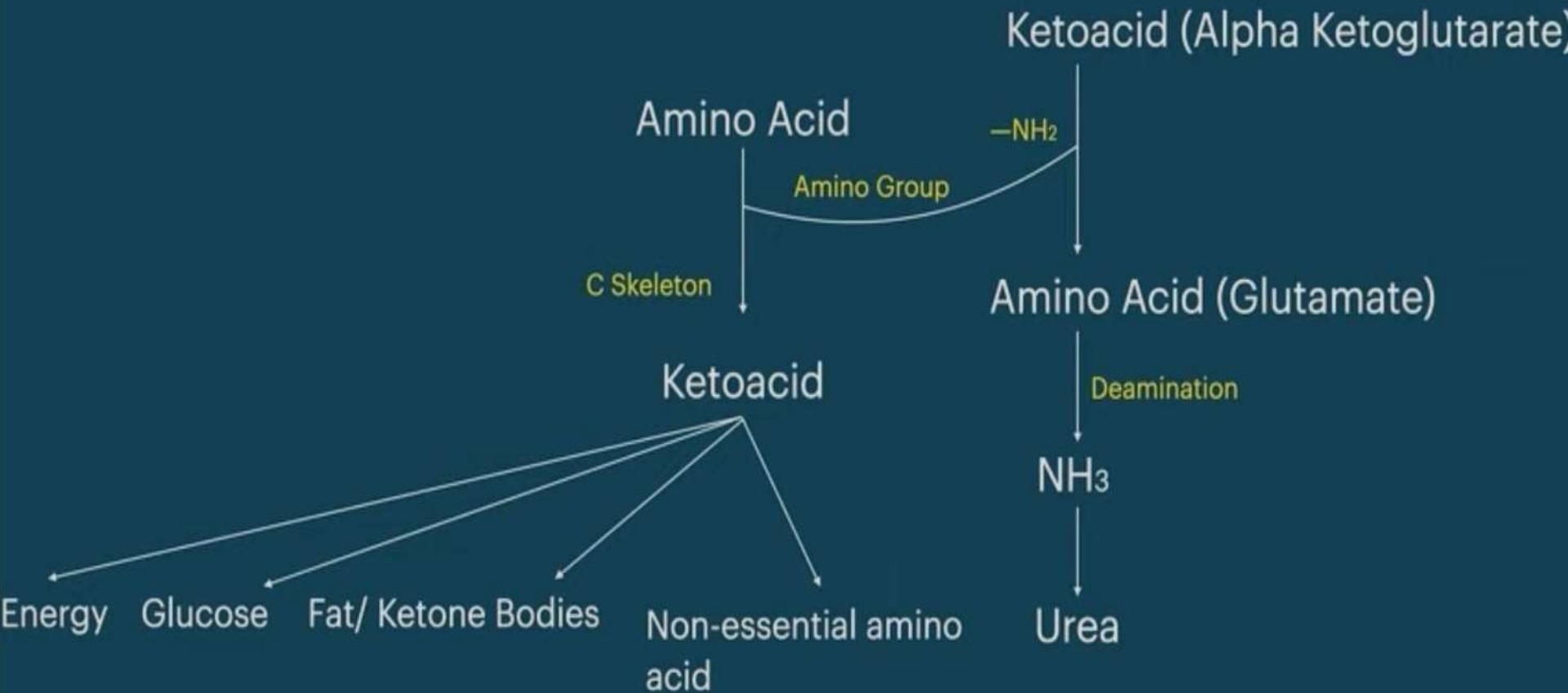# DEPARTMENT OF BIOTECHNOLOGY

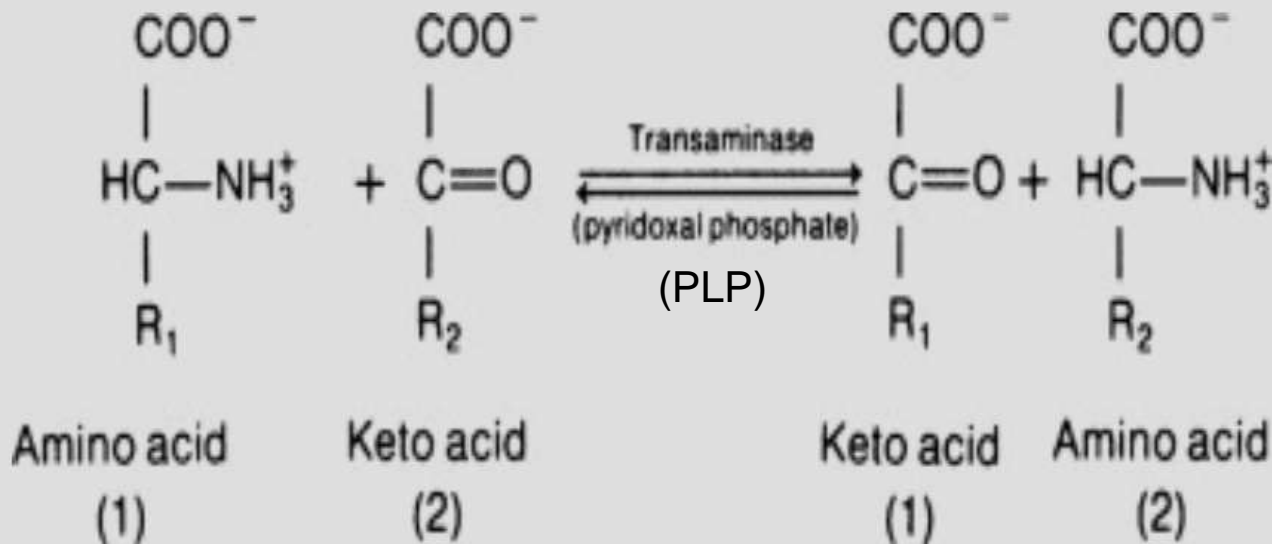## NITROGEN METABOLISM

By – Mayuri S. Bhad

Catabolism of amino acids occurs in 4 stages

- Transamination

- Oxidative Deamination

- Ammonia Transport
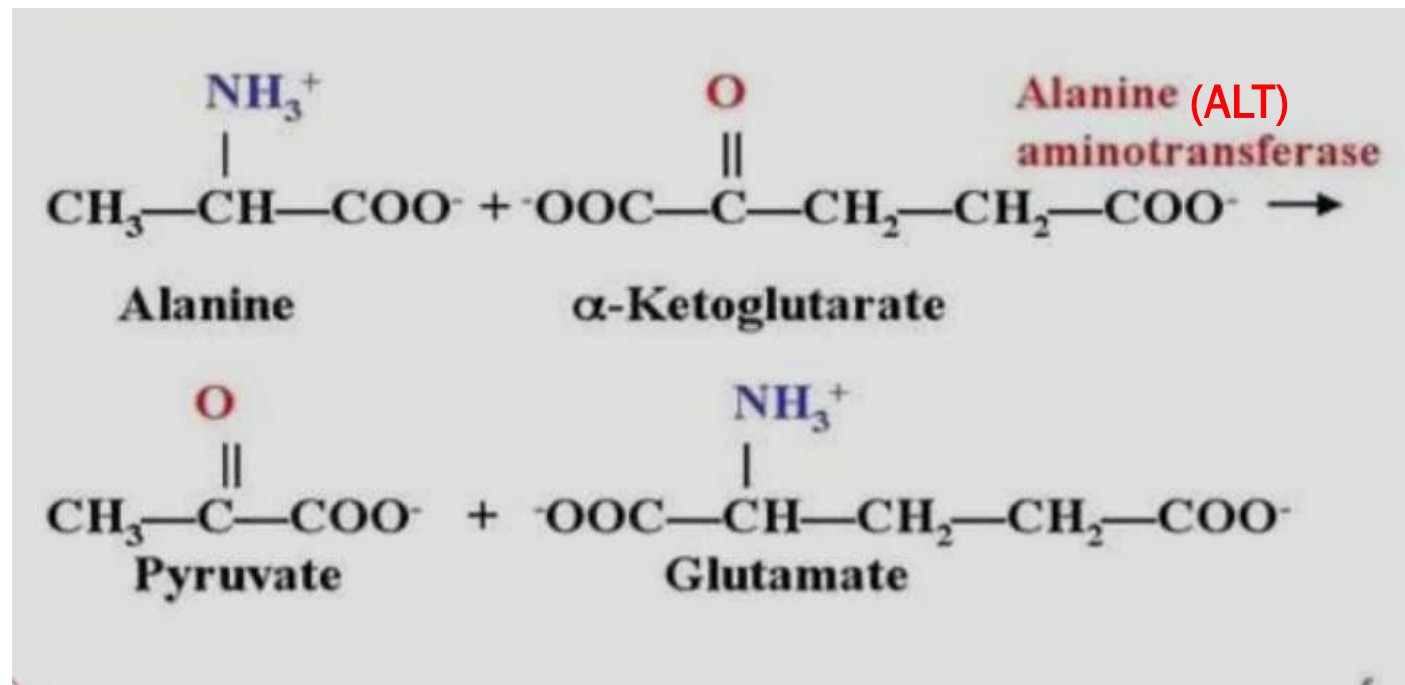
- Urea Cycle

TRANSAMINATION

- The transfer of an amino group (-NH2) group from an amino acid to a Keto acid , with the formation of a new amino acid and a new keto acid.

