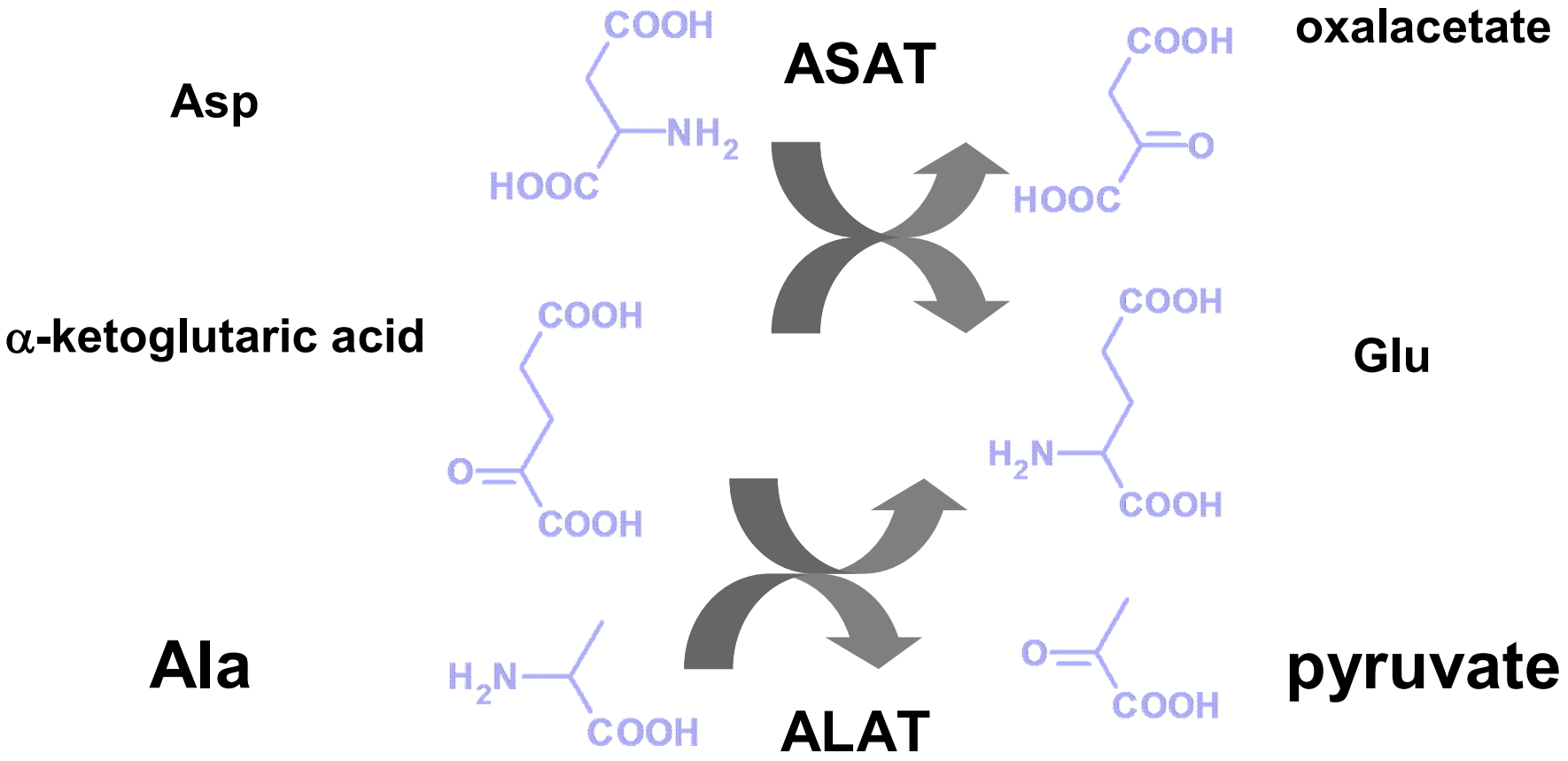
Amino acid metabolism

Removal of amino acid nitrogen

1. Hydrolysis (Removal of NH_3 from Asn and Gln)

2. Transamination (amino and oxo group; Amino acids and α–ketoacid pairs, transaminase or aminotransferase, cofactor: vitamin B_6 (PLP)



Removal of amino acid nitrogen

3. Deamination (remove NH_3)

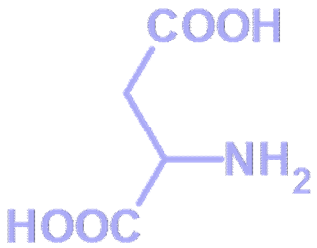
A. Oxidative dezaminálás (AS iminoacid ketoacid; $NAD(P)^+$ or O_2)

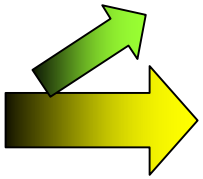
B. Direct deamination (Ammonia-lyase, creation of double bond, pl. His)

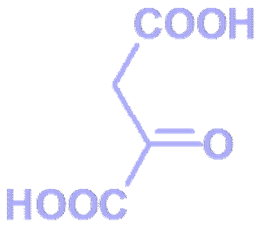
A. Oxidative deamination:

Amino acid **NH_3** **α–ketoacid**

Asp



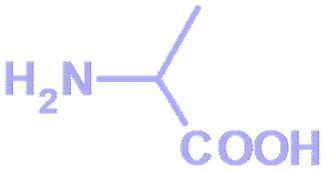


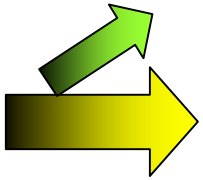


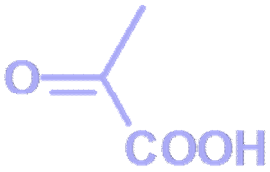
oxalacetate

NH_3

Ala







pyruvate

Fate of ammonia

Useful for biosynthesis of amino acids and nucleotids

Toxic for central nervous system

Origin of NH_3 – degradation of amino acids, nucleic acids,
Bacterias of the bowels product ~40%

Elimination of NH_3:

•Synthesis of glutamine from glutamic acid

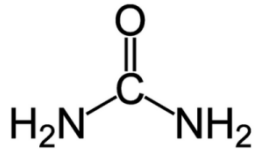
•Urea (synthetised by liver, excreated by kidney)

•Excreation of NH_4^+ by kidney

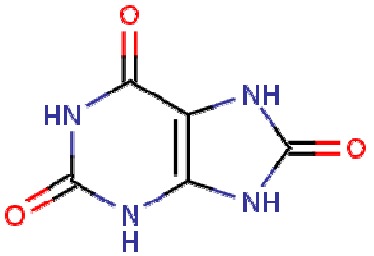
•Uric acid (degradation of purin excreated by kidney)

•Protein loss (hair, skin, bleeding, etc.)

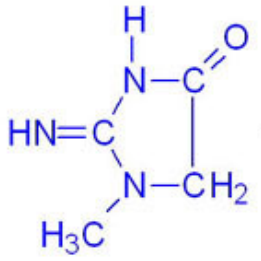
•Products from amino acids (pl. creatinine)



