METABOLISM OF AMINO ACIDS

Fate of absorbed amino acids

Enter in the formation of A.A. pool

AA pool

~ 80 % in muscles	~ 10 % in liver
~ 5 % in kidney	~ 5 % in blood

- **Definition: AA POOL** It include the free a.as distributed throughout the body
- The a.a. pool contains 100 gm a.as.50% of these a.as are in the form of glutamate & glutamine (Why?)
- In contrast to the amount of protein in the body (about 12 Kg in 70 Kg man), the a.a. pool is small (only 100 gm)

AA pool is not reserve !!

There is not a specific protein reserve in human body in contrast to saccharides (liver glycogen) and lipids (adip. tissue) !!

AA in blood

Resorption phase

- predominate Val, Leu, Ile
- liver does not take them up from circulation (no specific aminotransferases in liver for Val, Leu, Ile)

Postresorption phase and fasting

- predominate Gln and Ala
- released from muscles (Gln + Ala) and liver (Gln)

There are eight essential aminoacids

- valine
- leucine
- isoleucine
- threonine
- phenylalanine
- tryptophan
- lysine
- methionine

Conditionally essential aminoacids

histidine, arginine (in childhood and youth)

alanine, glutamine (in metabolic stress)

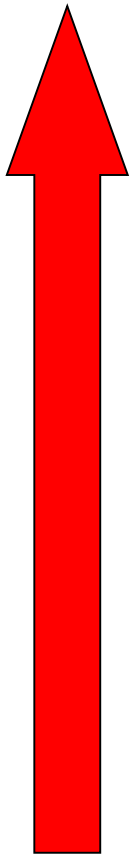
Biological value of proteins (BV) the amount of endogenous proteins made in body from 100 g of dietary proteins

about 30 % of methionine requirement can be made up by cysteine

about 50 % of phenylalanine requirement can be made up by tyrosine

Biological value of some proteins

Protein	BV (%)
Egg white	100
Whey	100
Whole egg	96
Casein	80
Beef	77
Pork	70
Oats	60
Wheat flour	53
Beans	46
Gelatine	25



Overall metabolism of proteins

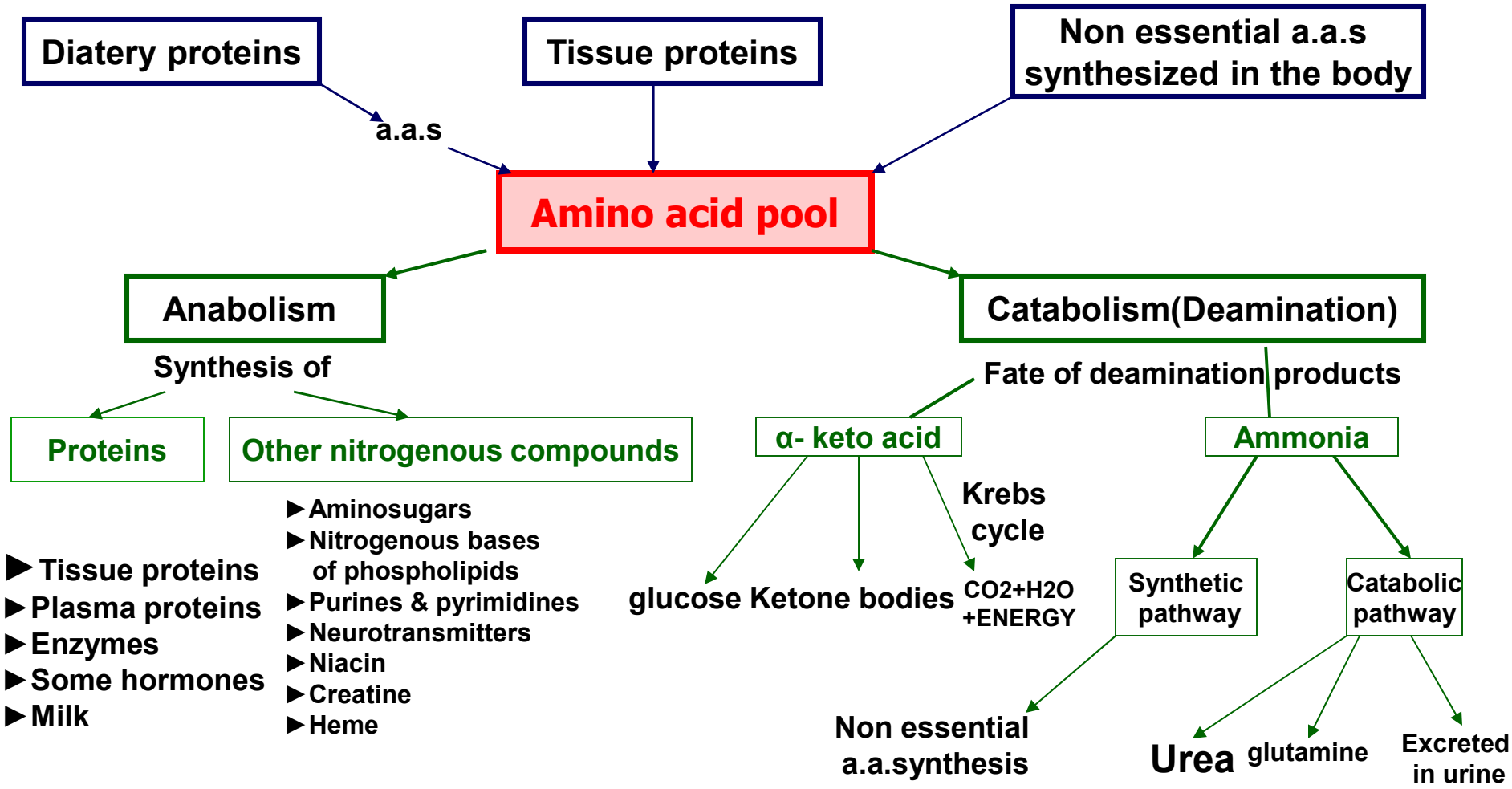
- All proteins in the body are continuously degraded (metabolized) and newly synthesized
- Free AA from food, tissue proteins and non-essential AA from synthesis , make AA pool
- AA pool is used for:

