

Protein and amino acid metabolism

Protein-rich products



Essential amino acids

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

Semiessential amino acids

- arginine and histidine

Proteases

Serine proteases

Cysteine proteases

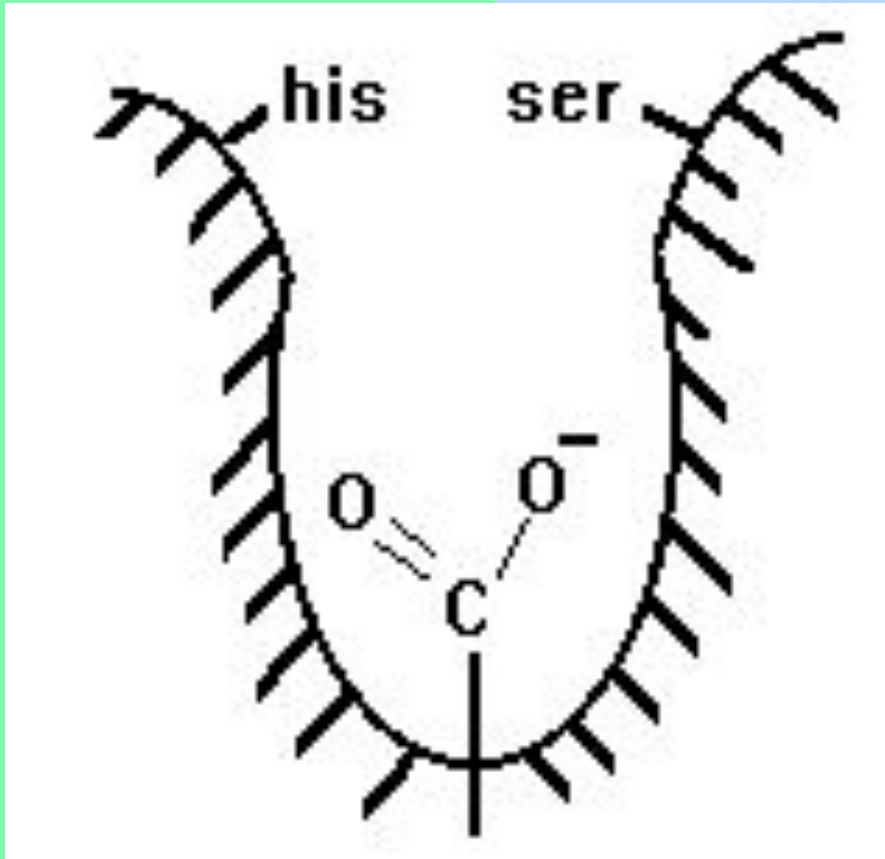
Aspartic proteases

Metalloproteases

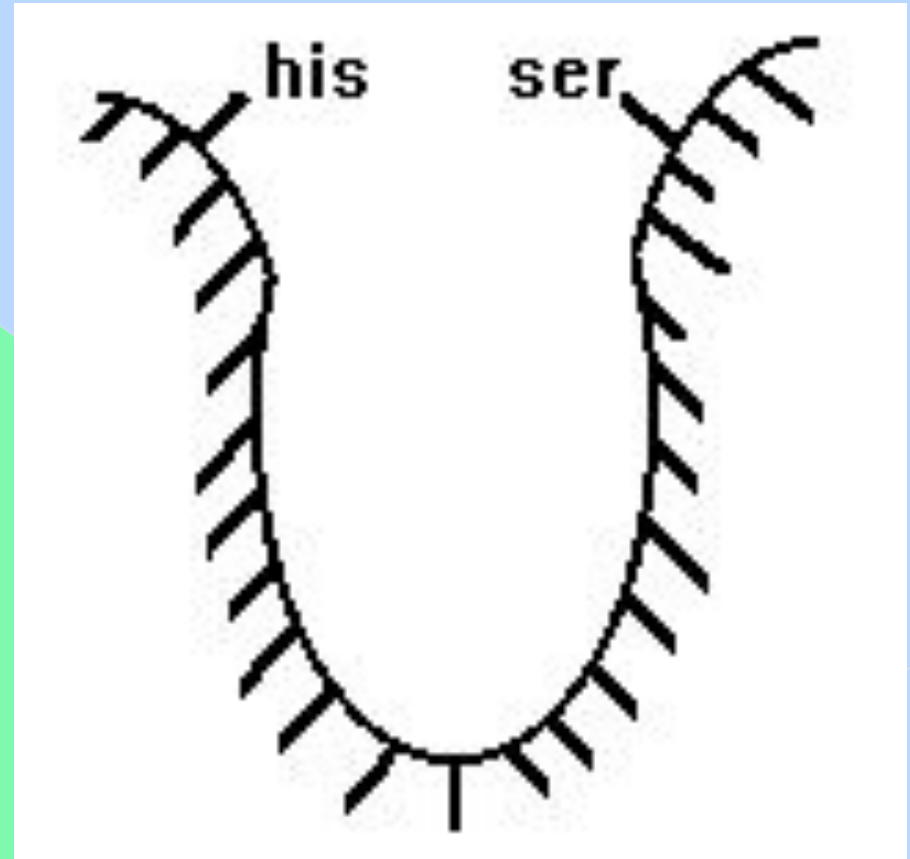
Treonine proteases

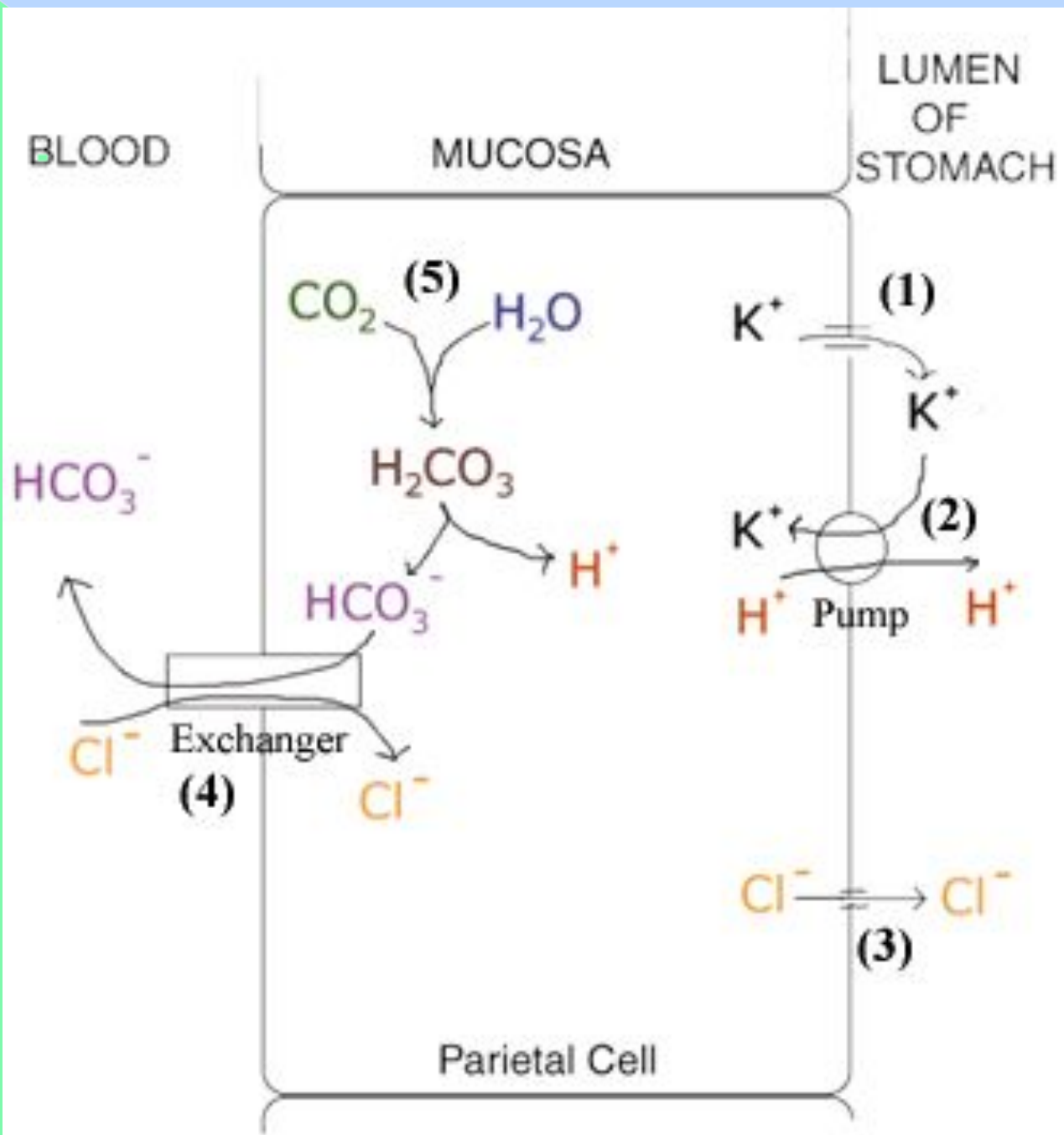
Glutamic proteases

Active site of trypsin



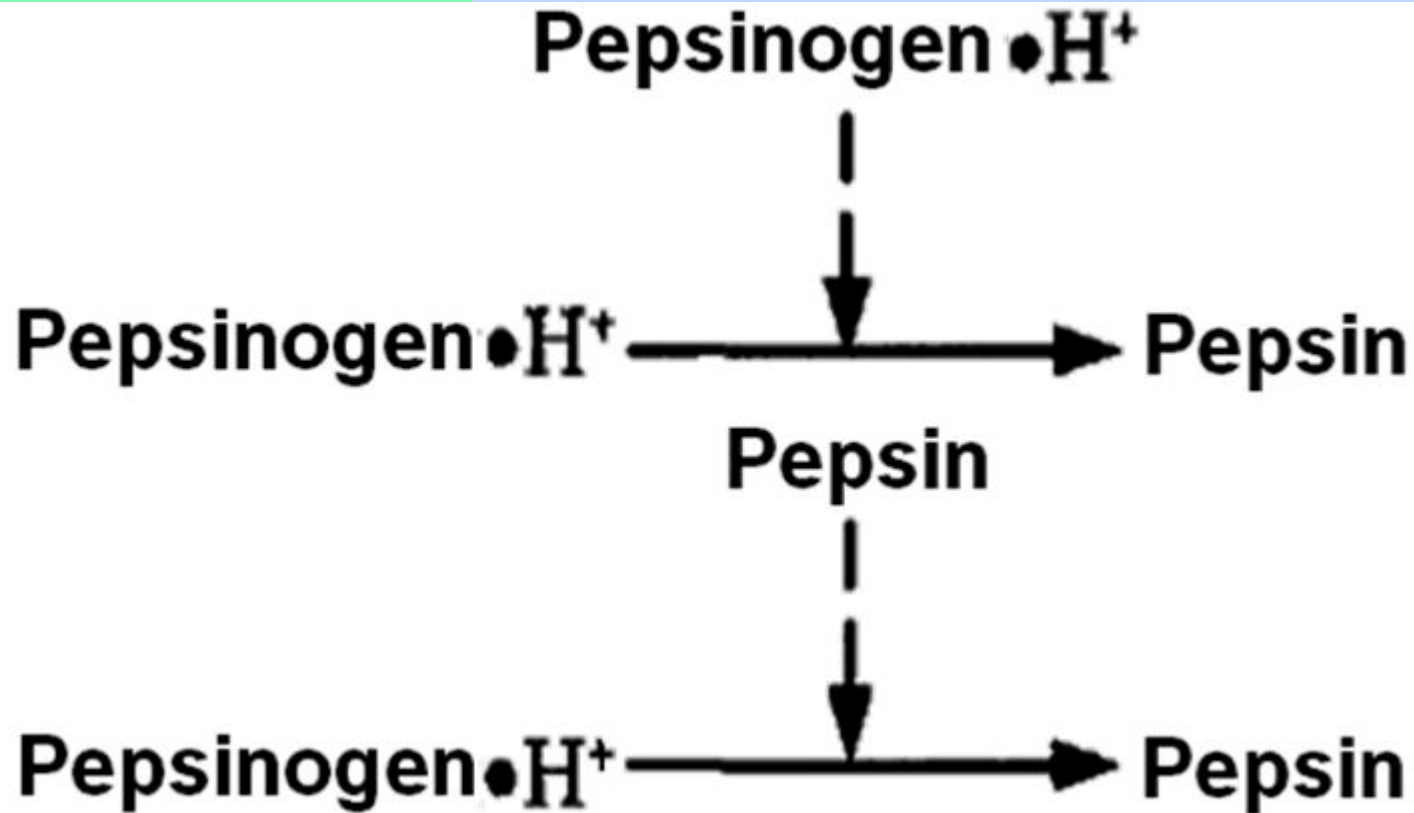
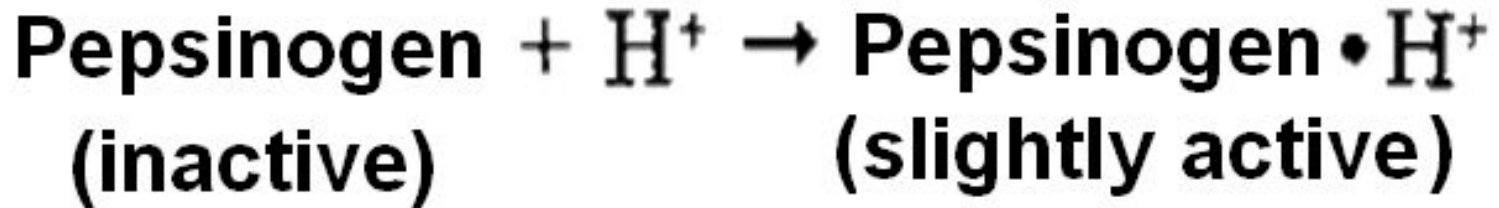
Active site of chymotrypsin