urea



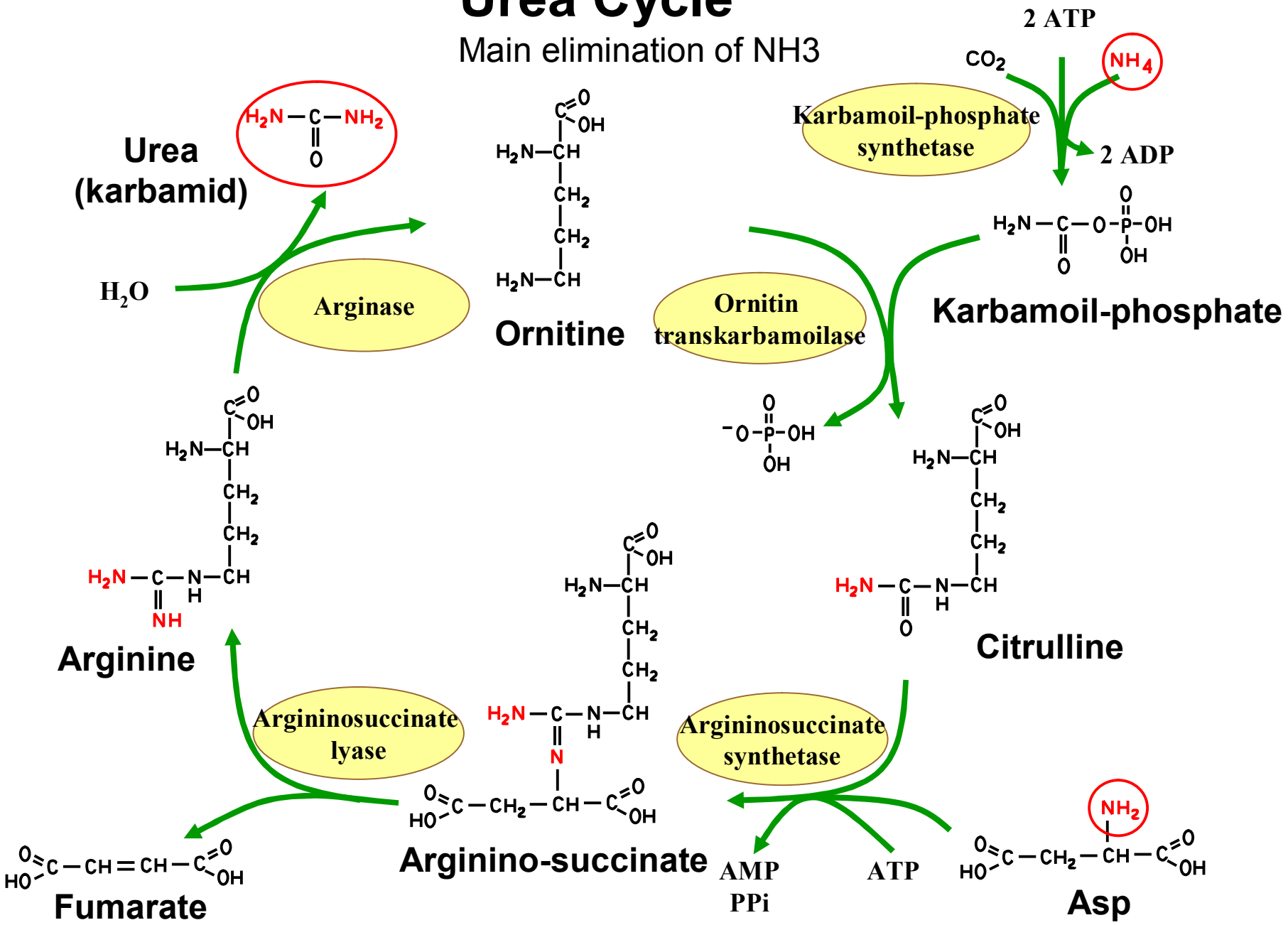
Uric acid



creatinine

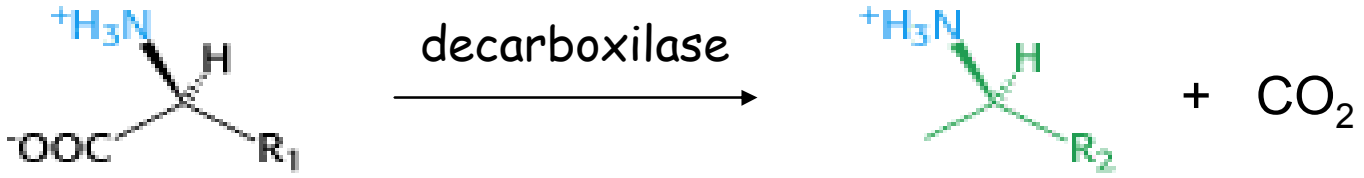
Urea Cycle

Main elimination of NH3



Decarboxilation

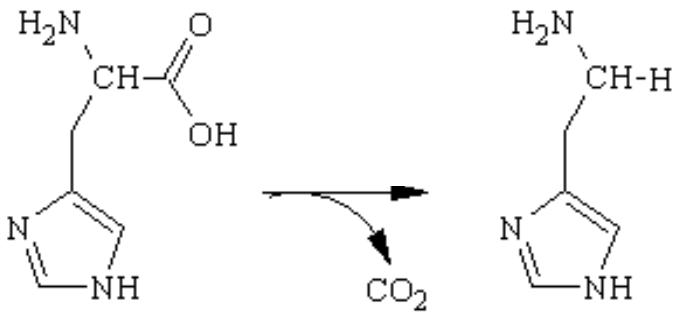
Mechanism of decarboxilation:



Amino acid amine

- Removal of carboxil group from amino acids

- example:
histidine to histamine



histidine histamine

Formation of C1 fragments, transportation and utilization

C1 fragments = one carbon containning molecule fragments

Metil (-CH3) metilene (-CH2-) metenil (=CH-) formil (-CHO)
formimino (-CHNH) CO2

Formation of C1 fragments

•Mainly during the metabolism of amino acids

•Methionine (metil)

•Serine, Glicine, Choline (metilene)

•Histidine (formimino)

•Triptophane (formil)

utilization of C1 fragments:

Serine, Metihonine, TMP & DNA,

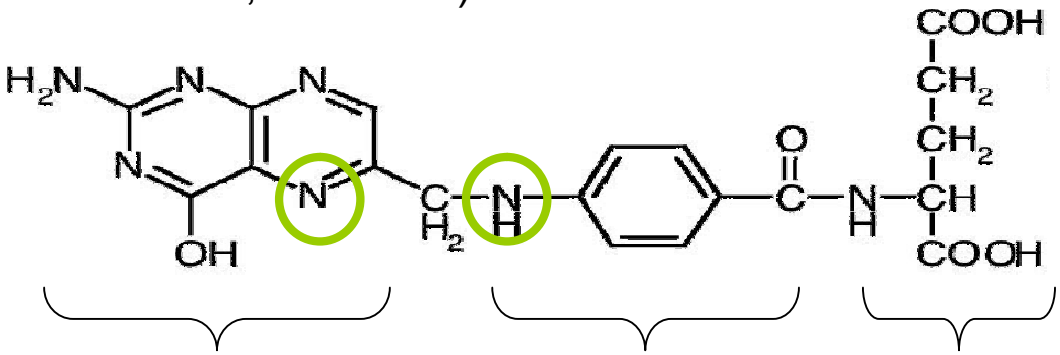
Purine bases and CO_2

Transportation of C1 fragments:

-S-adenosyl methionine (SAM, metil)

-Biotine (CO2, carboxilation reactions)

-Tetrahydrofolate (THF; metil, metilén, metenil, formil, formimino)

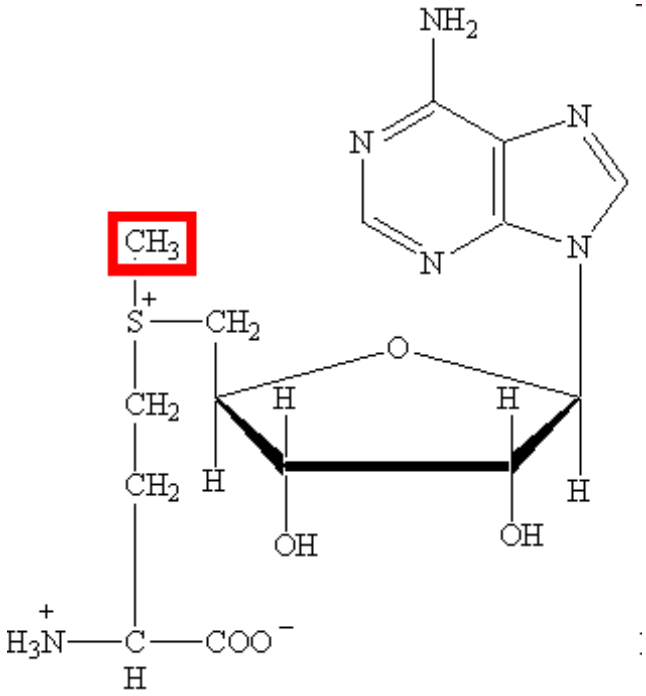


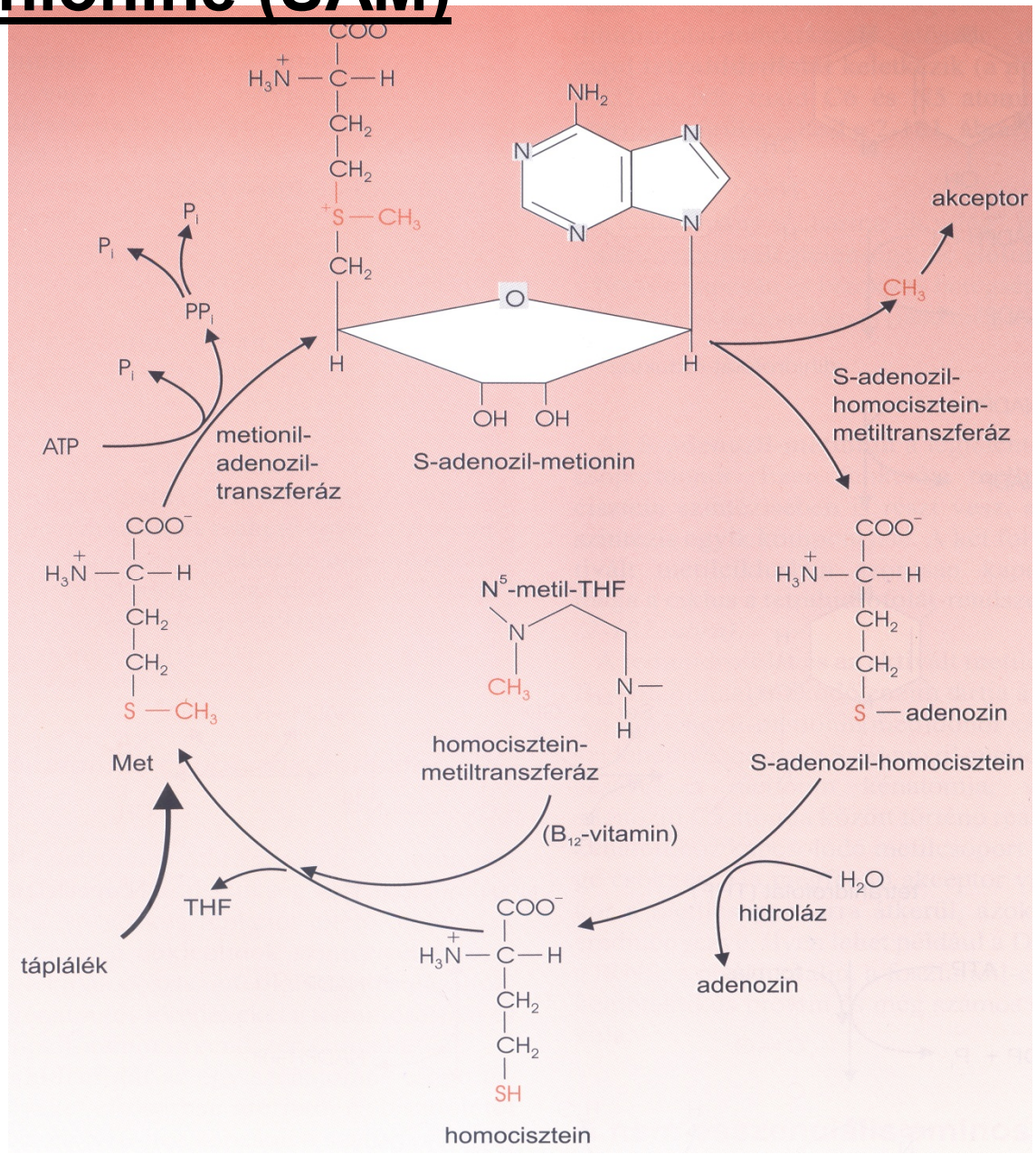
pteridine PABA glu

During the transport c1 fragments can modifiy to each other.