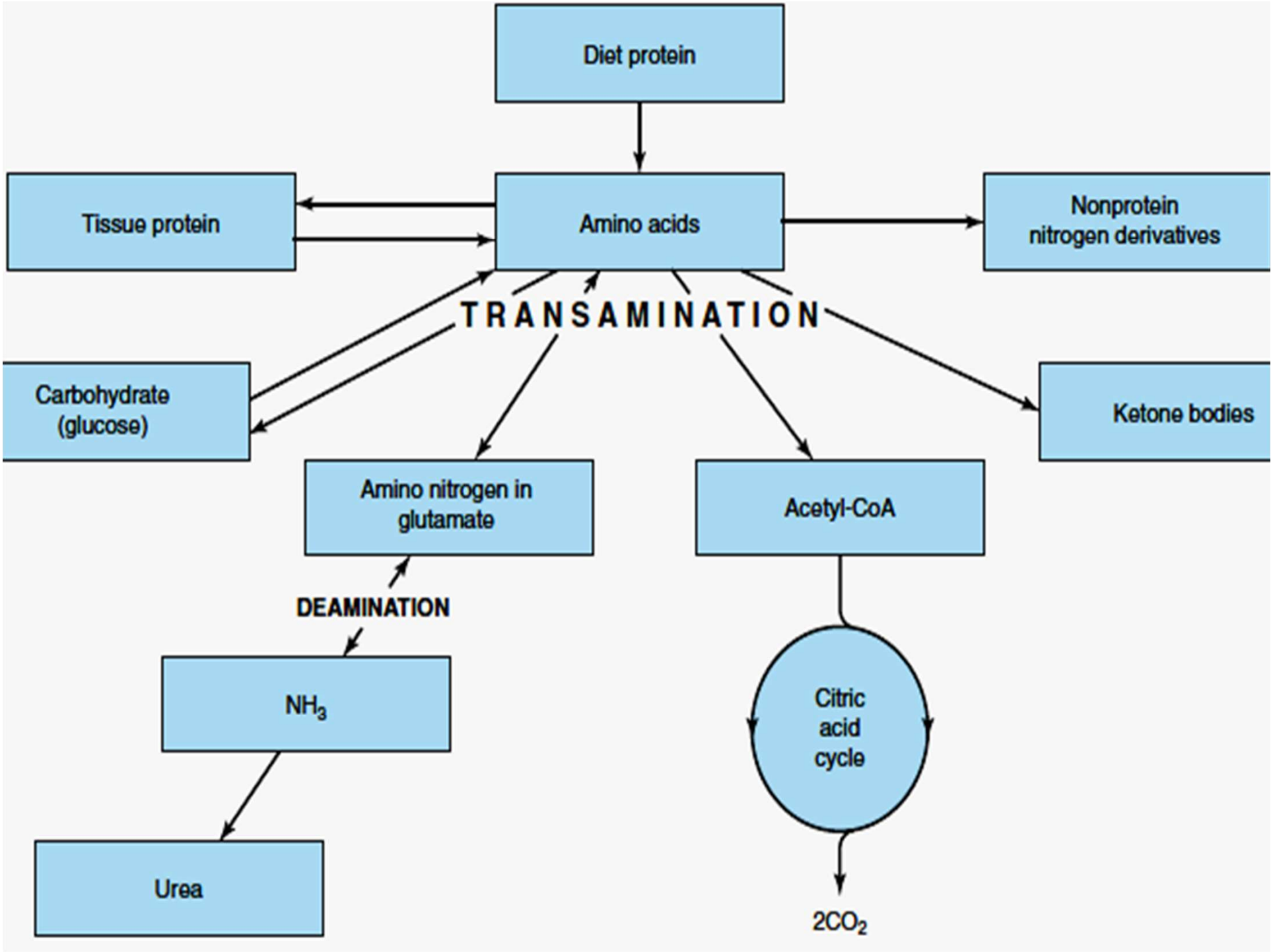
  i. New body proteins

  ii. Specialized products (amines, NO, porphyrines, NA bases ...)

  iii. Catabolic proceses (energy gain)

▶SOURCES & FATE OF THE AA. POOL:




Diet protein
Tissue protein
Amino acids
Nonprotein nitrogen derivatives
TRANSAMINATION
Carbohydrate (glucose)
Ketone bodies
Amino nitrogen in glutamate