HCL secretion

Pepsinogen activation




The selectivity of pepsin


Enzyme	Splittable peptide bonds
Pepsin	phenylalanine, tyrosine, glutamic acid

Trypsinogen activation

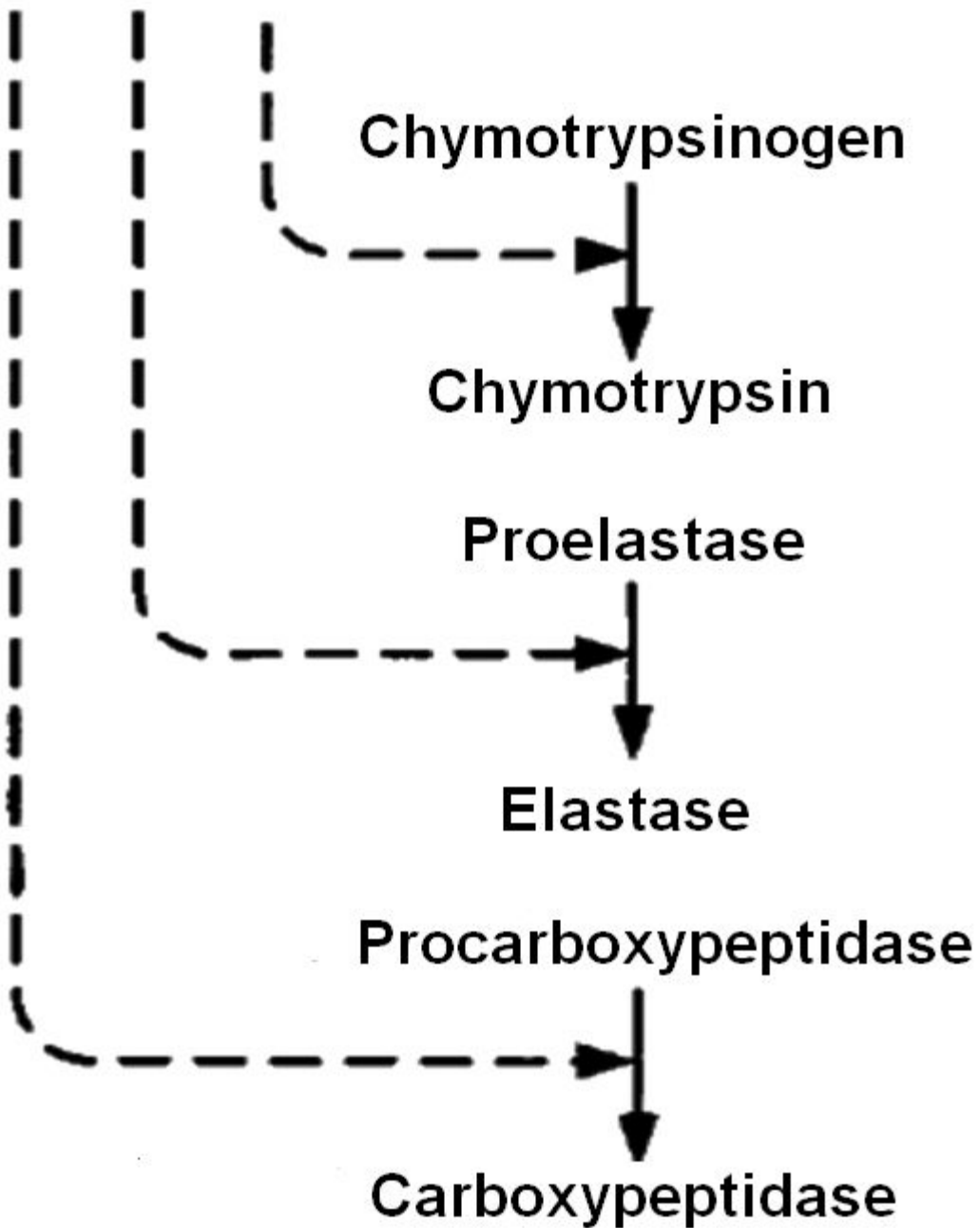
Enteropeptidase

Trypsinogen  **Trypsin**

Trypsinogen  **Trypsin**



Trypsin

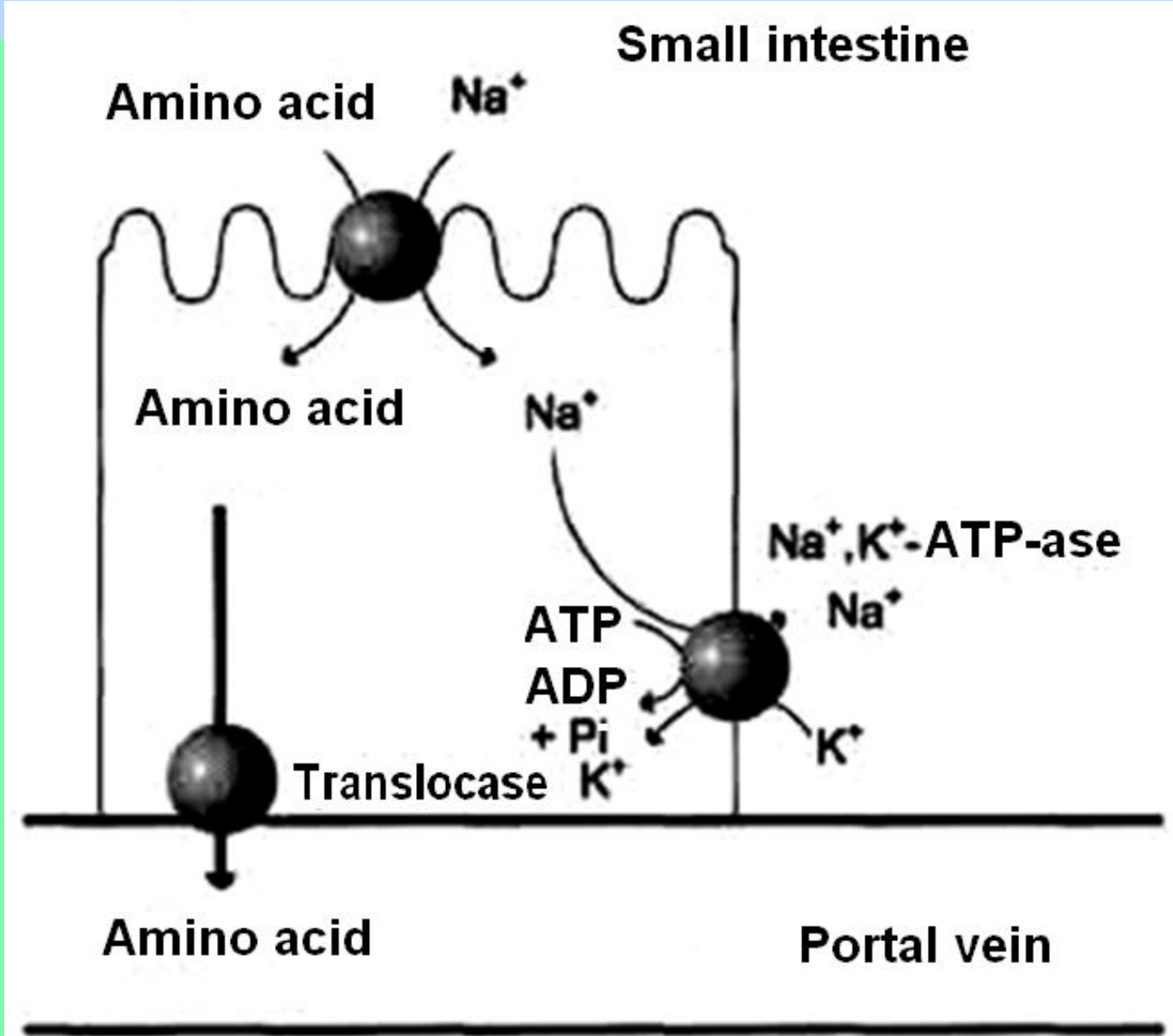


Activation of intestinal proteases

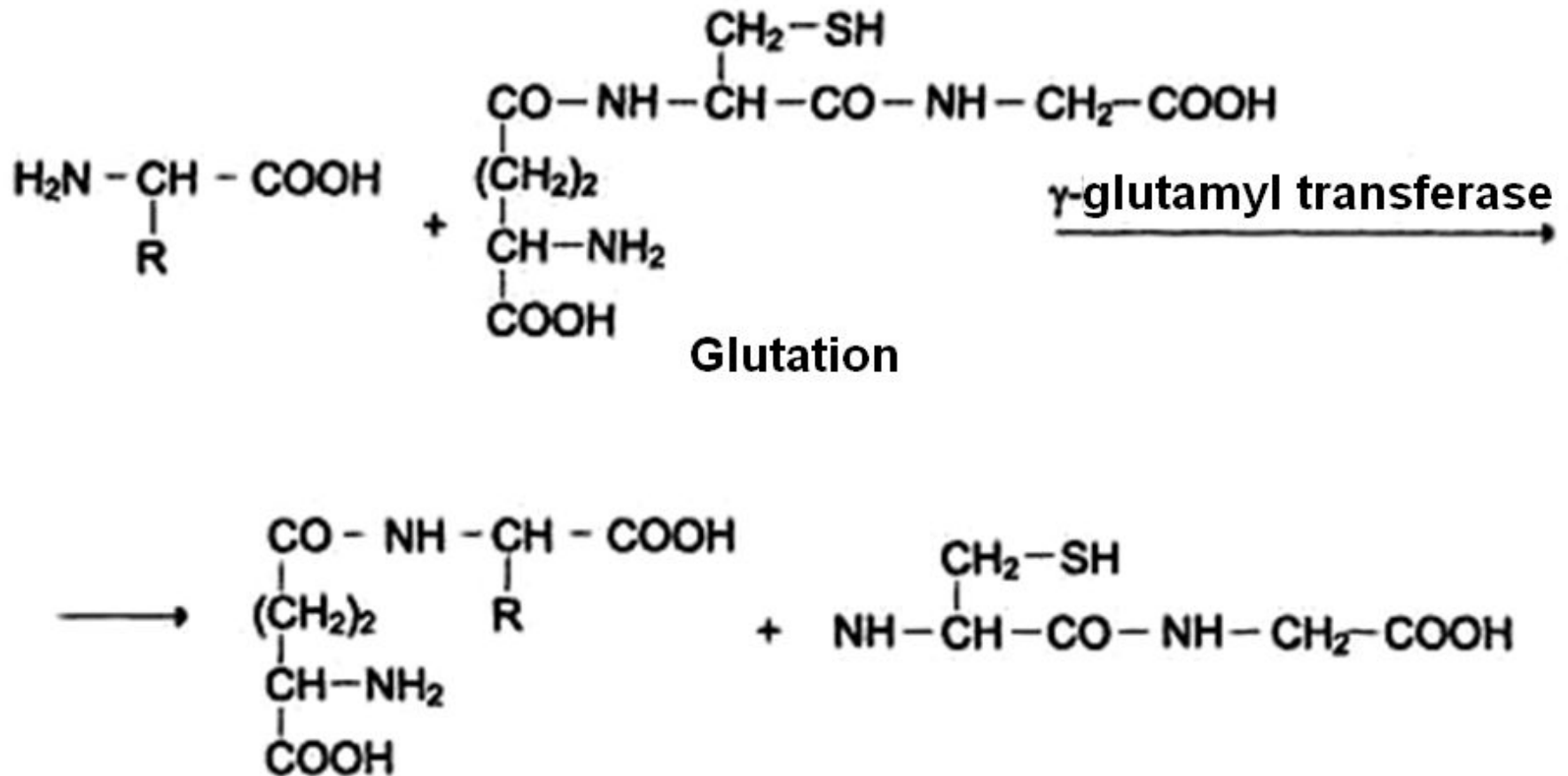
The selectivity of peptidases

Enzyme	Splittable peptide bonds
Trypsin	lysine, arginine
Chymotrypsin	tryptophan, phenylalanine, tyrosine
Elastase	alanine, serine, glycine
Carboxypeptidase A	alanine, leucine, valine
Carboxypeptidase B	lysine, arginine