Transamination involve moving an alpha amino group from a donor alpha Amino acid to the keto carbon of acceptor alpha keto acid
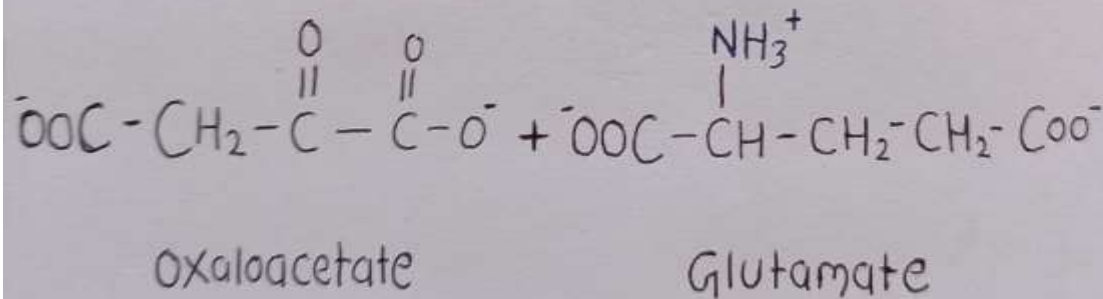
$$
\underset{\substack{\text{Amino acid} \\ (1)}}{\overset{\displaystyle COO^-}{\underset{\displaystyle R_1}{\mid \atop HC-NH_3^+ \atop \mid}}}
+
\underset{\substack{\text{Keto acid} \\ (2)}}{\overset{\displaystyle COO^-}{\underset{\displaystyle R_2}{\mid \atop C=O \atop \mid}}}
