.

(v) The hydrolytic cleavage of arginine is catalyzed by **arginase** which is present in the livers of all ureotelic organisms forming ornithine and urea.

Smaller quantities of arginase also occur in renal tissue, brain, mammary gland, testicular tissue and skin. Ornithine and lysine are the competitive inhibitors of arginine.

The cycle for the overall reactions is given in Fig. 20.7.

The biosynthesis of urea occurs mainly in the **liver**. 1 mol. of urea is synthesized from 1 mol. of ammonia, 1 mol. of carbon dioxide, 3 mols. of ATP (2 of which are converted to ADP and Pi and 1 to AMP + PPi), 5 enzymes catalyzing the reactions and 6 amino acids involved in the reaction.

One amino acid, N-acetyl-glutamate, serves as an enzyme **activator**. The remaining 5 amino acids aspartate, arginine, ornithine, citrulline and arginosuccinic acid – all function as carriers of atoms which ultimately become urea. Aspartate and arginine occur in protein while ornithine, citrulline, arginosuccinate do not.

Urea formation is partly a cyclical process. Ornithine used in reaction (2) is regenerated in reaction (5).

An active man consuming about 300g of carbohydrates, 100g of fat, 100g of protein daily excrete about 16.5g of nitrogen. 95 per cent is eliminated by the kidneys and 5 per cent in the stool. The major pathway of nitrogen excretion in humans is as urea which is synthesized in the liver.

Blood level : Normal concentration of urea in the blood is 20 to 40mg/100 ml.

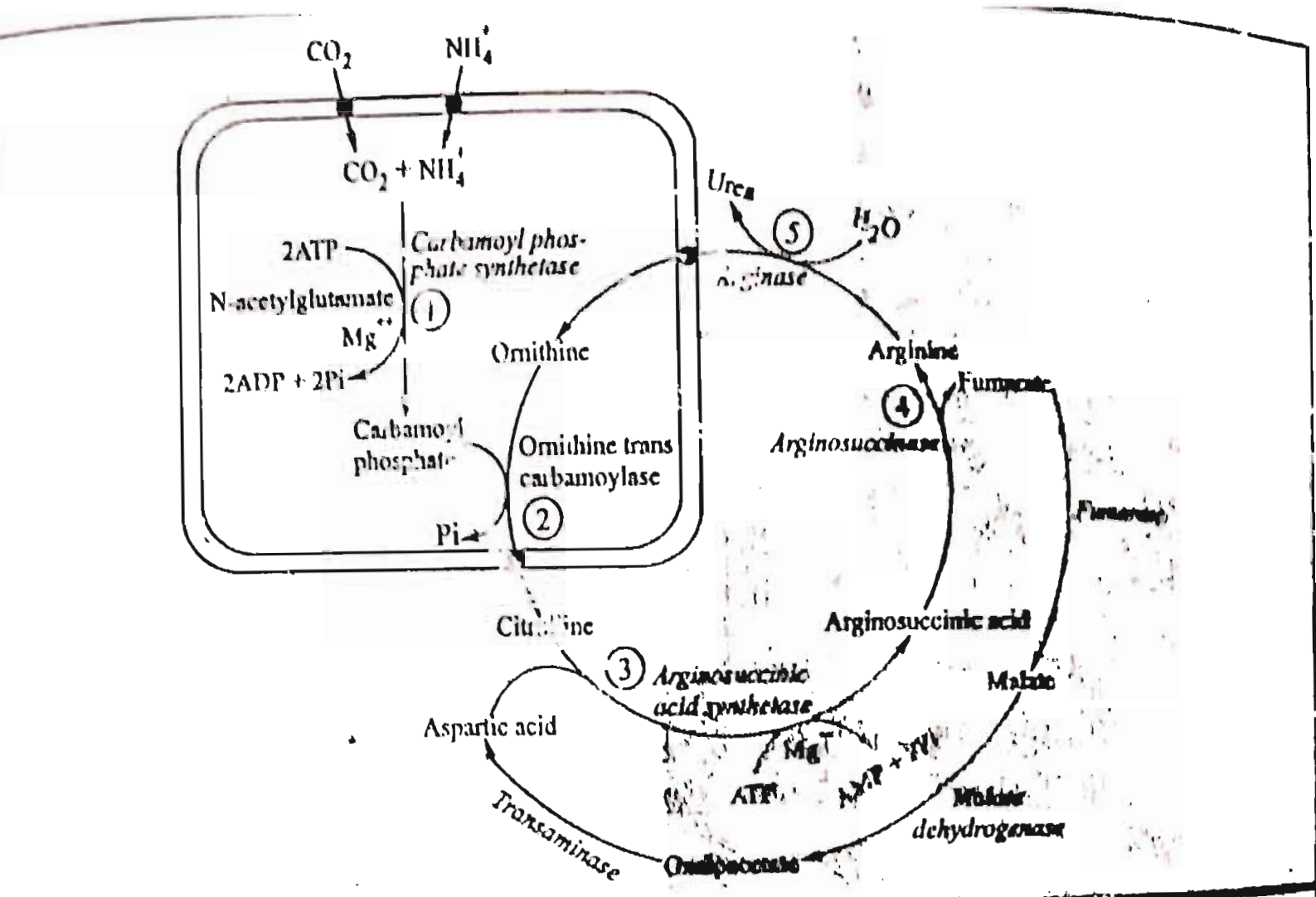


Fig. 20.7 : Flow chart of Biosynthesis of urea or ornithine-urea cycle. Reactions 1 and 2 take place in the matrix of liver mitochondria and reaction 3, 4, 5, in liver cytosol. Specific carriers (•) present in the inner membranes of liver mitochondria for the transverse of NH_4^+, CO_2, ornithine, citrulline

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- It is a 5-step process.
- 2 steps occurs in mitochondria.
- 3 steps in cytosol.

Enzyme involved Ac. to the ~~Reaction~~ Step of Reaction.

Step I → (1) Carbamoyl Phosphate Synthetase.

Step II → (2) Ornithine trans- Carbamoylase

Step III → (3) Argino succinate synthetase

Step IV → (4) Argino succinase

Step V → (5) Arginase.

Steps involved in Urea Cycle.

Step I → Synthesis of Carbamoyl Phosphate + ~~Ornithine~~

Step II → Synthesis of ~~Citrulline~~ Citruline

Step III → Synthesis of Argino Succinate.

Step IV → Cleavage of Argino Succinate to Arginine, fumaric Acid

Step V → Cleavage of Arginine to Urea + L-ornithine

The end