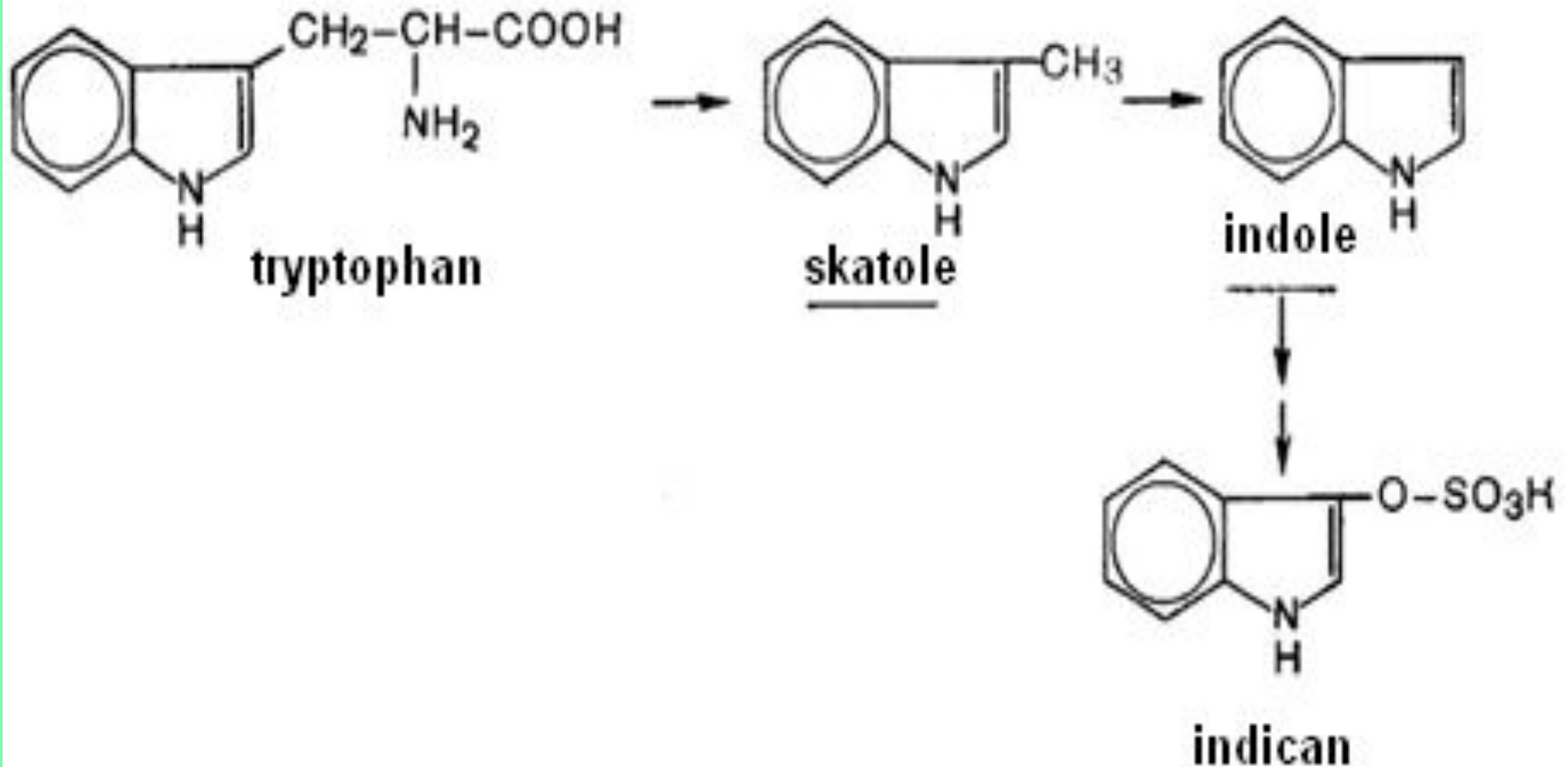
Amino acid absorption



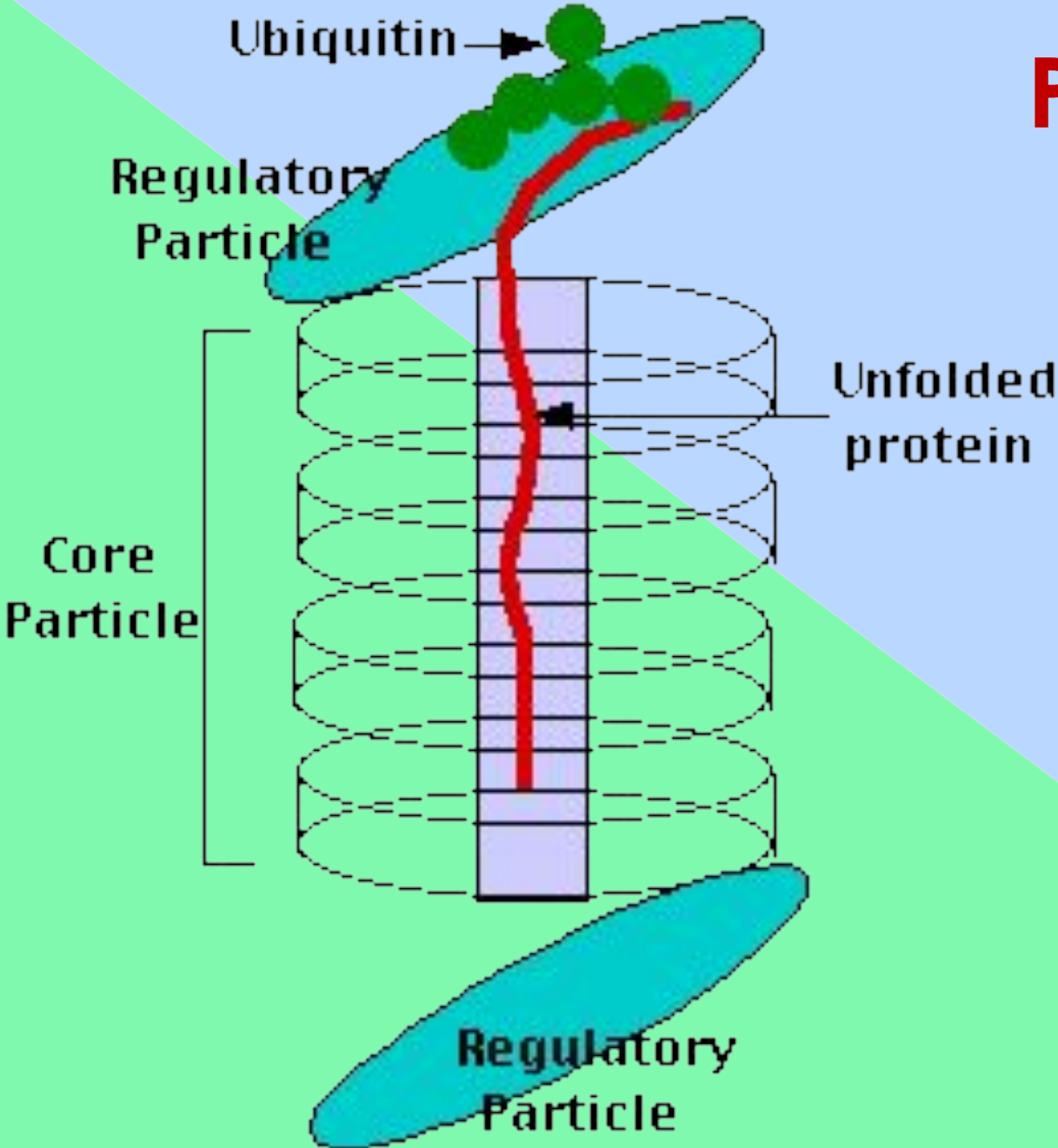
Transport Catalytic cycle of GGT



Conversion of amino acids under the action of intestinal microflora



Proteolysis in tissues

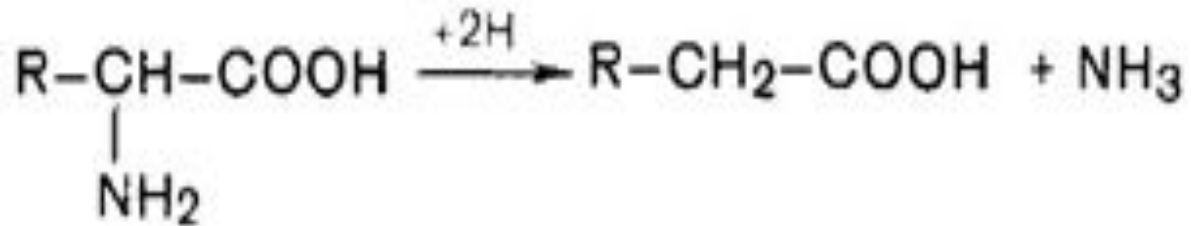




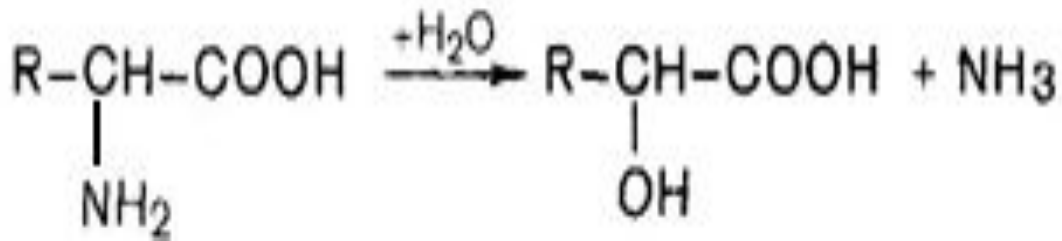