\underset{\substack{\text{(pyridoxal phosphate)} \\ \text{(PLP)}}}{\overset{\text{Transaminase}}{\rightleftharpoons}}
\underset{\substack{\text{Keto acid} \\ (1)}}{\overset{\displaystyle COO^-}{\underset{\displaystyle R_1}{\mid \atop C=O \atop \mid}}}
+
\underset{\substack{\text{Amino acid} \\ (2)}}{\overset{\displaystyle COO^-}{\underset{\displaystyle R_2}{\mid \atop HC-NH_3^+ \atop \mid}}}
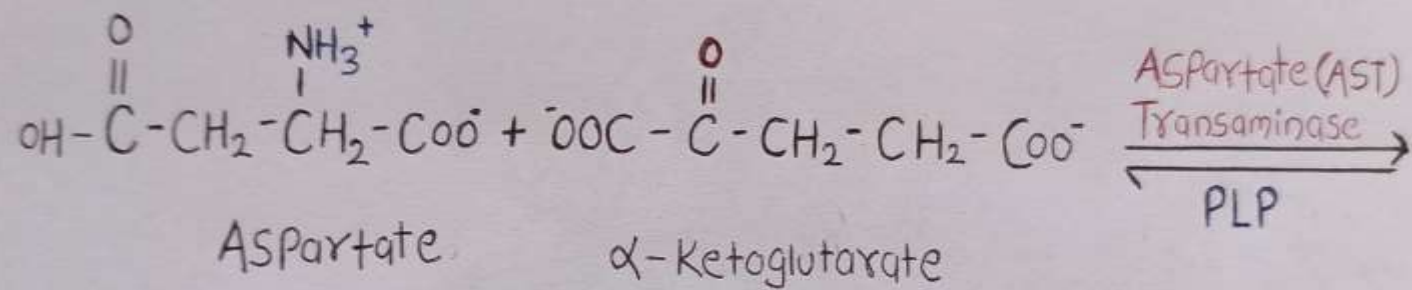$$