Acetyl-CoA
DEAMINATION
NH_3
Citric acid cycle
Urea
$2CO_2$

GENERAL STRATEGY

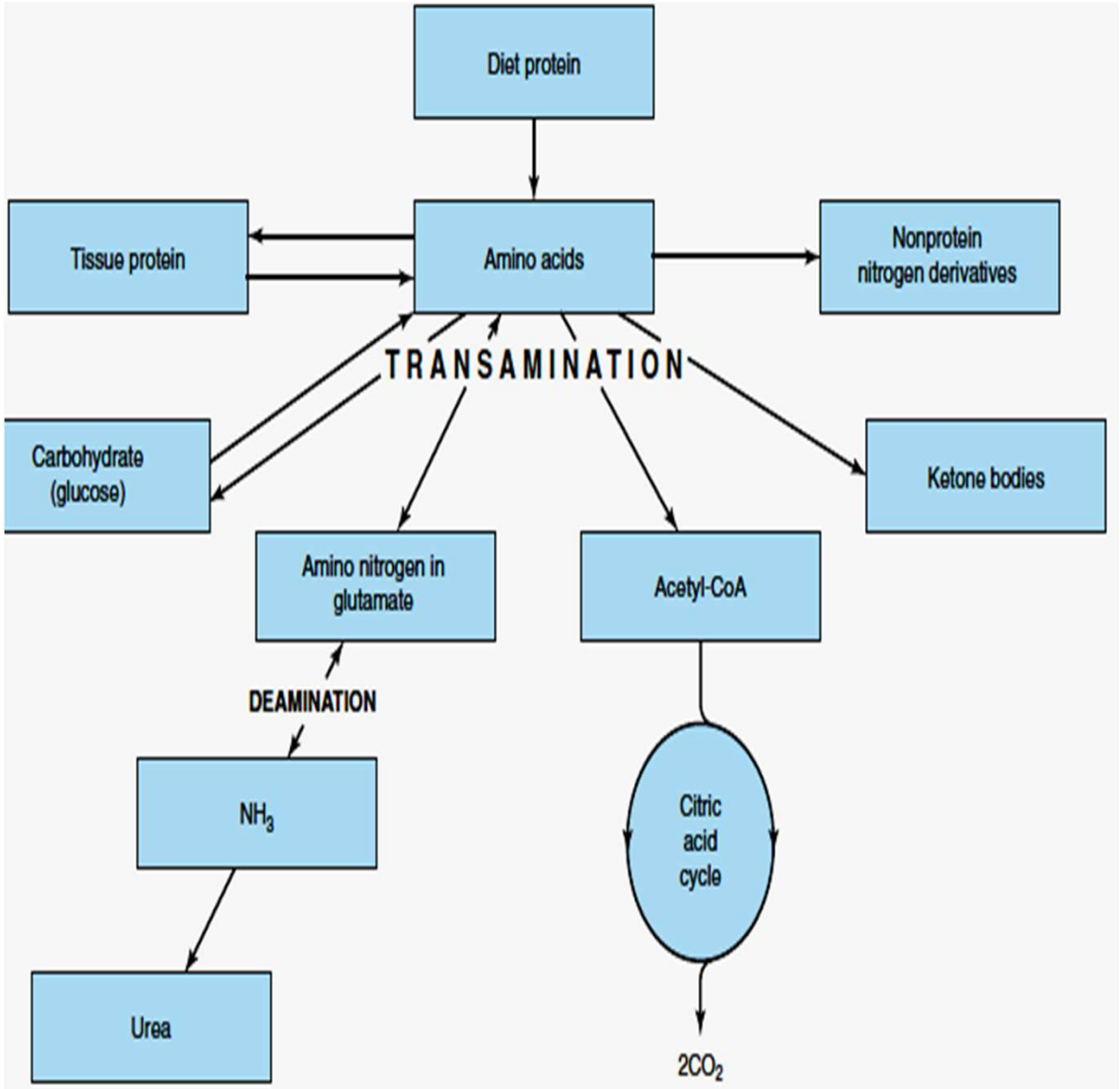
- **Removal of N from amino acid by *transamination* (generally first or second step of amino acid catabolic pathways) and collection of N in glutamic acid**
- ***Deamination* of glutamic acid with release of NH_4^+ by glutamate dehydrogenase**