**Avram Hershko,
Aaron Ciechanover and Irwin Rose
Nobel Prize in Chemistry, 2004**

Reactions of amino group

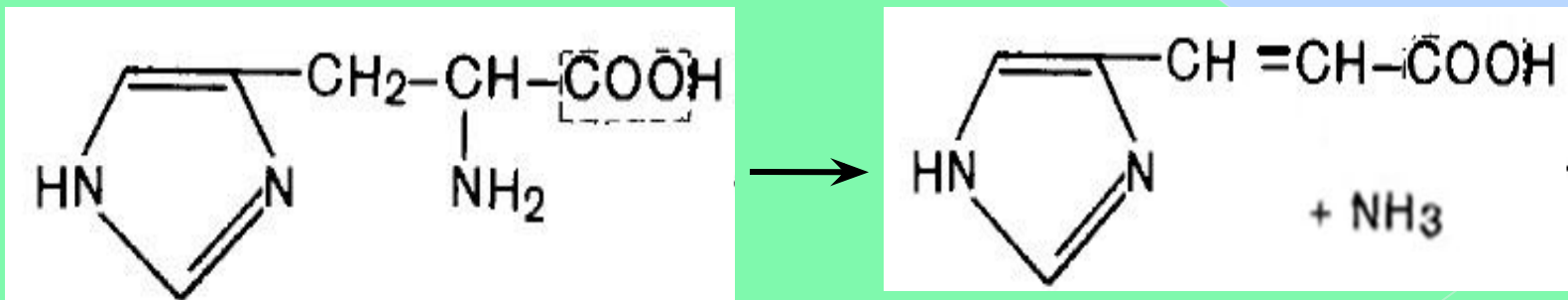
Reductive deamination



Hydrolytic deamination



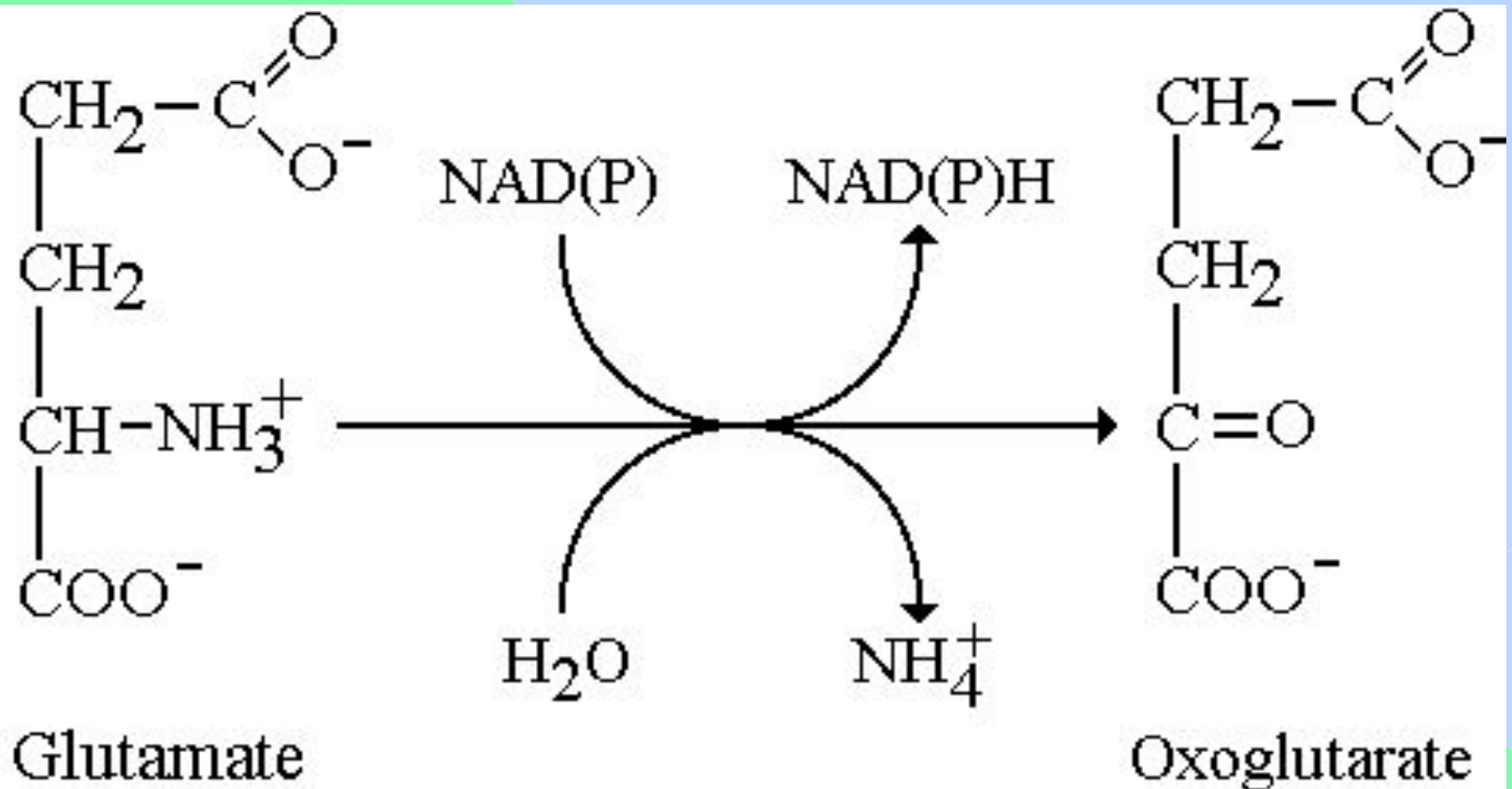
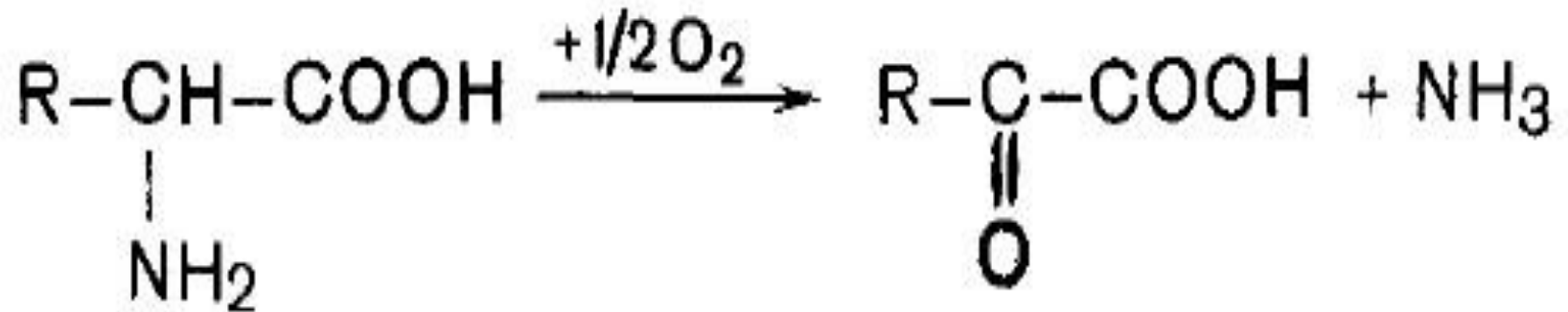
Intramolecular deamination