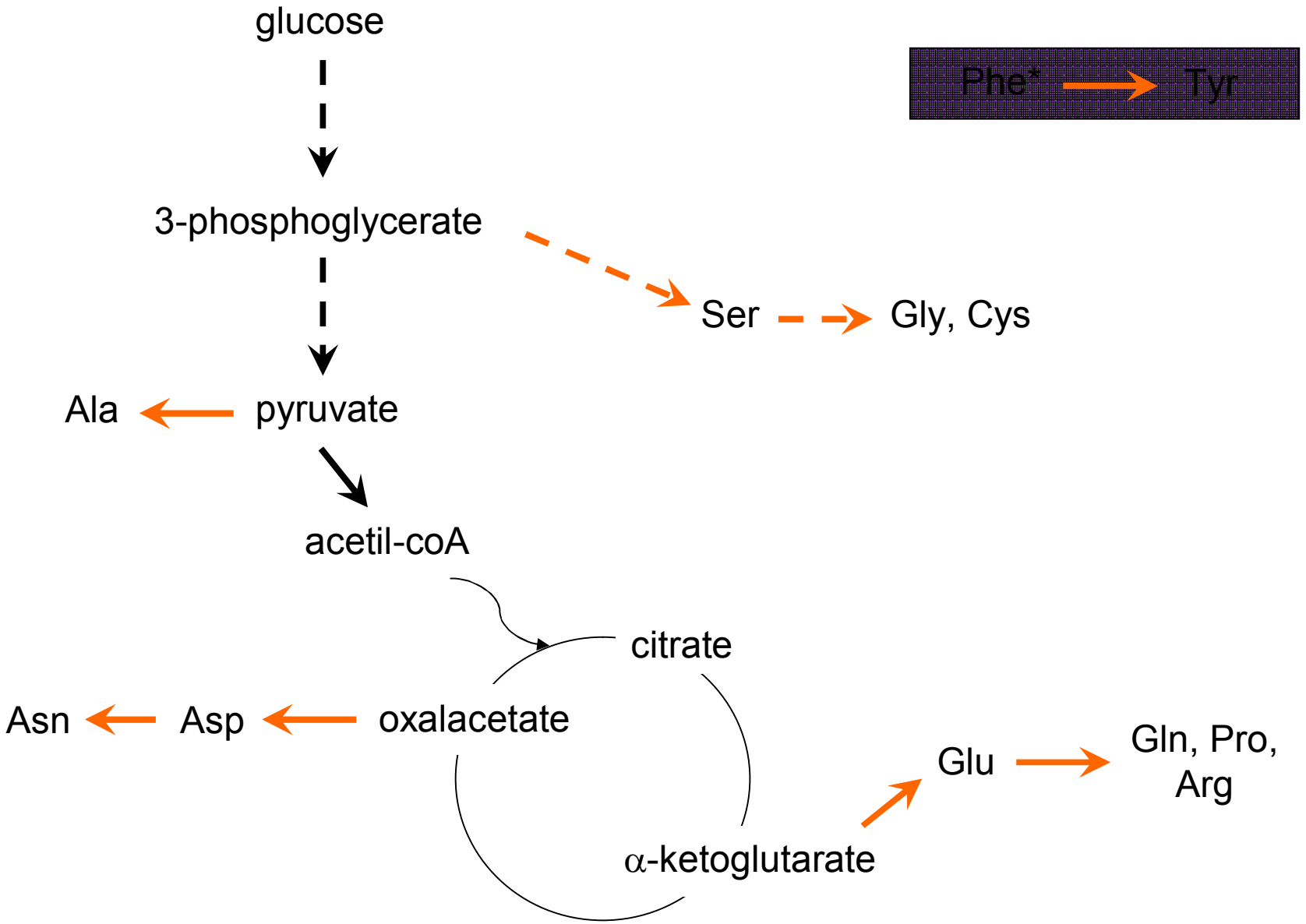
Transportation of C1 fragments: S-adenosyl-methionine (SAM)

Main transpoter, donor of metil group





Synthesis of Non-essential amino acids

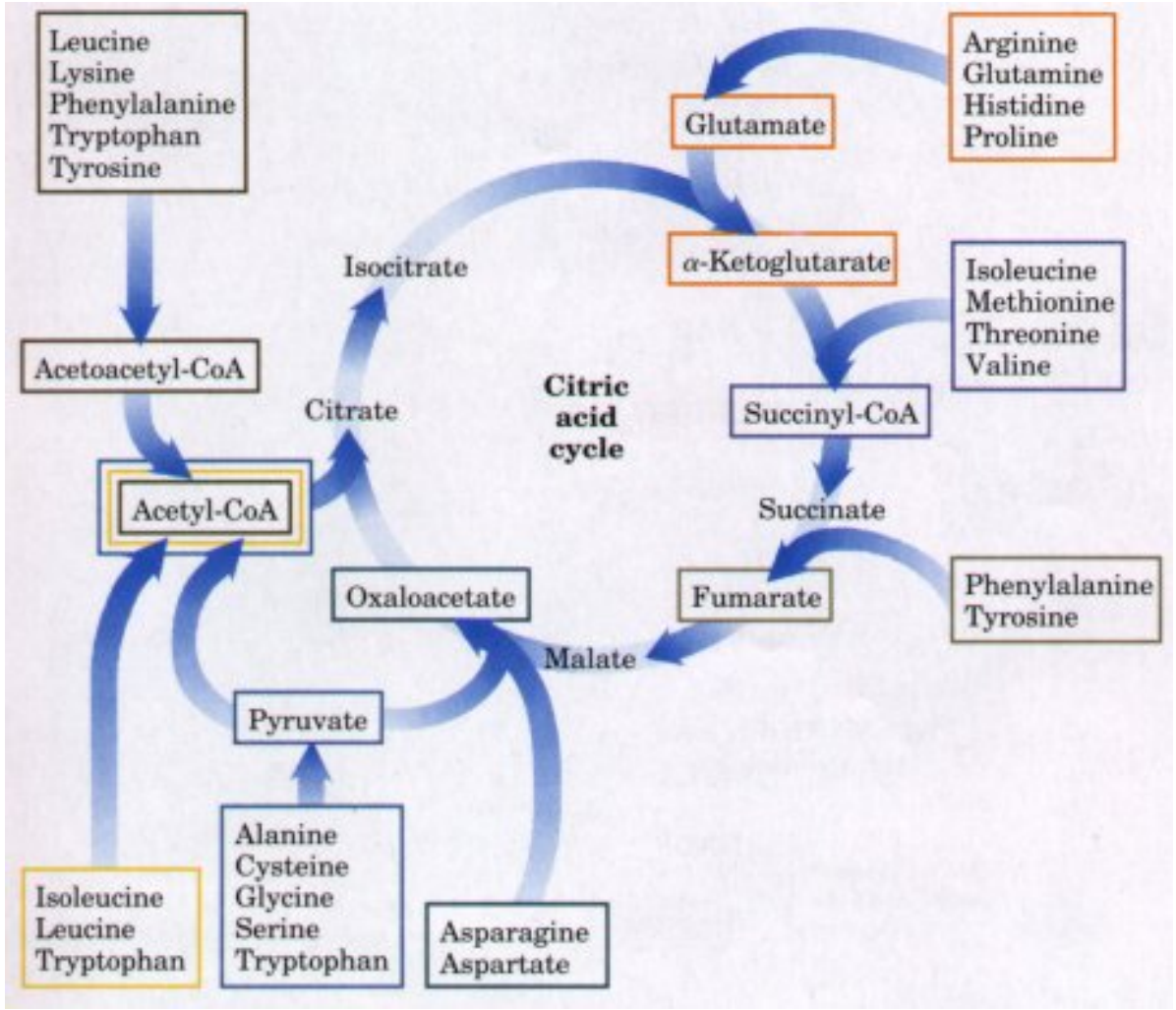


The fate of the carbon skeleton of amino acids

ketogenic amino acids: degraded directly into acetyl-CoA or acetoacetyl-CoA. Unable to be converted to glucose as both carbon atoms in the ketone body are ultimately degraded to carbon dioxide in the citric acid cycle. Only ketogenic: *Leu* and *Lys*.