Salient features of transamination

1) Transamination is catalyzed by a group of enzymes called transaminases (aminotransferases)

2) There are multiple transaminase enzymes which vary in substrate specificity (specific for each pair of amino and acid)

$$CH_3-\underset{\underset{NH_3^+}{|}}{CH}-COO^- + {}^-OOC-\underset{\underset{O}{\|}}{C}-CH_2-CH_2-COO^- \longrightarrow$$

Alanine   α-Ketoglutarate   Alanine (ALT) aminotransferase

$$CH_3-\underset{\underset{O}{\|}}{C}-COO^- + {}^-OOC-\underset{\underset{NH_3^+}{|}}{CH}-CH_2-CH_2-COO^-$$

Pyruvate   Glutamate

- co-enzyme -- Pyridoxalphosphate (PLP) , a Vit B6 derivative.

$$OH-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{NH_3^+}{|}}{CH_2}-COO^- + {}^-OOC-\overset{\overset{O}{\|}}{C}-CH_2-CH_2-COO^- \xrightleftharpoons[PLP]{\text{Aspartate (AST)}\atop\text{Transaminase}}$$

Aspartate   α-Ketoglutarate

$$^-OOC-CH_2-\overset{\overset{O}{\|}}{C}-\overset{\overset{O}{\|}}{C}-O^- + {}^-OOC-\overset{\overset{NH_3^+}{|}}{CH}-CH_2-CH_2-COO^-$$

Oxaloacetate   Glutamate
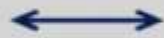
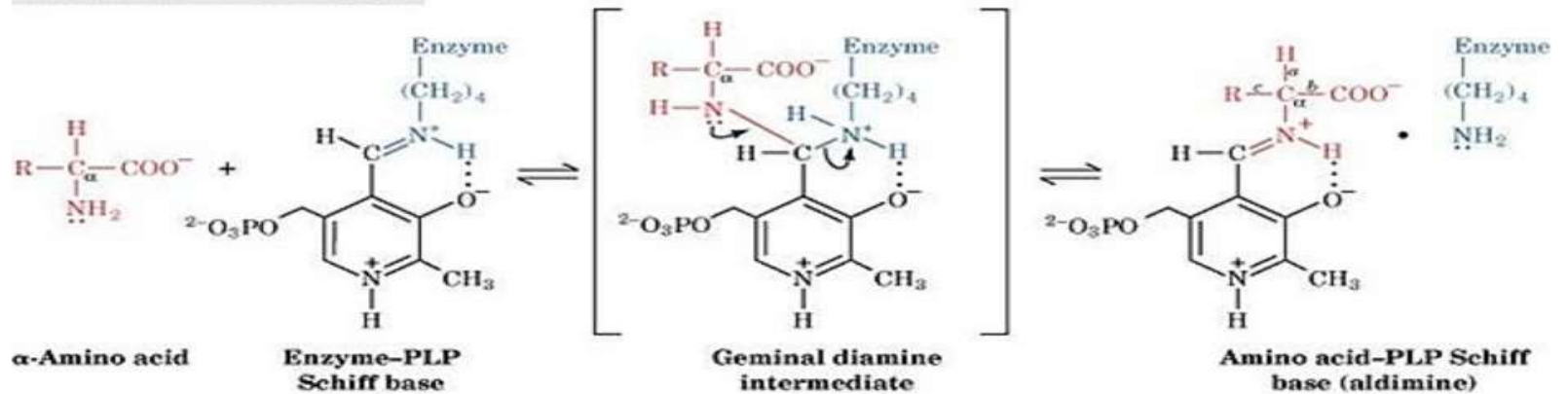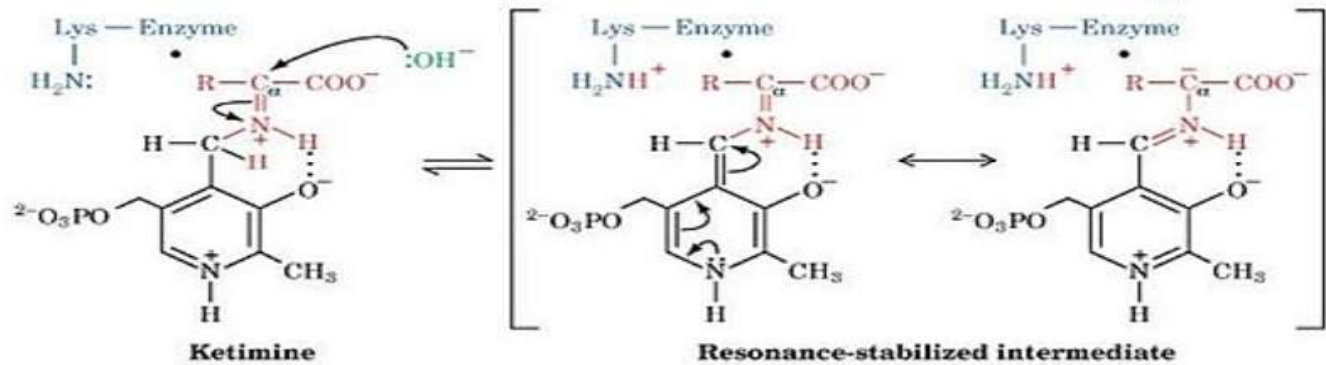|		
AA₁ + α- KG	⟷	**ketoacid₁ + Glutamate**
Alanine + α- KG	⟷	**Pyruvate + Glutamate**
Aspartate + α- KG	⟷	**Oxaloacetetae +Glutamate**