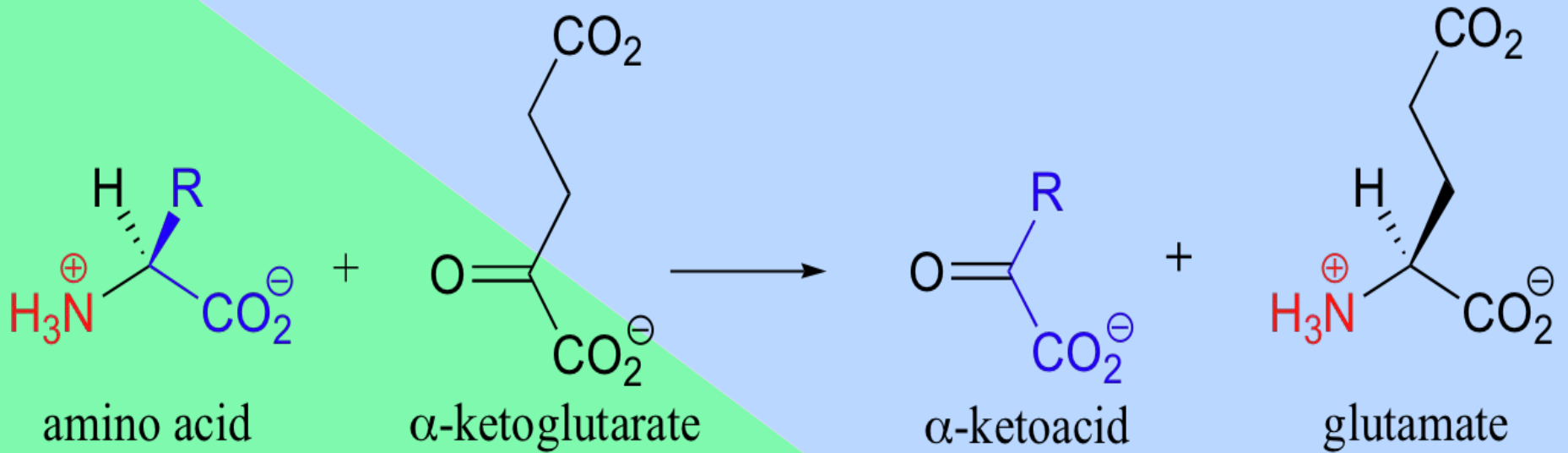
histidine

urocanic acid

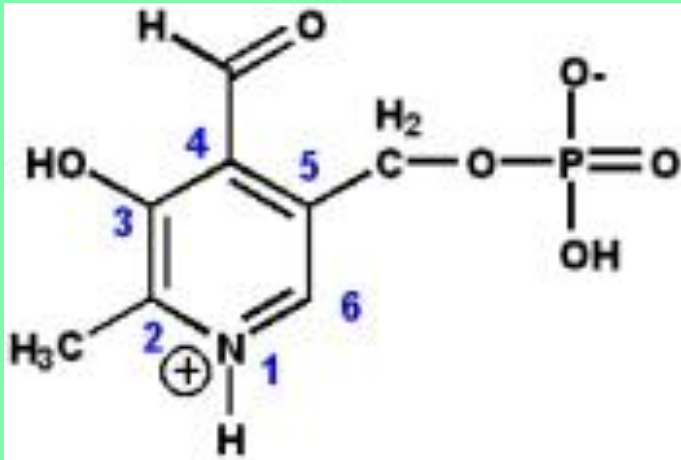
Oxidative deamination



Transamination

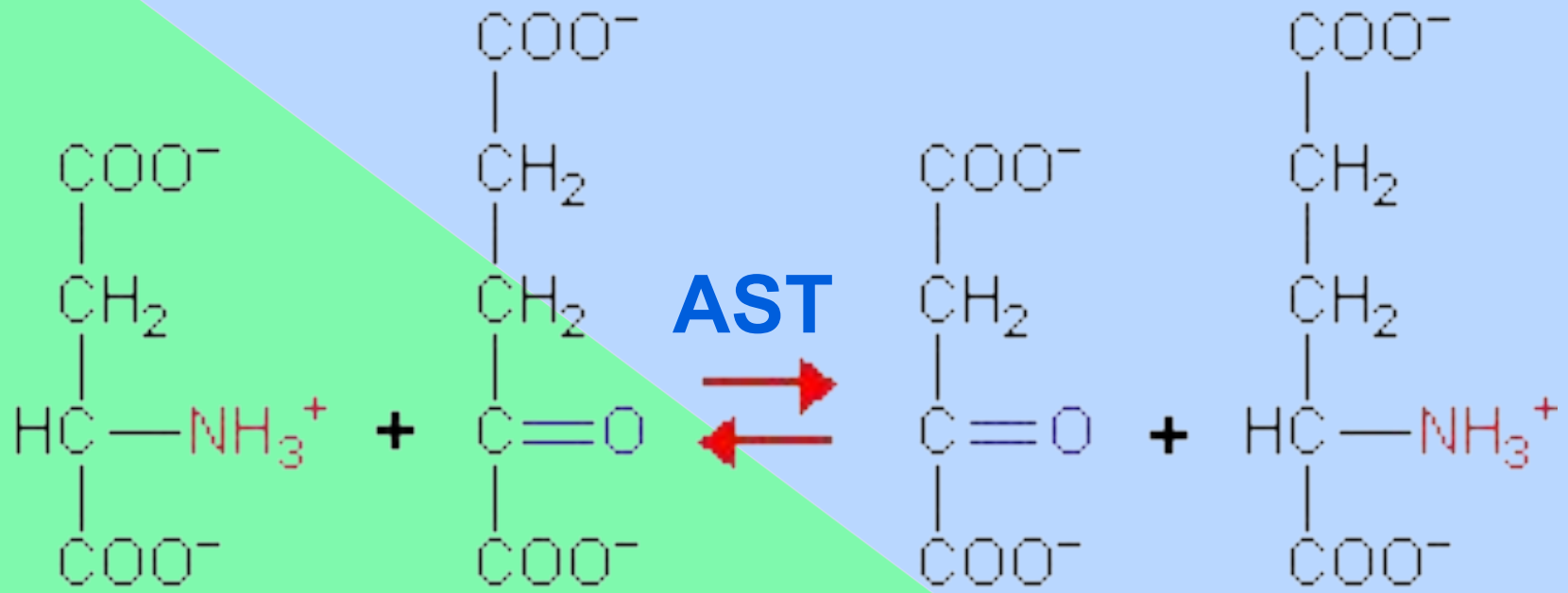


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 NH_3 eliminated



Pyridoxal-5-phosphate (PLP)

Evaluation of transaminase activity



aspartate α-ketoglutarate oxaloacetate glutamate

Aminotransferase (Transaminase)



Transaminases in human tissues (U/g protein)

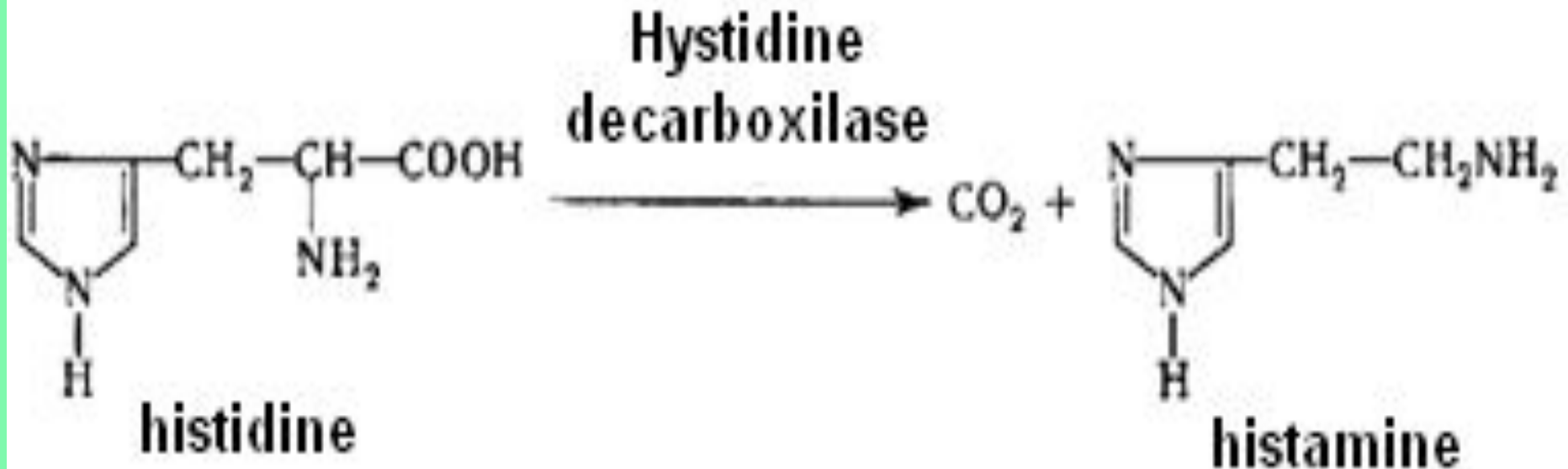
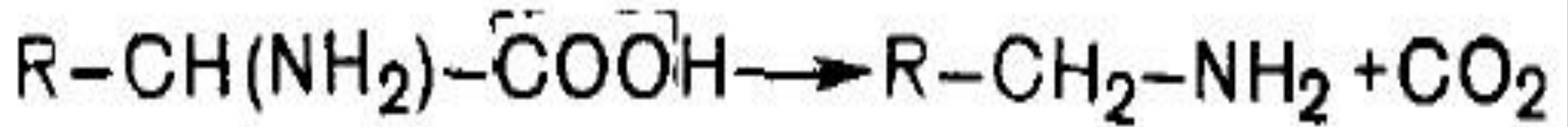
Tissues	AST	ALT
Heart	1166	66
Liver	612	358
Cerebral cortex	1230	8
Skeletal muscle	357	33
Pancreas	86	20

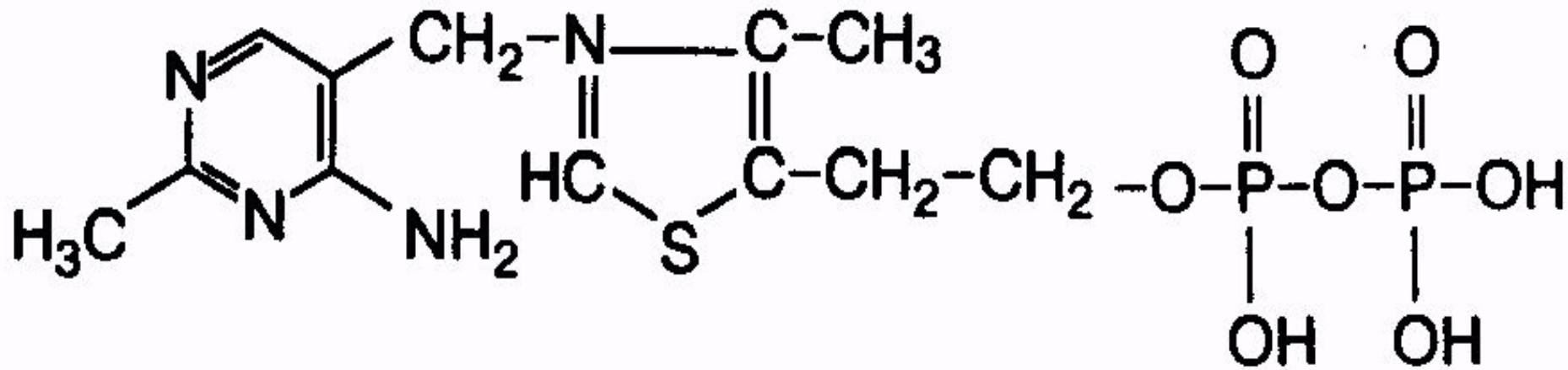
$$\text{de Ritis ratio} = \frac{\text{AST}}{\text{ALT}}$$