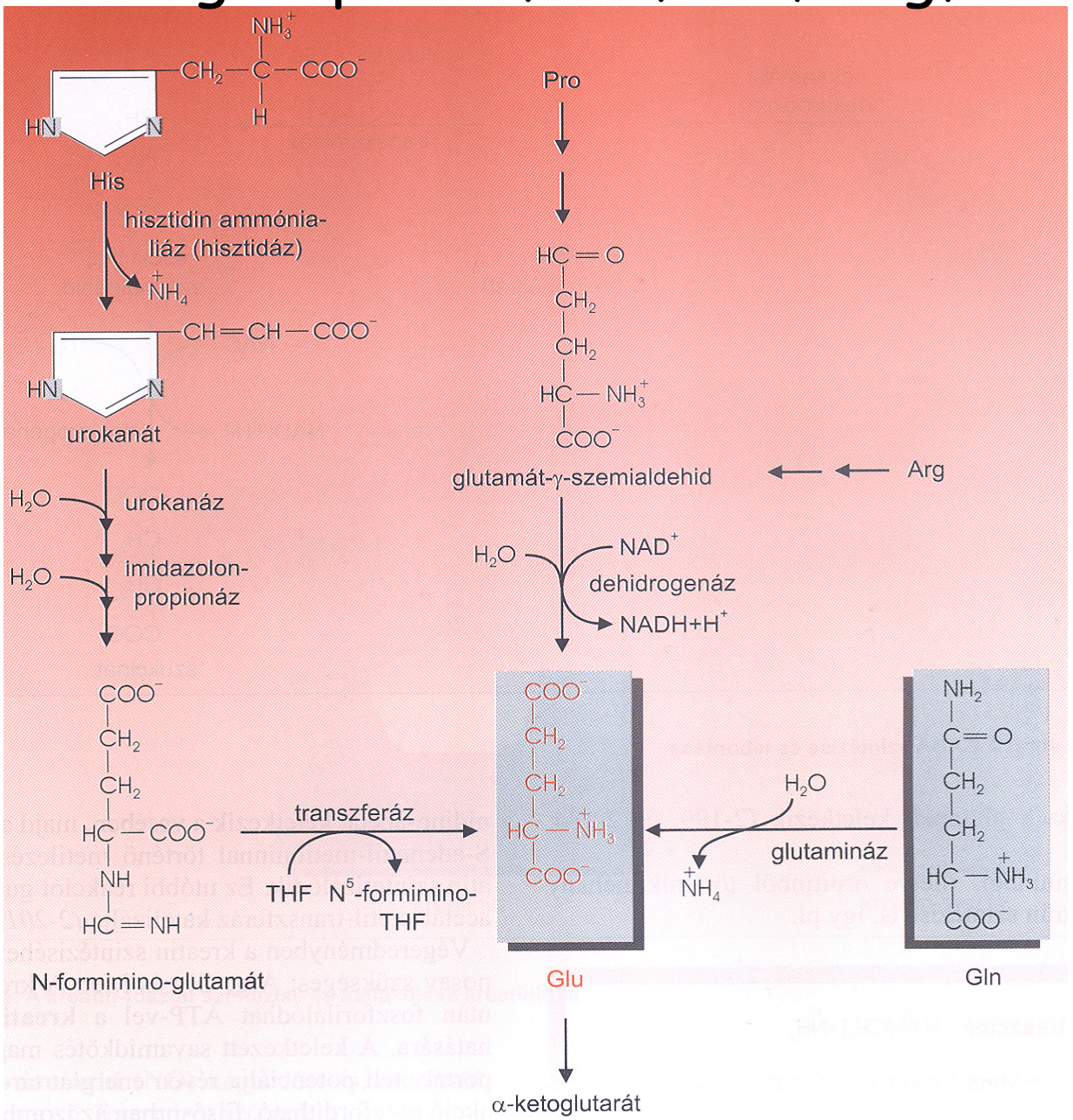
Glucogenic amino acids: degraded into pyruvate or intermediate of citric cycle, can be converted into glucose through gluco neogenesis.

The 20 amino acid's carbon skeleton degraded into: *pyruvate*, *acetil-CoA*, *acetoacetil-CoA*, *alfa-ketoglutarate*, *succynil-CoA*, *fumarate* and *oxalacetate*.



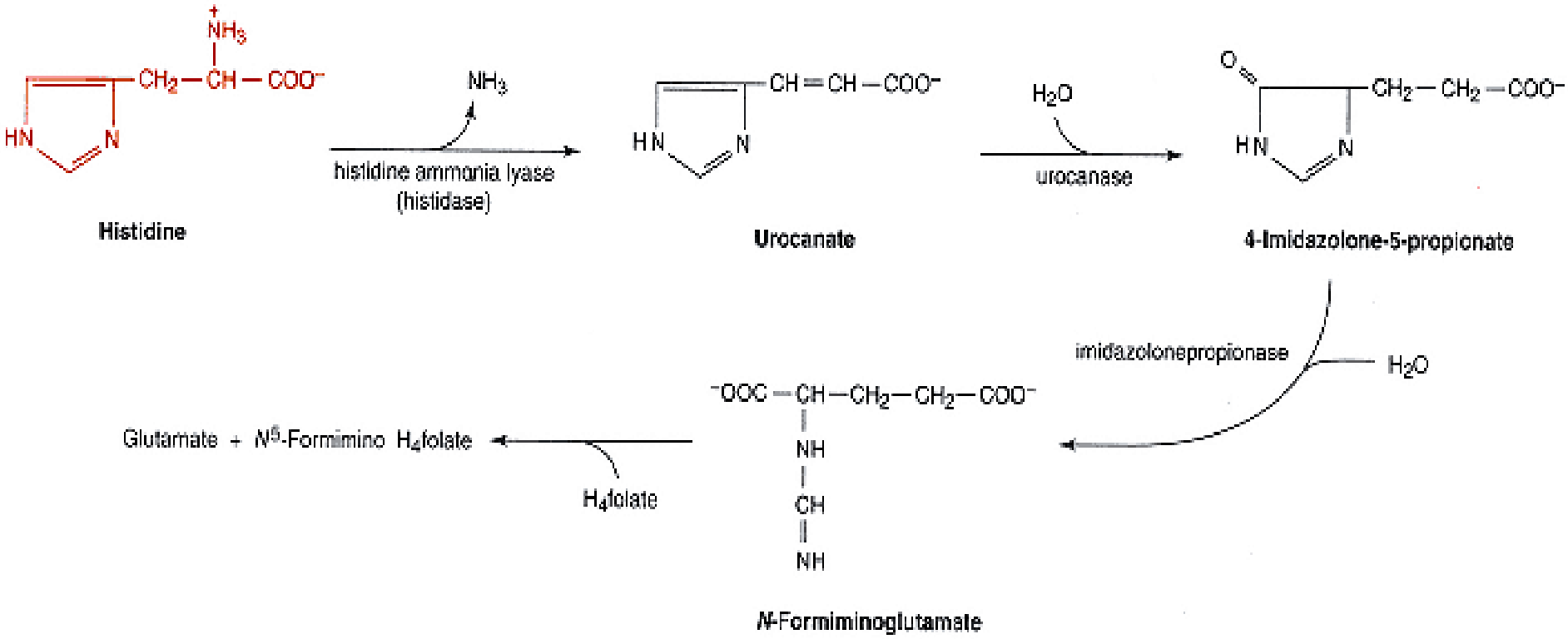
alpha-ketoglutarate group : Glu, Gln, Pro, Arg, His

DEGRADATION OF ARGININE, GLUTAMINE, HISTIDINE, PROLINE



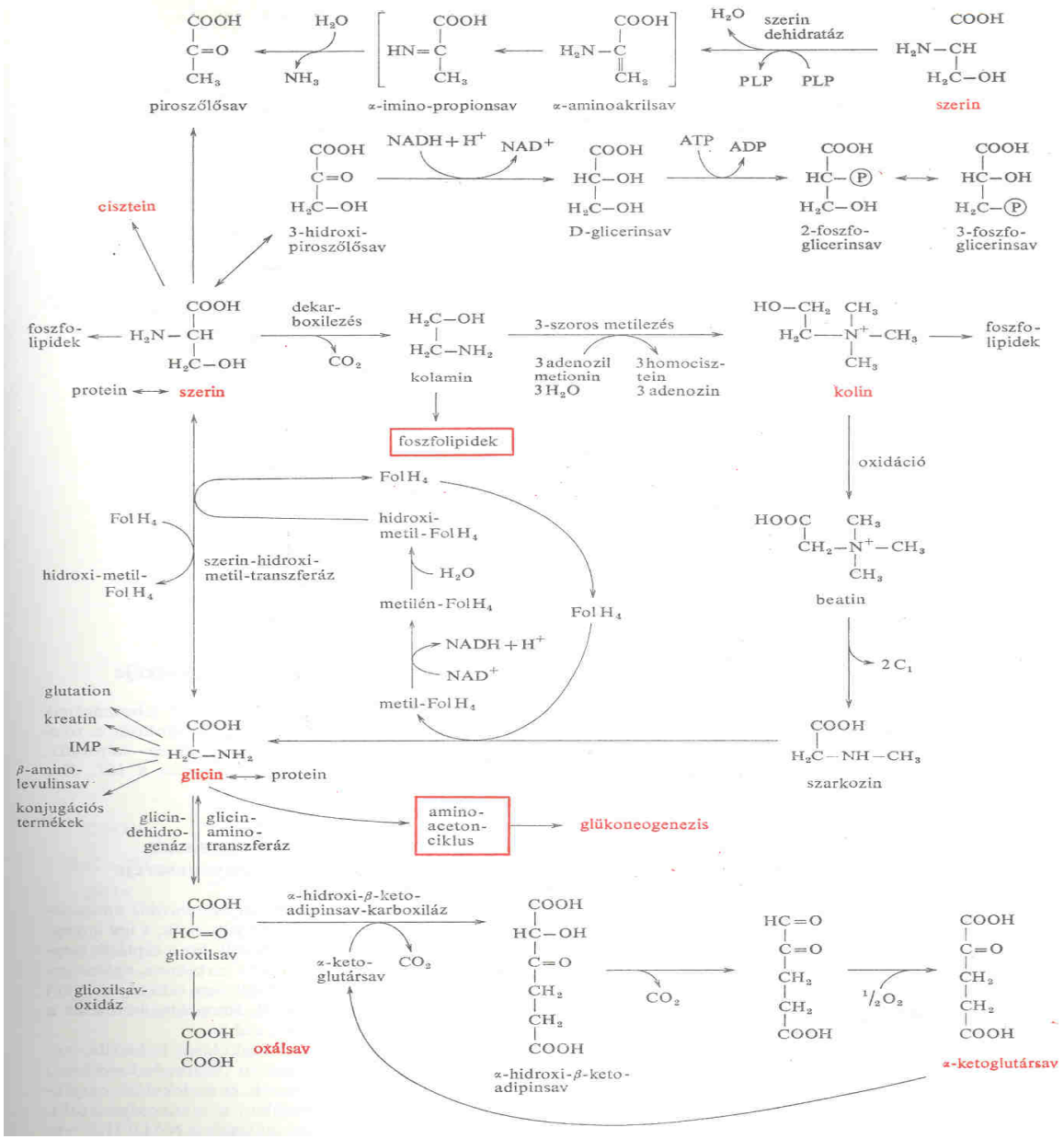
alpha-ketoglutarate group : Glu, Gln, Pro, Arg, His