Collection of N in glutamine or alanine for delivery to liver

- **Removal of NH_4^+ by :**

i. secretion; or

ii. Conversion to urea or other less toxic form.

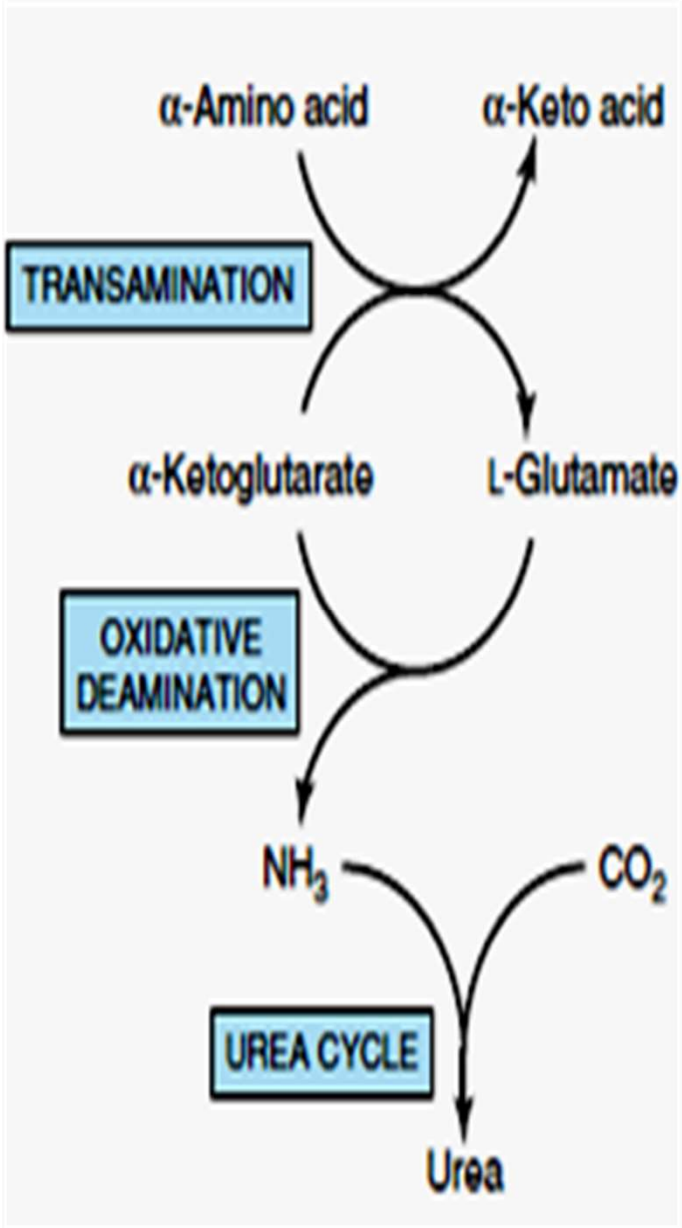


ure 15–4. Overview of amino acid metabolism showing the major pathways and end products.