Myocardial infarction DRr > 1,3

Viral hepatitis DRr < 1

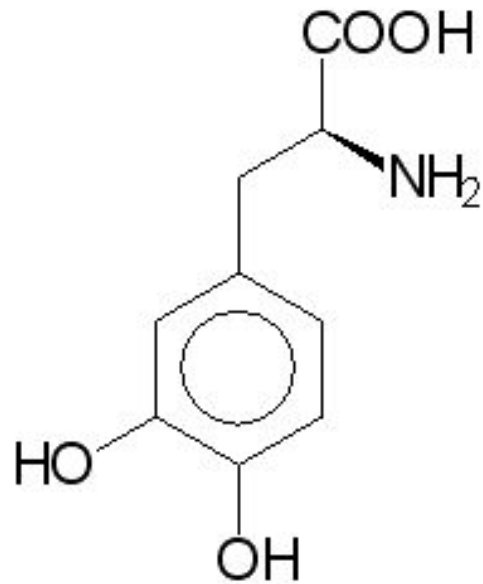
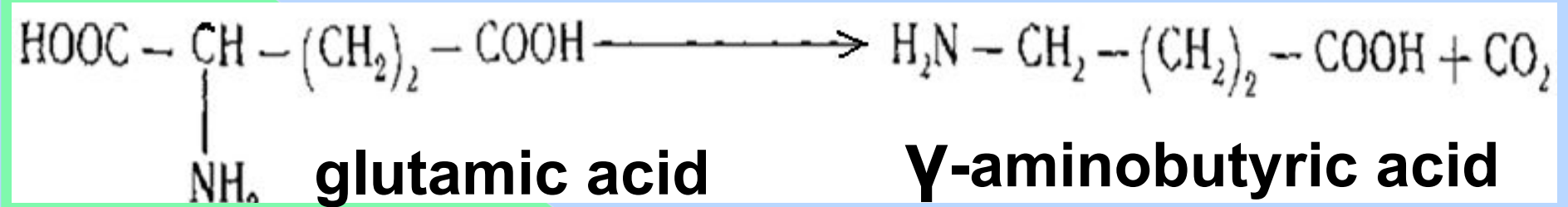
Decarboxylation



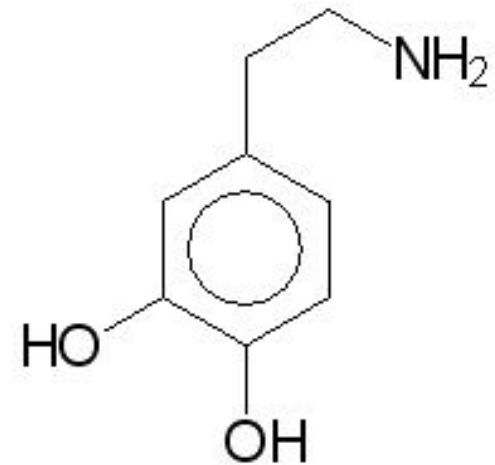


thiamine pyrophosphate

Decarboxylation

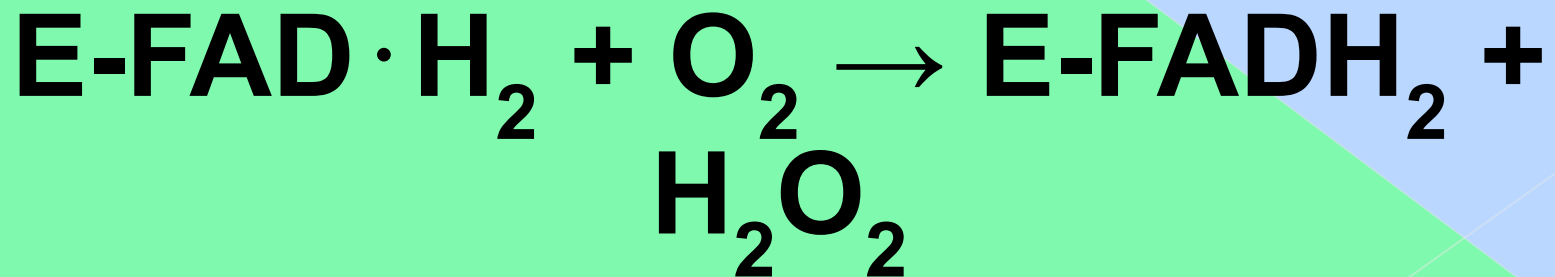
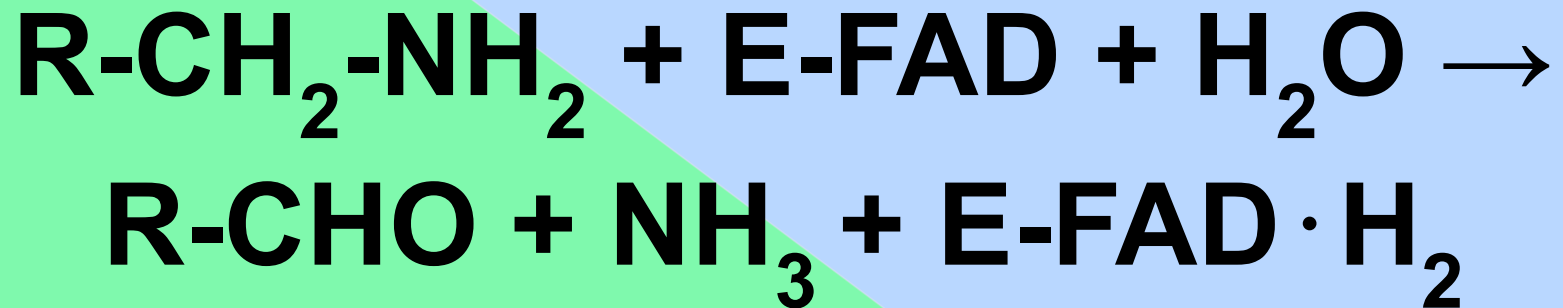


L-Dopa

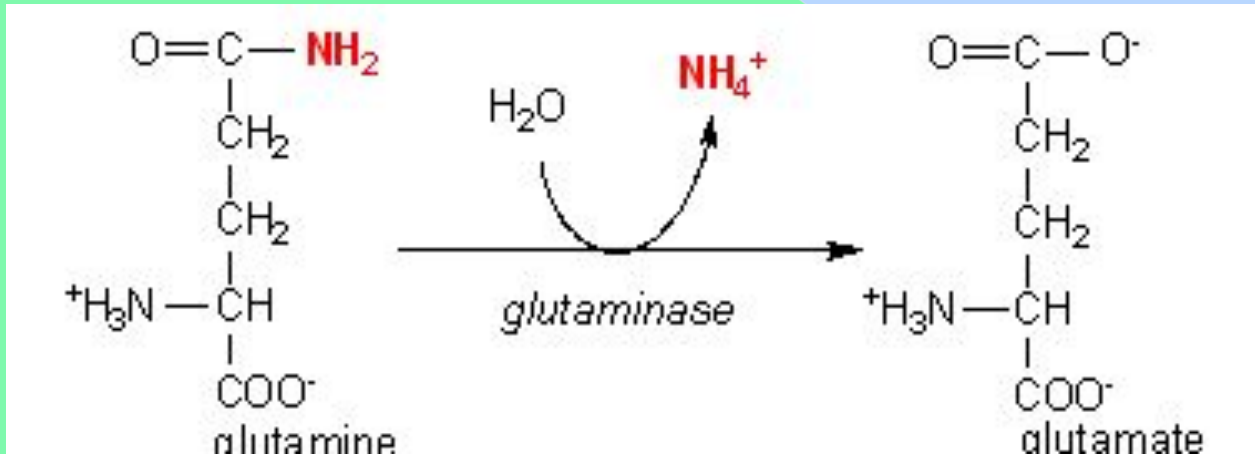
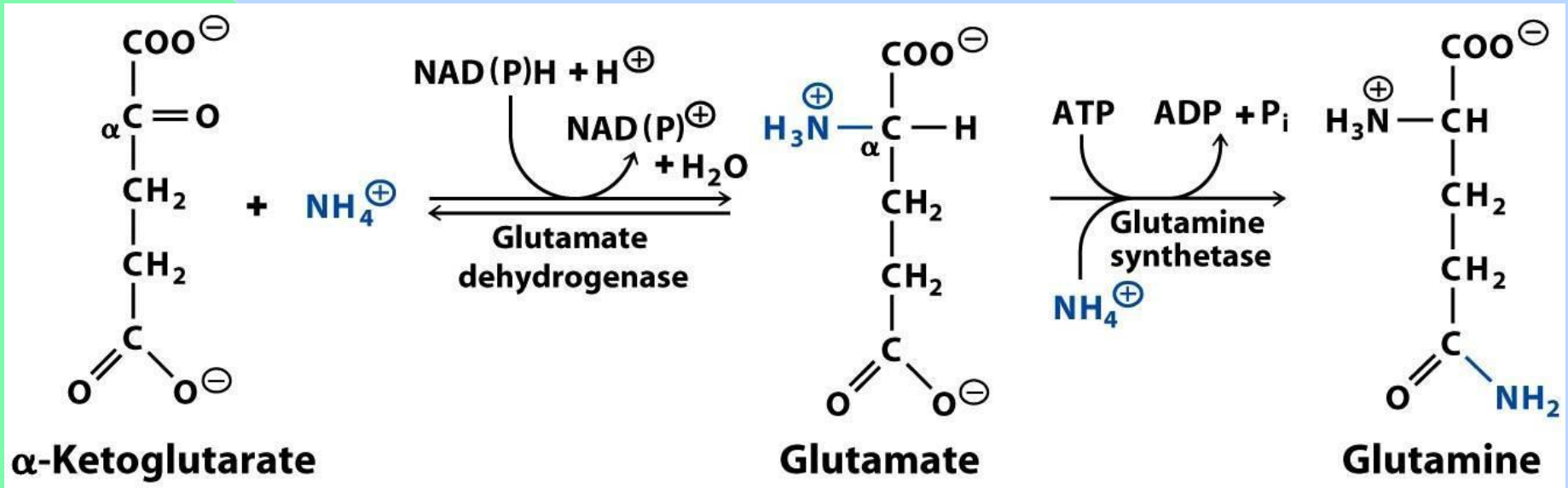