Degradation of HISTIDINE



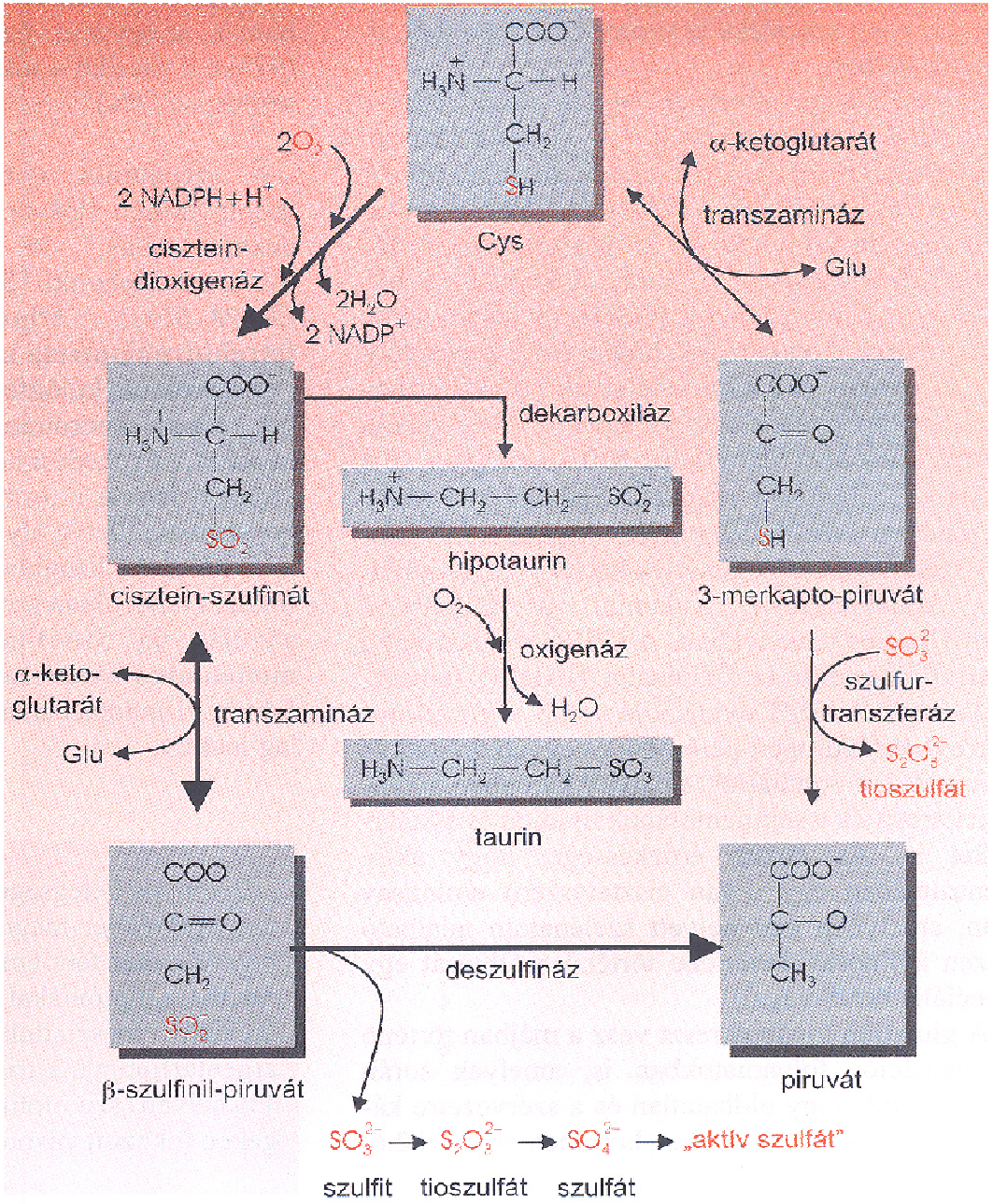
Pyruvate group : Gly, Ser, Ala, Cys, Trp

DEGRADATION of SERINE AND GLYCINE



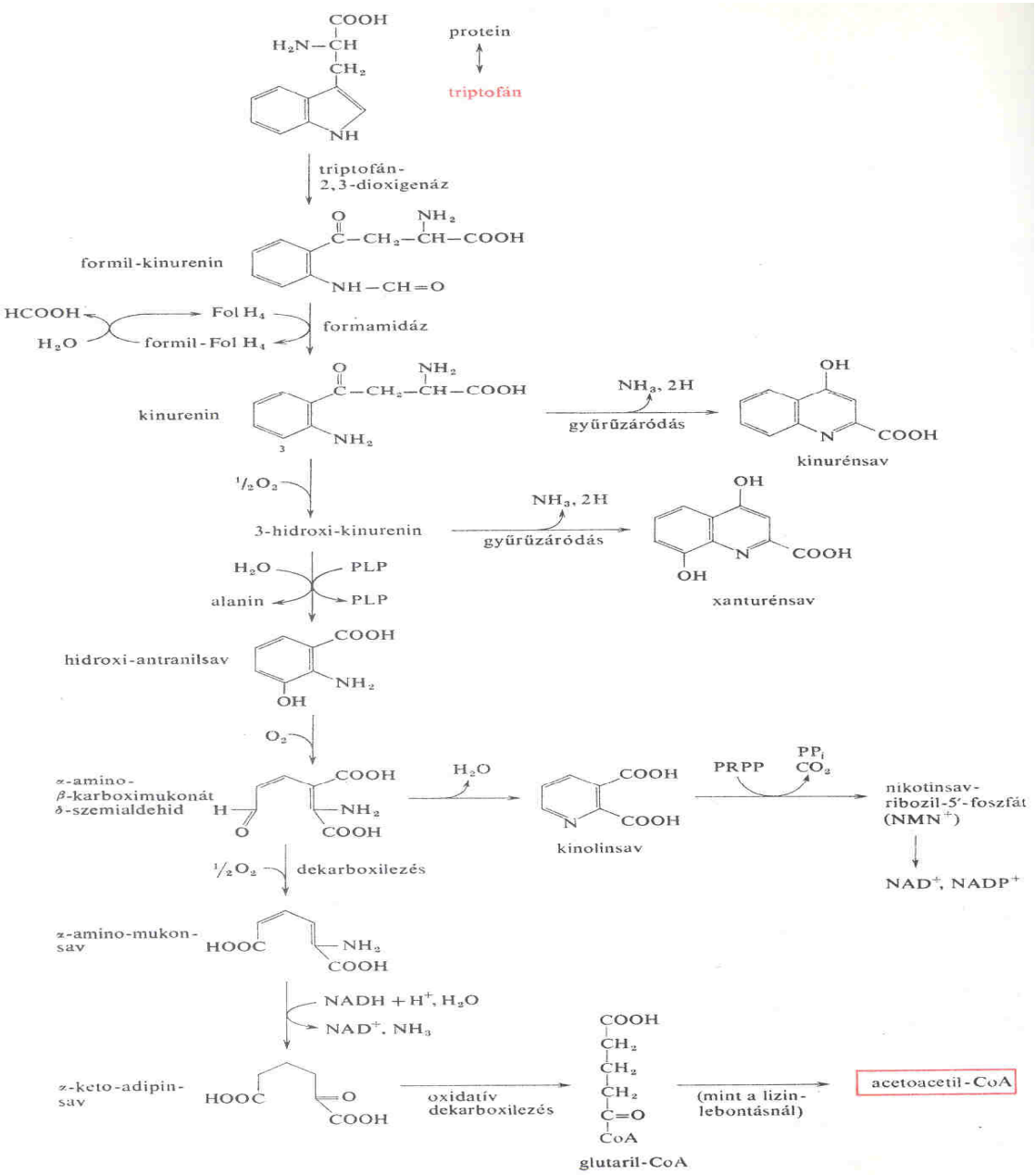
Pyruvate group : Gly, Ser, Ala, Cys, Trp