Ammonia

Formation and elimination in the body

Ammonia is a metabolic product of amino acid deamination catalyzed by enzymes. Ammonia is quickly converted to urea, which is much less toxic, particularly less basic. This urea is a major component of the dry weight of urine. The liver converts ammonia to urea through a series of reactions known as the urea cycle. Liver dysfunction, such as that seen in cirrhosis, may lead to elevated amounts of ammonia in the blood (hyperammonemia). Likewise, defects in the enzymes responsible for the urea cycle, leads to this disorder. It causes confusion and coma, neurological problems, and aciduria (acid in the urine).

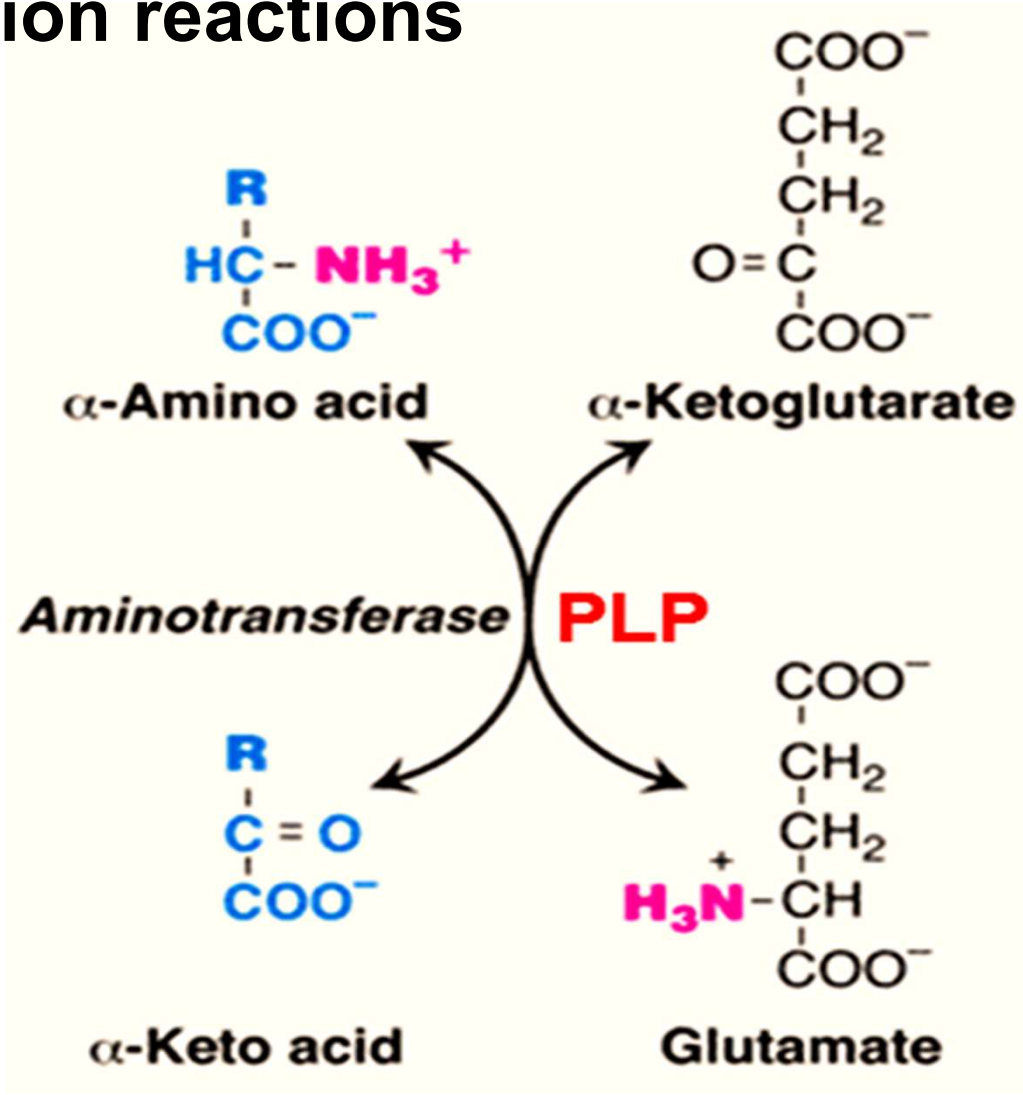


- **Transamination** is a chemical reaction between two molecules.
- One is an amino acid, which contains an amine (NH_2) group.