3) Transamination is reversible

4) No free NH3 is liberated , only transfer of amino group

5) Transamination is important for redistribution of amino acids and production of non essential amino acids .

6) It diverts excess of amino acids towards energy generation .

7) Amino acids undergo transamination to finally concentrate nitrogen in glutamate .

8) Glutamate undergoes oxidative deamination to liberate free NH3 for urea synthesis .

9) All alpha amino acids except lysine, threonine, Proline and Hydroxyproline participate in transamination .

10)It involves both anabolism and catabolism, since reversible.

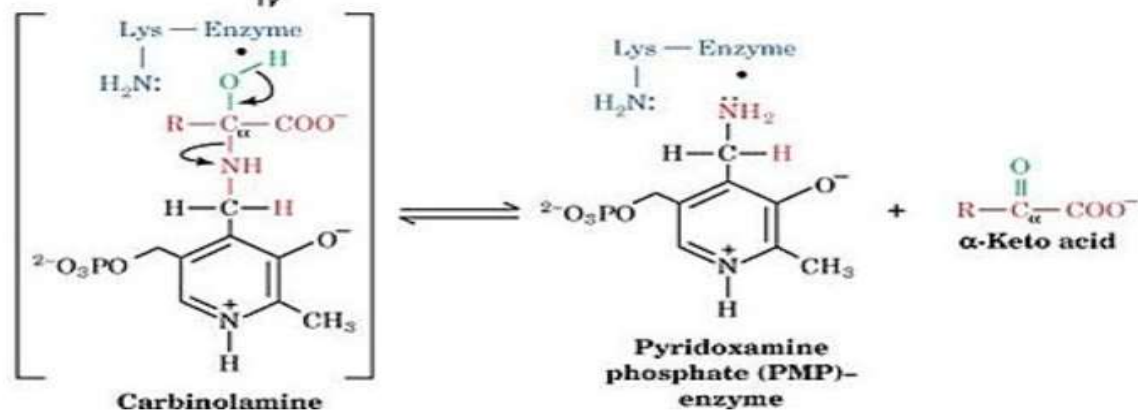11) Liver, kidney, Heart, Brain – adequate amount of transaminase enzymes.