DEGRADATION OF CYSTEINE



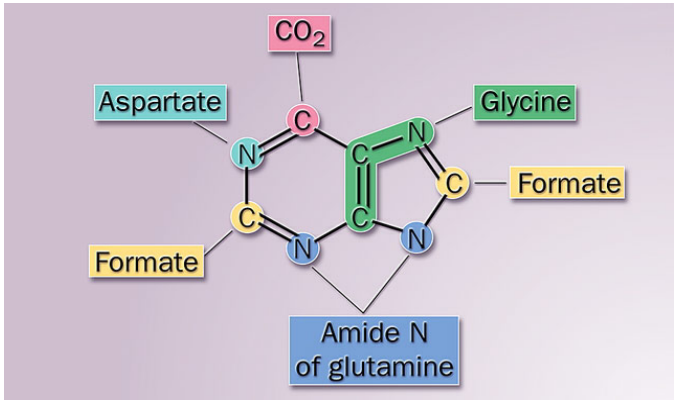
Pyruvate group: Gly, Ser, Ala, Cys, Trp

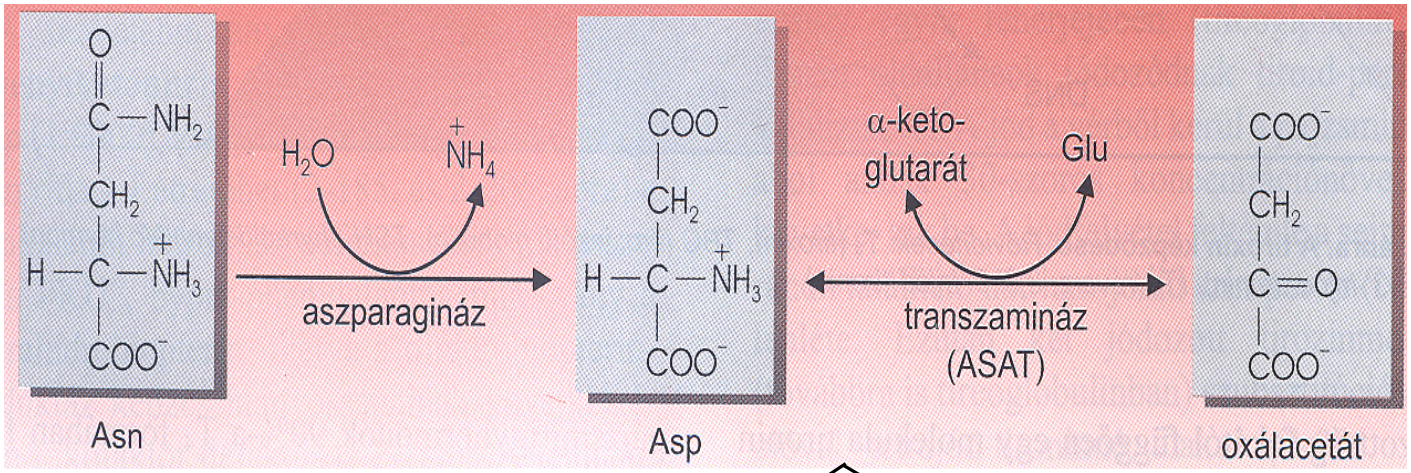
DEGRADATION OF TRYPTOPHANE



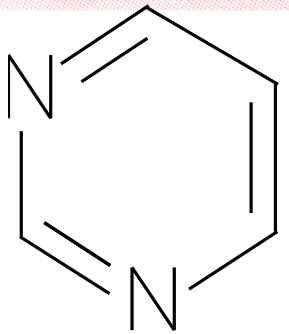
Oxalacetate group: Asp, Asn

- ✓ glucogenic amino acids
- ✓ Asp: transamination ⟶ oxalacetate
- ✓ Biosynthesis of nucleotides
  urea cycle (one nitrogene of urea!)
- ✓ Asn deaminatiion: asparaginase





From
Carbamyl-phosphate



From Aspartate

Participation of amino acids in the synthesis of nitrogen containing substances

Serine

-Glycine

-Cysteine

-Ethanolamine

-Cholin (acetylcholine)

-Phospholipids

(phosphatidyl serine,

phosphatidyl ethanolamine,

phosphatidyl choline,

sphingosine)

-C1 fragments

Glycine

-Serine

-Creatine~P (creatine, creatinine)

-Purine bases

-Porhyrines (DALA)

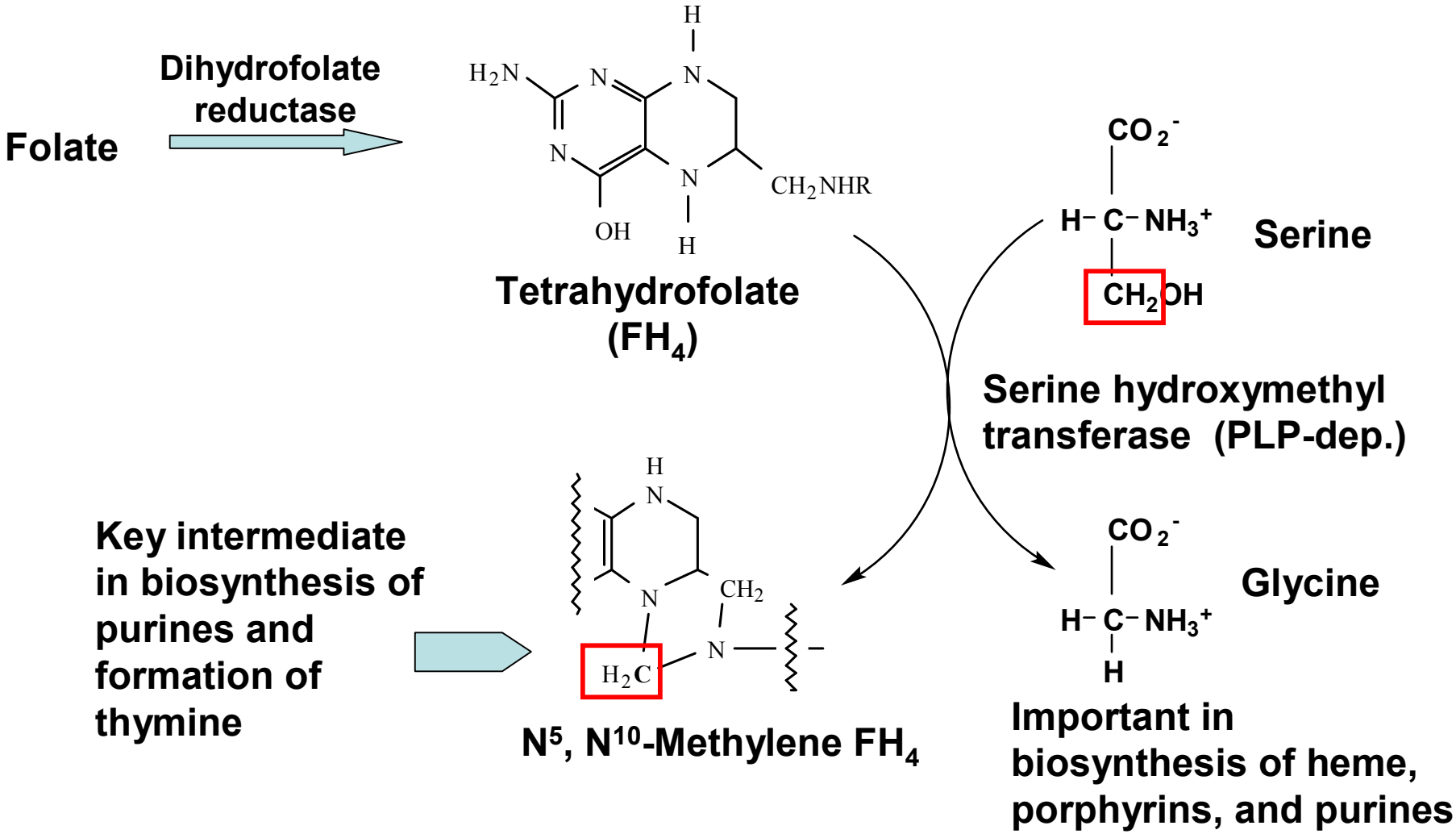
-Glutatione

-Conjugeted products

(pl bile acids)