- The other is a keto acid, which contains a keto (=O) group.
- In transamination, the NH_2 group on one molecule is exchanged with the =O group on the other molecule. The amino acid becomes a keto acid, and the keto acid becomes an amino acid.
- Transamination in biochemistry is accomplished by enzymes called transaminases or aminotransferases.

TRANSAMINATION

► **α-ketoglutarate & glutamate** are often involved in transamination reactions

Coenzyme: PLP (Pyridoxal phosphate)



Salient Features of Transamination

1. Reversible reaction

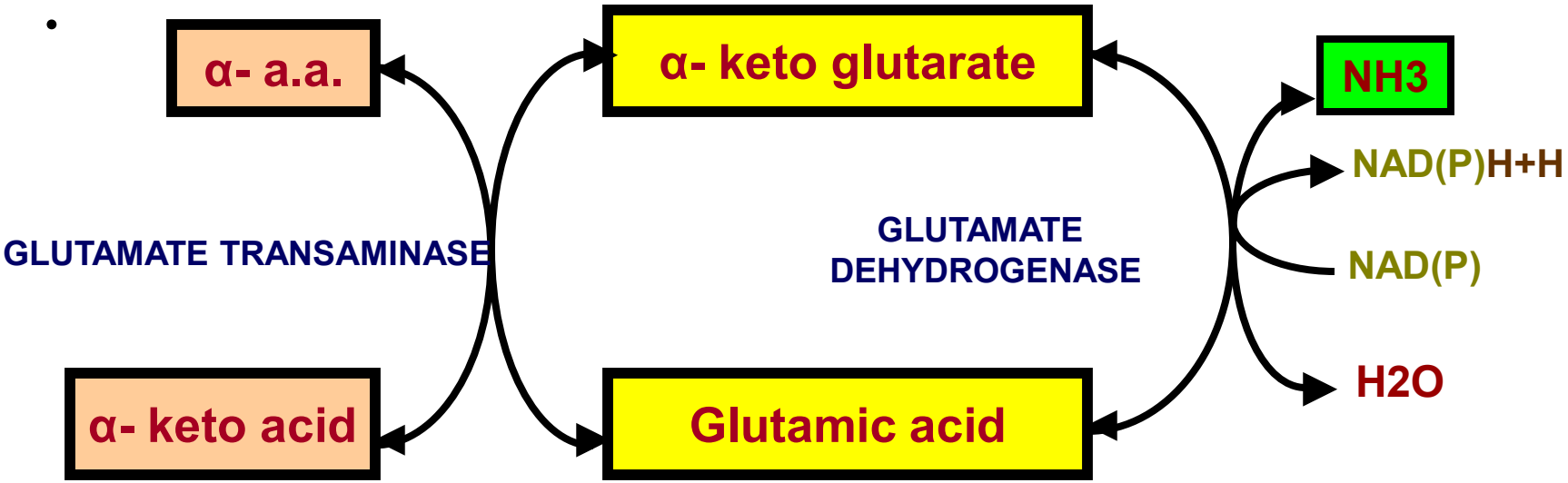
2. Site: takes place principally in liver, heart and brain

In transaminations, nitrogen of most AA is concentrated in glutamate

Glutamate then undergoes oxidative deamination and releases **free ammonia NH_3**