DA

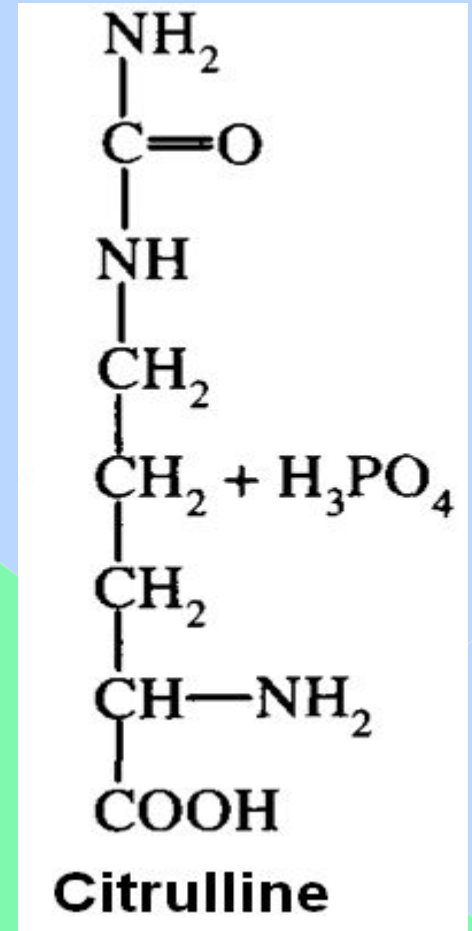
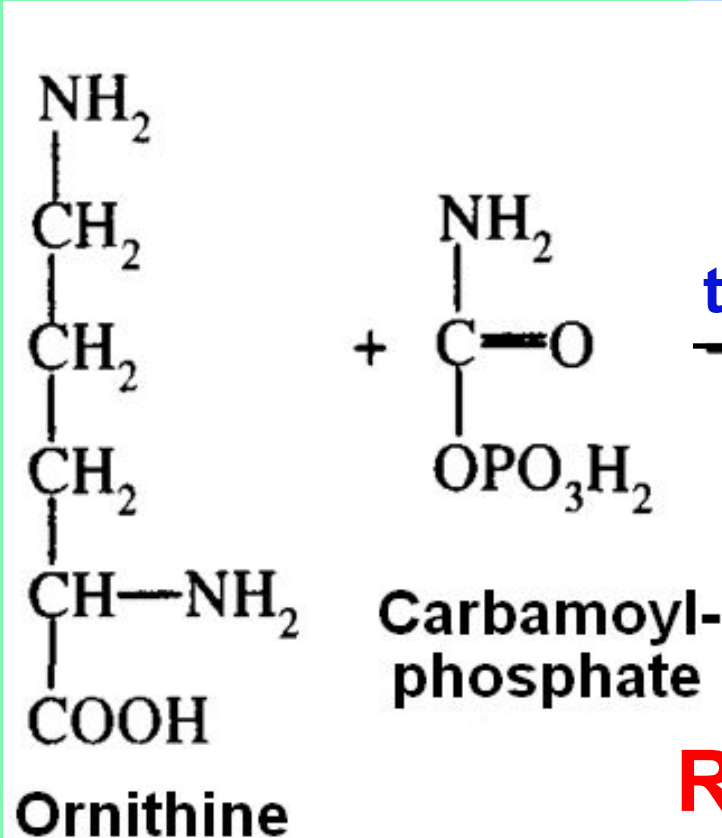
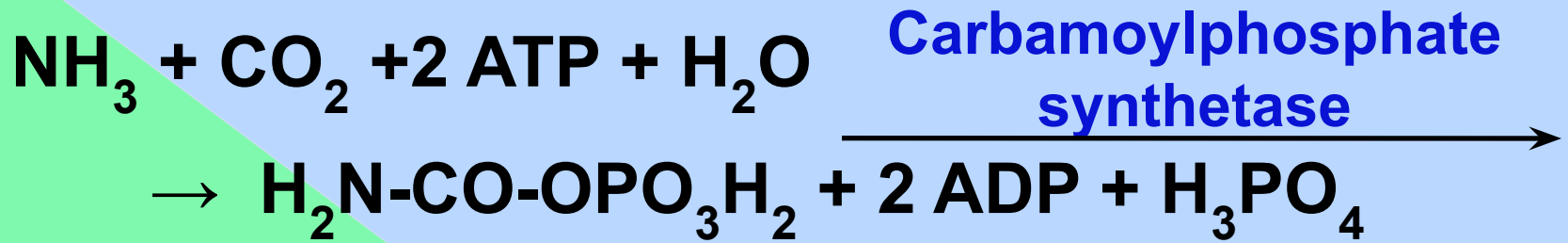
Oxidative deamination of biogenic amines



Ammonia neutralisation

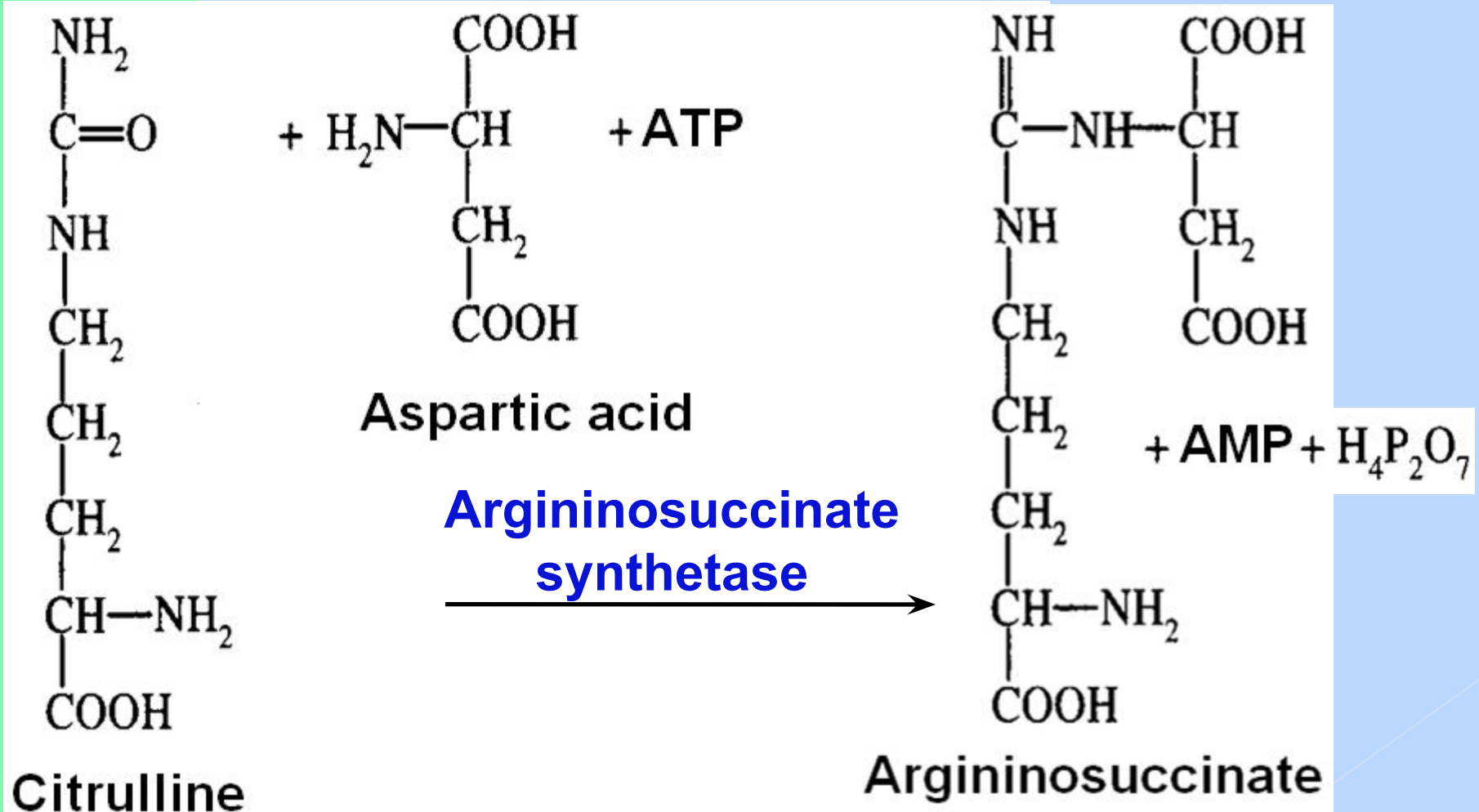


Urea cycle. Reactions 1, 2

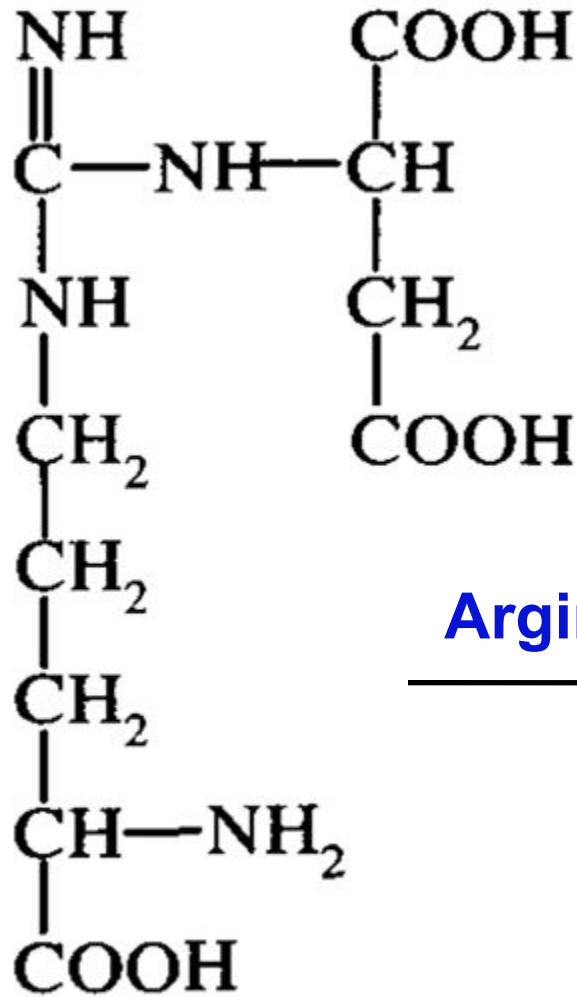


Rate-limiting!