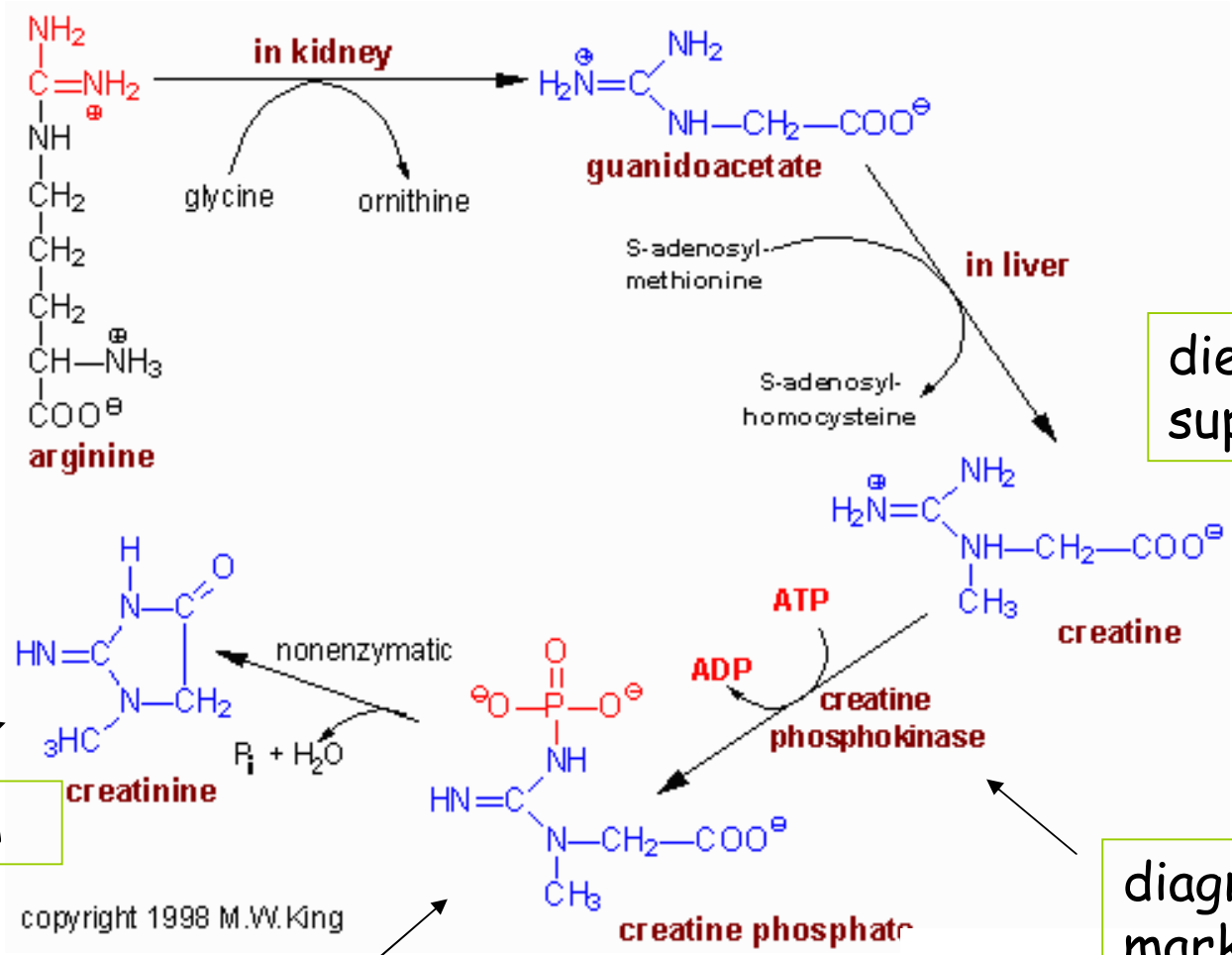
-Oxalate

Conversion of Serine to Glycine



Creatine, phosphocreatine, creatinine szintézise

Creatine szintézis



dietary supplement

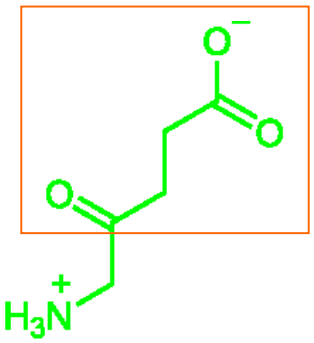
Renal function

diagnostic marker

Important in muscle and brain

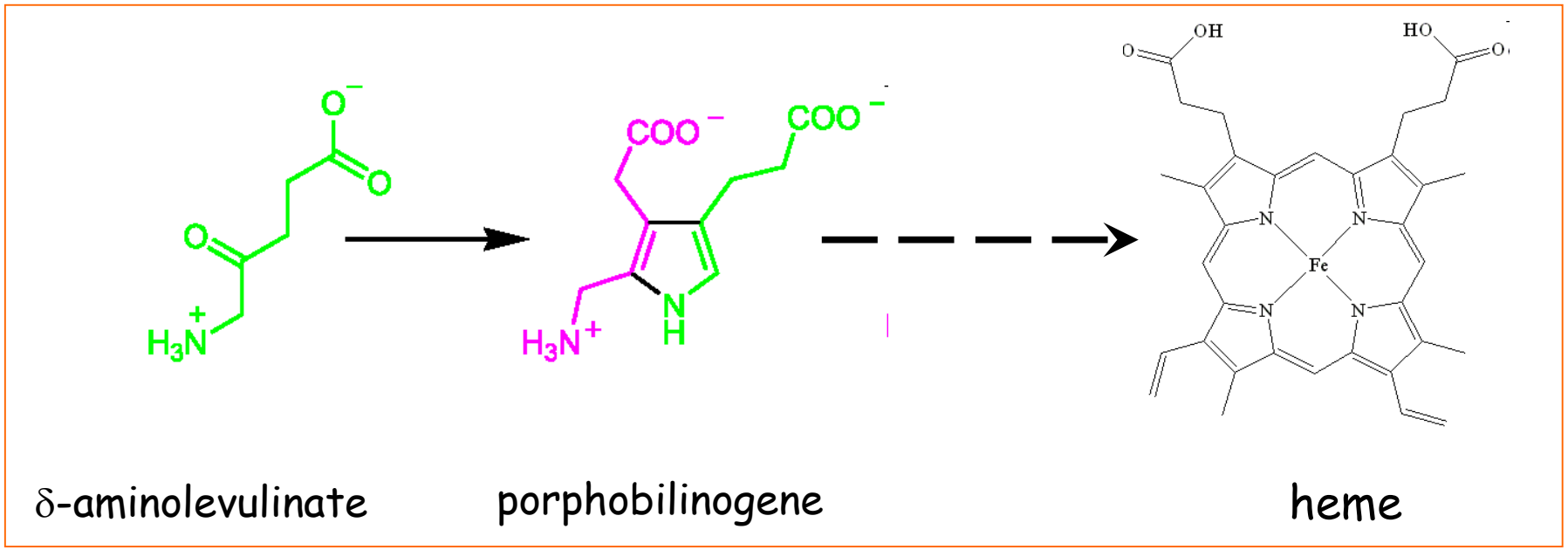
Glycine

porphyrine synthesis:



succynil-coA

glycine

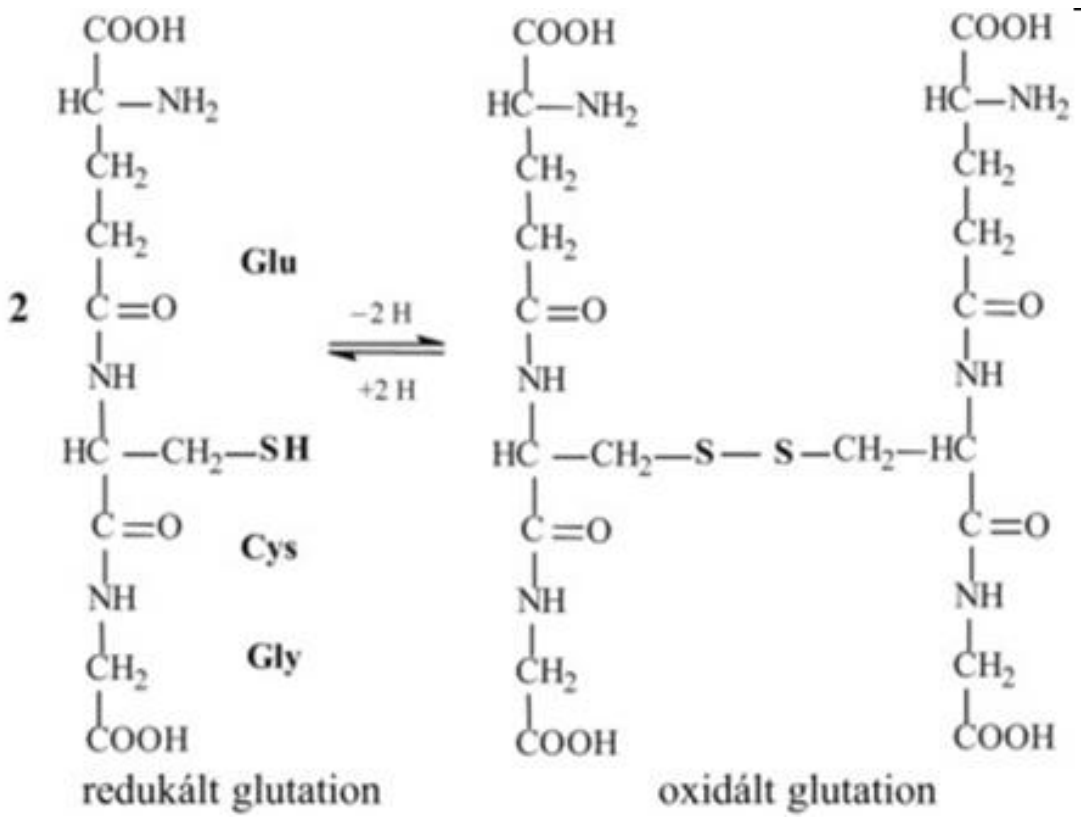


δ-aminolevulinate porphobilinogene heme

Glu, Cys, Gly,

glutathione

- ✓ important antioxidant (rbc!, glucose-6-P-dehydrogenase deficiency)
- ✓ involved in detoxification