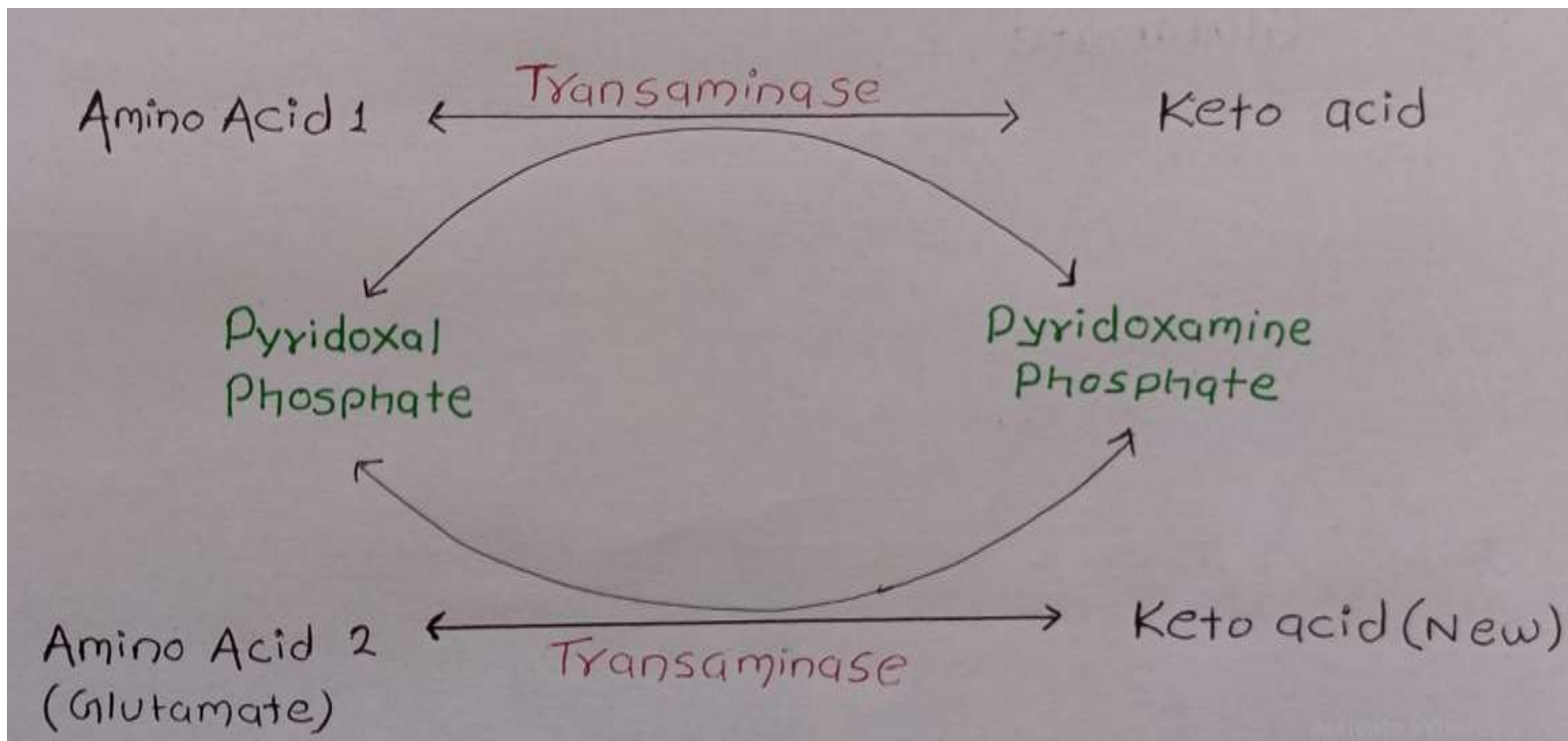
Steps 1 & 1': Transimination:

α-Amino acid Enzyme–PLP Schiff base Geminal diamine intermediate Amino acid–PLP Schiff base (aldimine)

Steps 2 & 2': Tautomerization:

Ketimine Resonance-stabilized intermediate

Steps 3 & 3': Hydrolysis:

Carbinolamine Pyridoxamine phosphate (PMP)–enzyme α-Keto acid

The most common compounds involved as a donor/acceptor pair in Transamination reactions are glutamate and alpha – ketoglutarate , Which participate in reactions with many different aminotransferases.

All the amino nitrogen from amino acids that undergo transamination Can be concentrated in glutamate. This is important because L-glutamate Is the only amino acid that undergoes oxidative deamination.