Urea cycle. Reaction 3

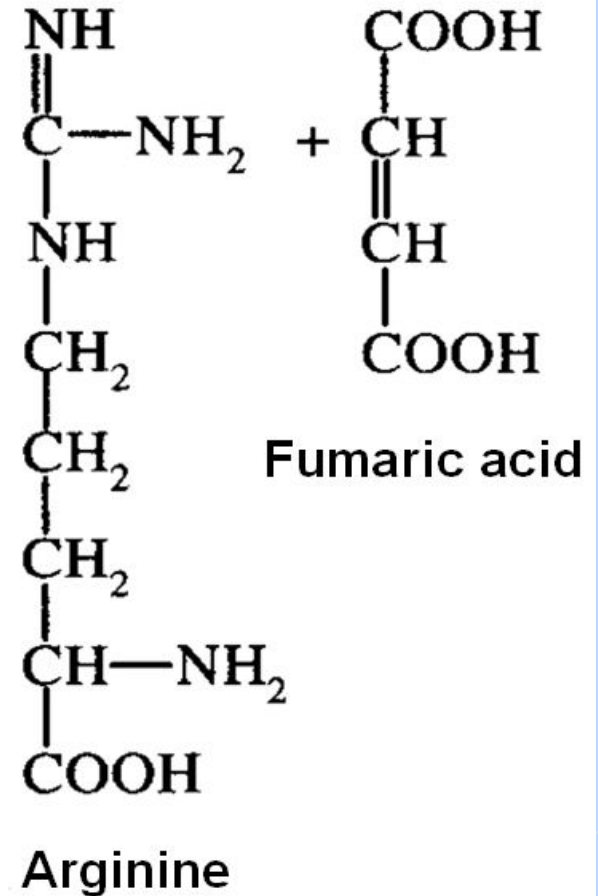


Urea cycle. Reaction 4

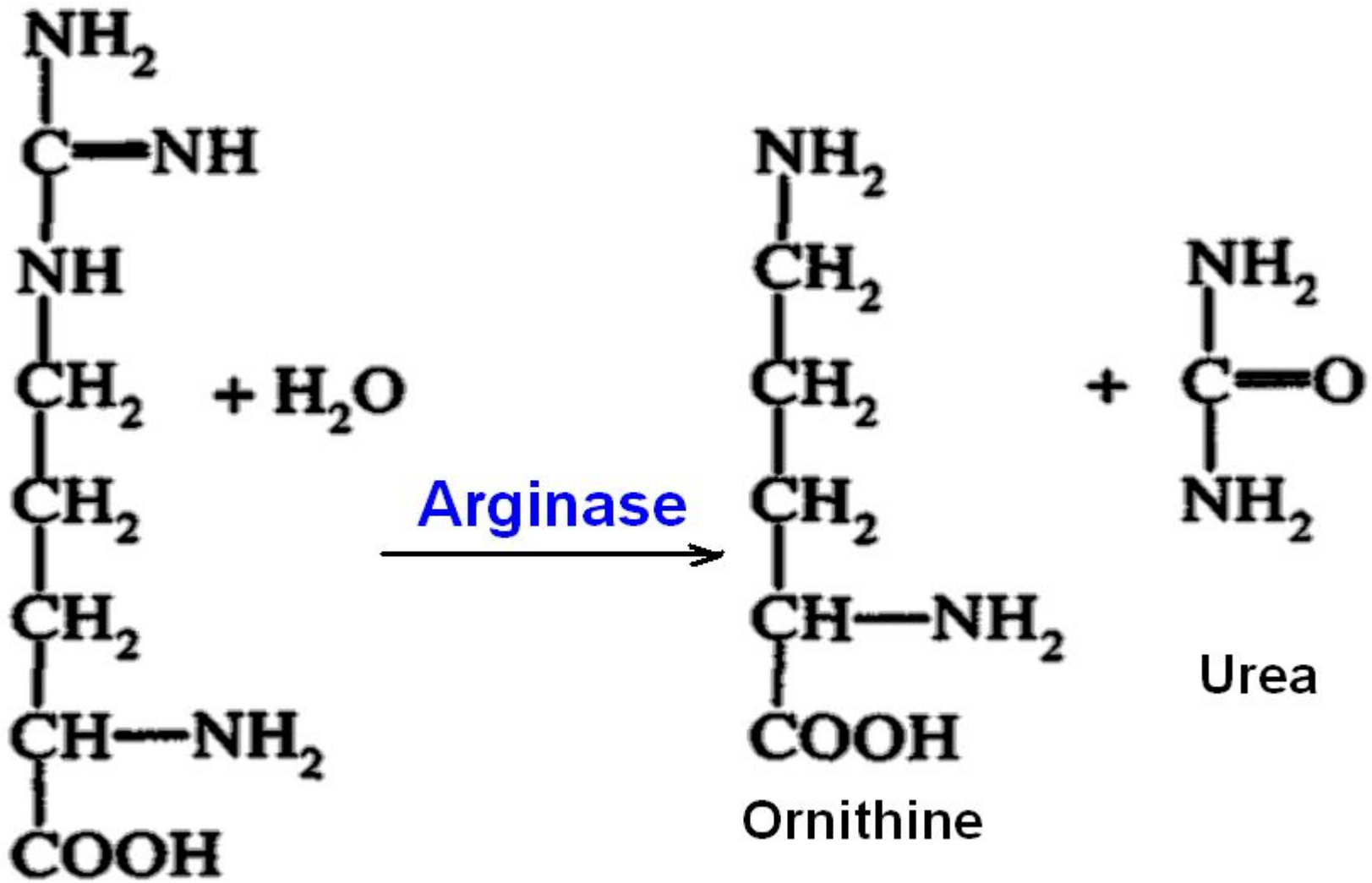


Argininosuccinate

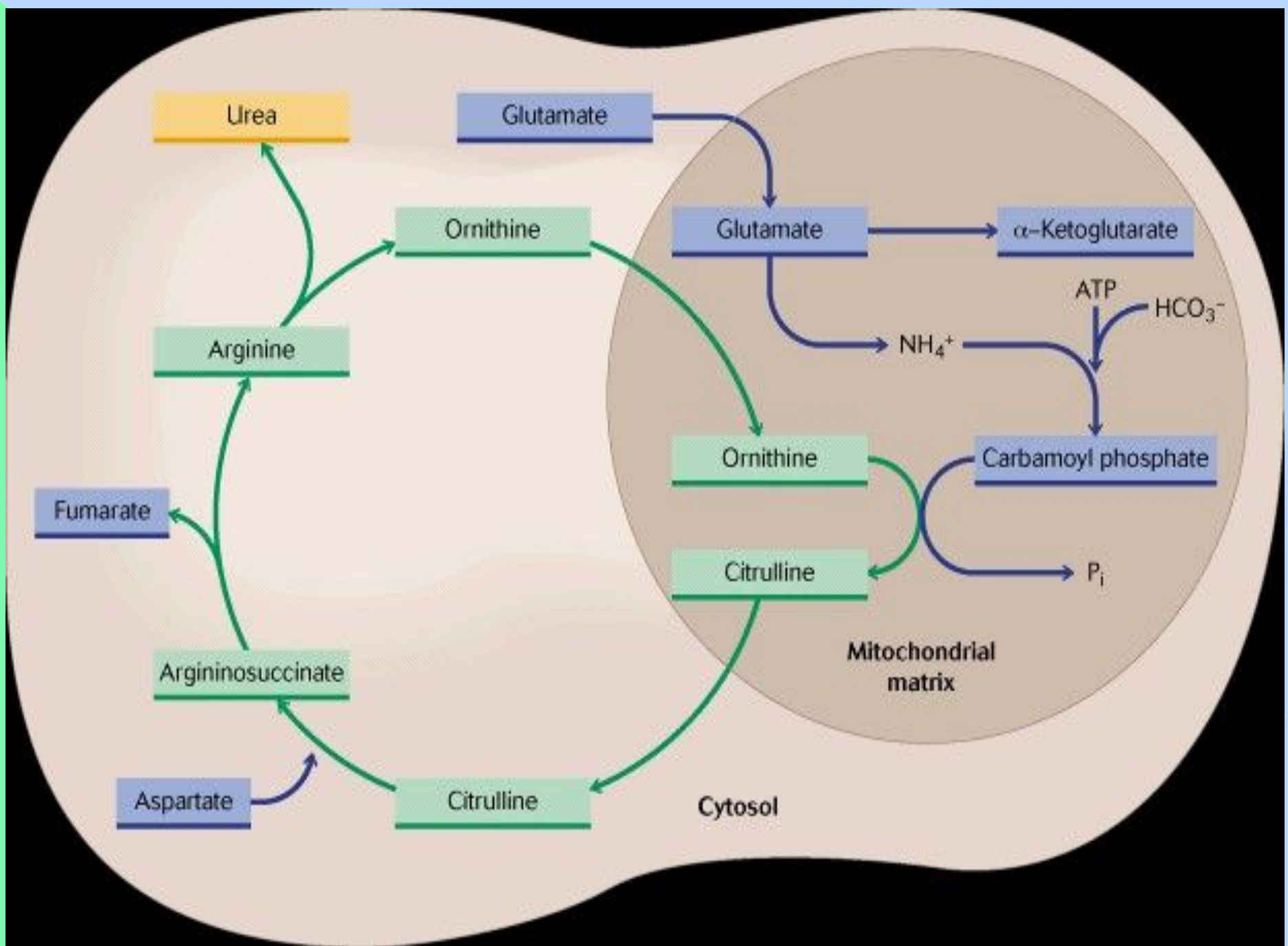
Argininosuccinase



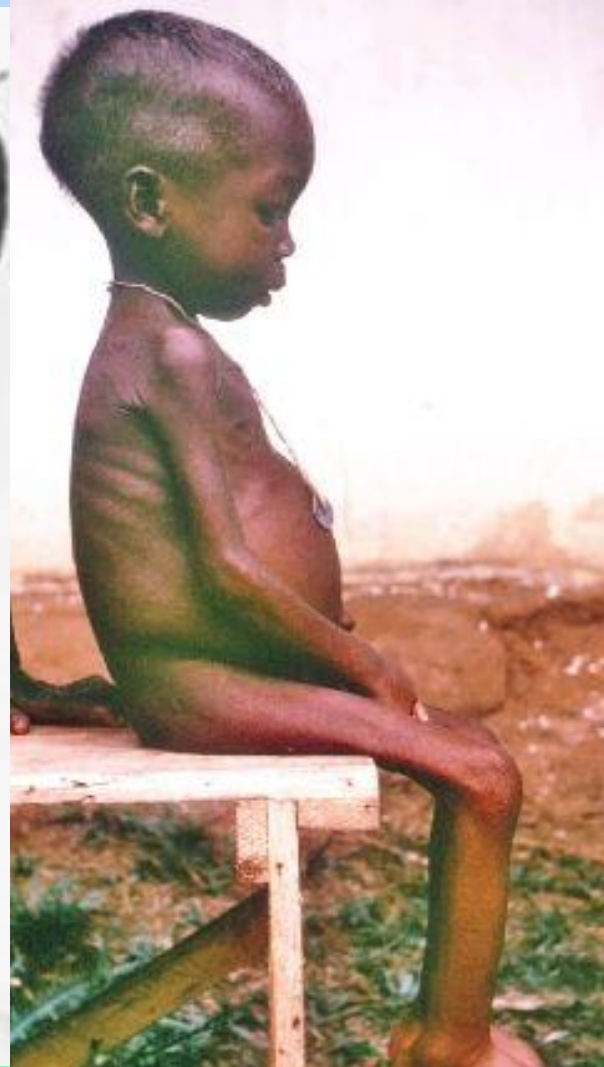
Urea cycle. Reaction 5



Rate-limiting!



Kwashiorkor



Urea cycle schematic

Amino acids

Ammonia
(**toxin**)

no urea

urea

Missing enzymes
(ammonia builds up to toxic levels)

Normal pathway
(normal enzymes present)

Hereditary disorders of Urea cycle

Disease	Enzyme	Mode of inheritance	Clinical presentations	Blood metabolites
Hyper-ammonemia, type I	Carbamoyl phosphate synthetase I	Autosomal recessive	Coma, and death within 24-48 hours after birth	Gln Ala NH₃
Hyper-ammonemia, type II	Ornithine carbamoyl-transferase	X-linked	Hypotension, reduced tolerance to proteins	Gln Ala NH₃