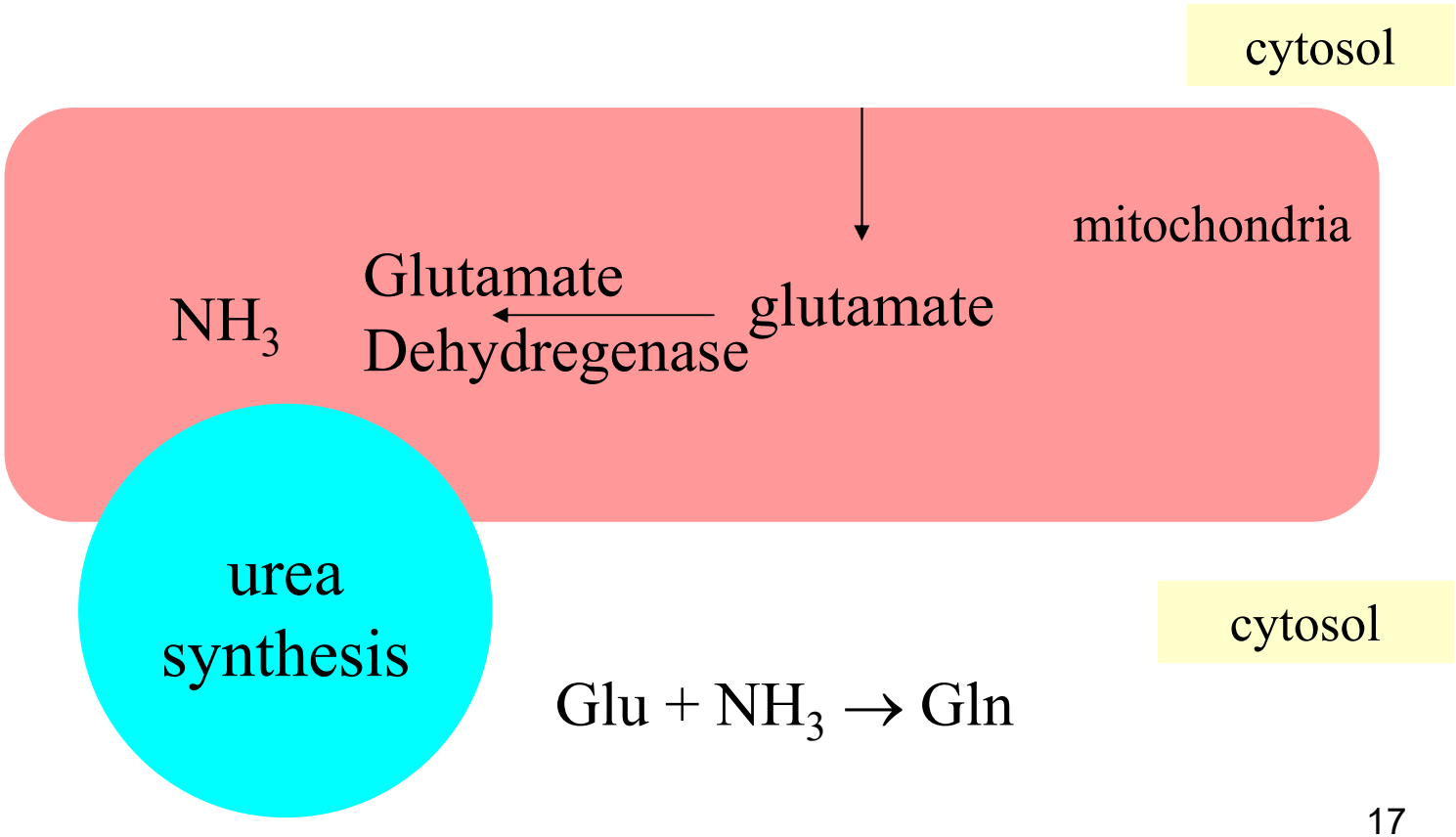
DEAMINATION

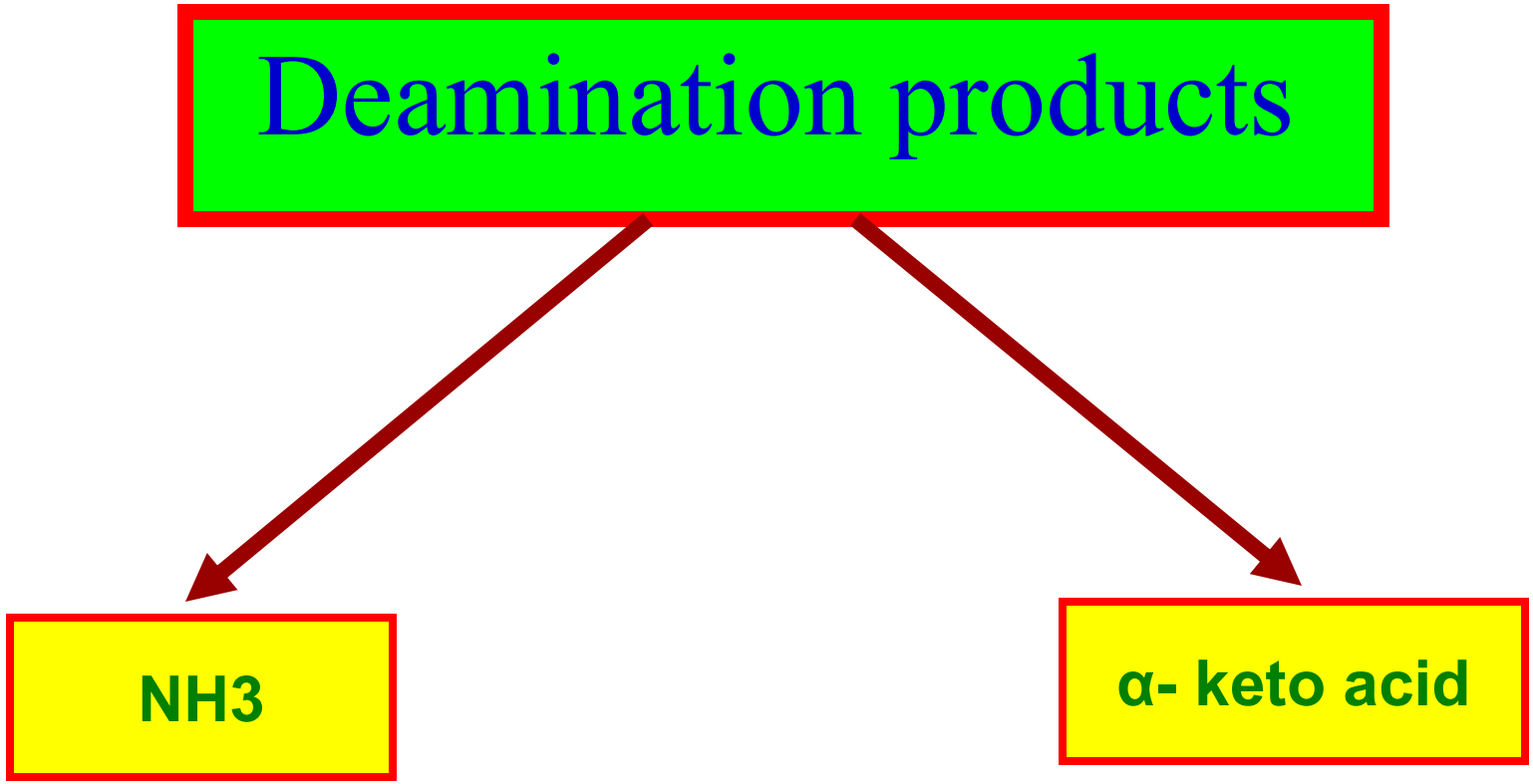
- The removal of amino group from the AAs as NH_3
- Transamination involves only shuffling of NH_3 groups among the AAs
- Deamination results in the liberation of NH_3 for urea synthesis
- Simultaneously, the C-skeleton of AAs is converted to keto acids



Intracellular localization

Transamination $\Rightarrow$ glutamate




Deamination products
NH3
α- keto acid

►IMPORTANCE OF OXIDATIVE DEAMINATION

glutamate dehydrogenase enzyme is the only enzyme by which a.a. undergoes oxidative deamination in the mammalian tissue.

Oxidative deamination by glutamate dehydrogenase is an essential component of TRANSDEAMINATION.

TRANSDEAMINATION

- The amino group of amino acids is released by a coupled reaction, TRANSDEAMINATION
- Transamination followed by oxidative deamination.
- Transamination takes place in the cytoplasm of all the cells of the body : the amino group is transported to liver as glutamic acid, which is finally oxidatively deaminated in the mitochondria of hepatocytes.
- Thus, the two components of the reaction are physically far away, but phisiologically they are coupled. Hence, Transdeamination.

■Diagnostic value of transamination :

Transaminases are normally intracellular enzymes. They are elevated in the blood when damage to the cells producing these enzymes occurs.

* Increase level of both ALT & AST indicates possible damage to the liver cells.

* Increase level of AST ALONE suggests damage to heart muscle , skeletal muscle or kidney.