Participation of amino acids in the synthesis of nitrogen containing substances

Cysteine

-Glutathione

-Cystine

-Active sulfate

-taurine

Methionine

-SAM

-Homocysteine

-Cysteine

Histidine

-Histamine

-Glu

Tryptophane

-tryptamine

-Serotonine

-Ala

-kynurenine

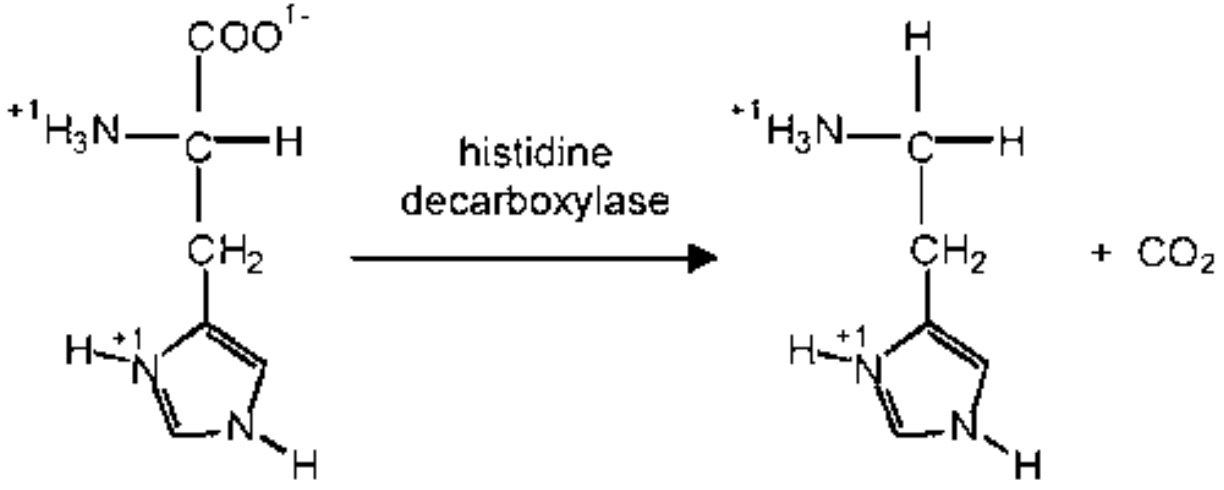
-Nicotin acid ribozyl-5-P

-melatonine

Participation of amino acids in the synthesis of nitrogen containing substances

Histamine

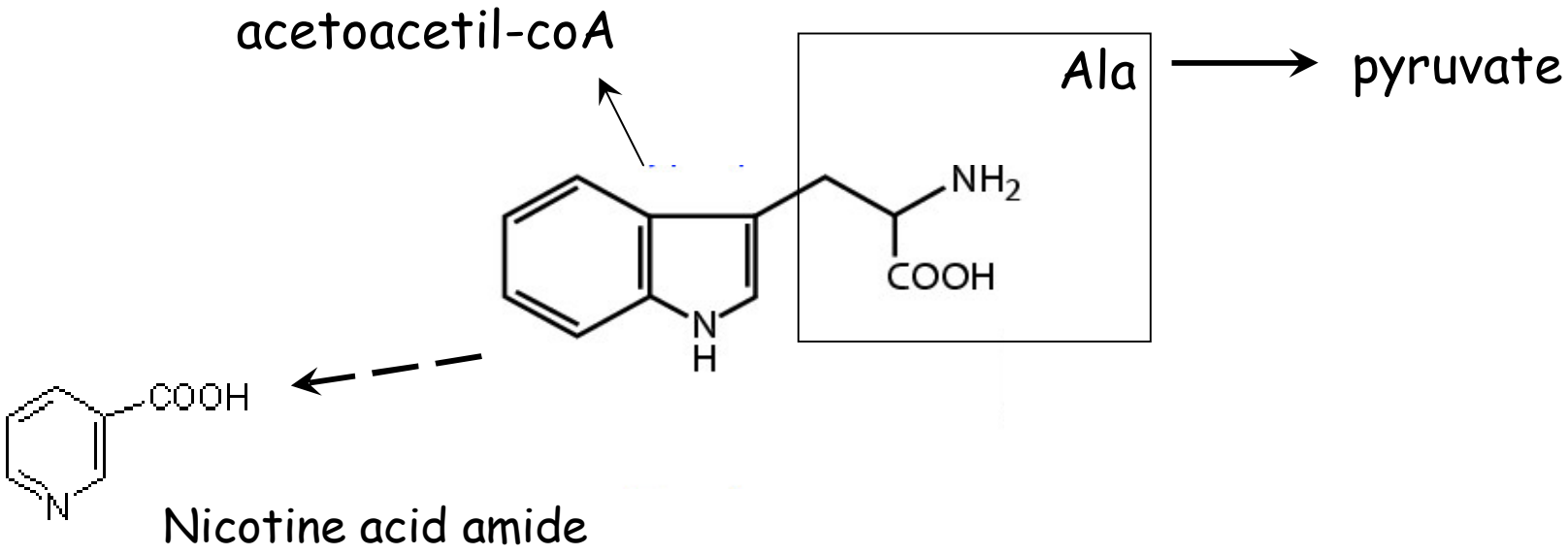
- Decarboxilation of histidine
- In lung, stomach, mast cells
- effects:
  * vasodilatation (oedema) (H1)
  * Blood pressure depression (H1)
  * in lung: bronchial constriction (H1)
  * stomach: hydrogen chloride secretion (H2)
- Mediator of allergic reaction



Participation of amino acids in the synthesis of nitrogen containing substances

Tryptophane:

- ✓ degradated into: pyruvate and acetoacetil-coA
- ✓ 99% degradated, 1% biogenic amine
- ✓ NAD^+ synthesis (3%)

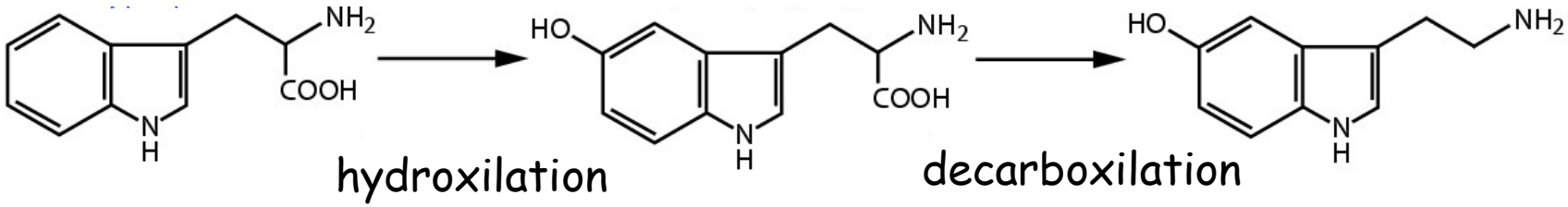


Participation of amino acids in the synthesis of nitrogen containing substances

Serotonin = 5-hydroxi-tryptamine

biological role:

- Normal mood
- sleep- awake regulation
- Regulation of appetite
- Regulation of body temperature
- Vasoconstriction



tryptophane

5-hydroxi-tryptophane

5-hydroxi-tryptamine (serotonin)

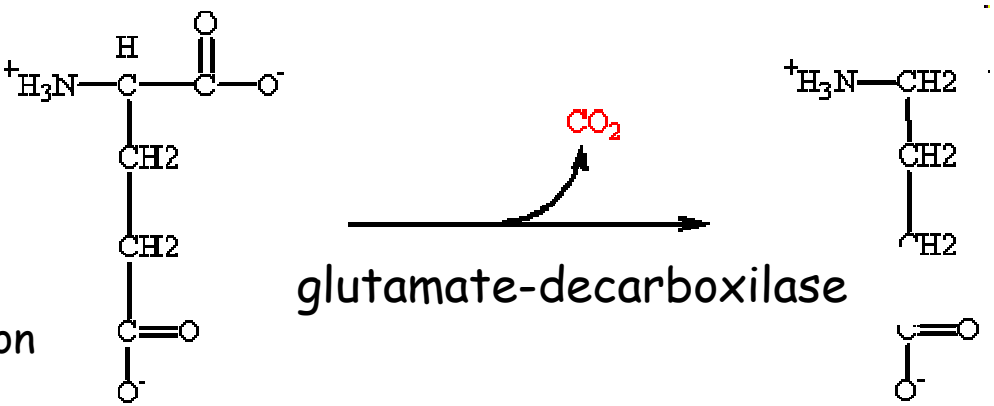
Participation of amino acids in the synthesis of nitrogen containing substances

Glutamate:

- Gln
- Purine bases
- Pirimidine bases
- γ–amino-butyric acid (GABA)
- Pro
- Arg
- glutathione
- α-keto-glutarate

α γ-amino-butyric acid (GABA) synthesis

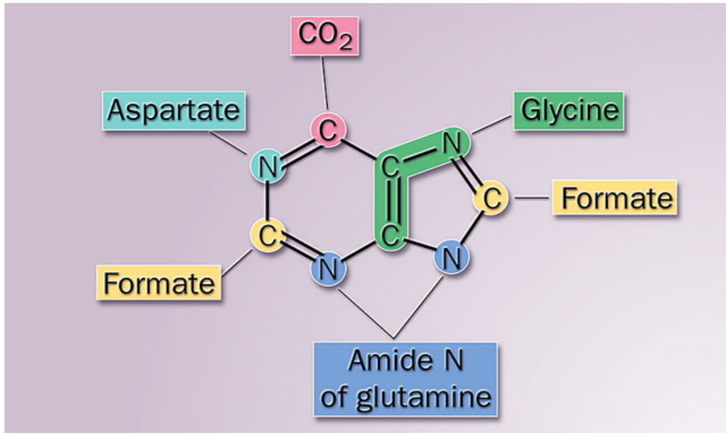
- ✓ main inhibitor neurotransmitter of central nervous system
- ✓ activation of ionotropic and metabotropic receptors
- ✓ synthesis: glutamate decarboxilation

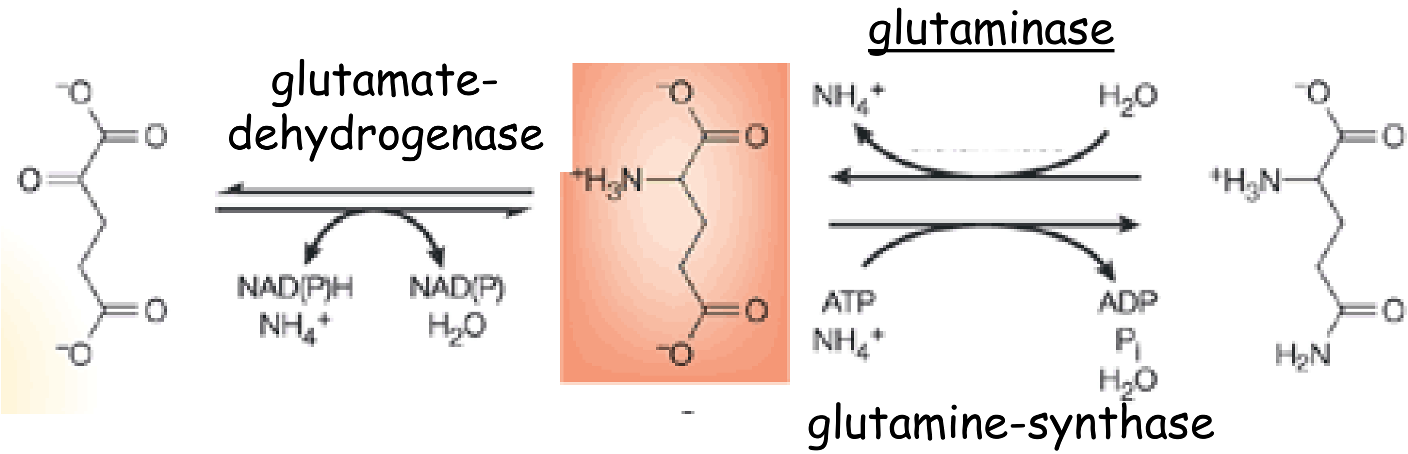


Participation of amino acids in the synthesis of nitrogen containing substances

Glutamate:

synthesis of purine nucleotids





α-ketoglutarate

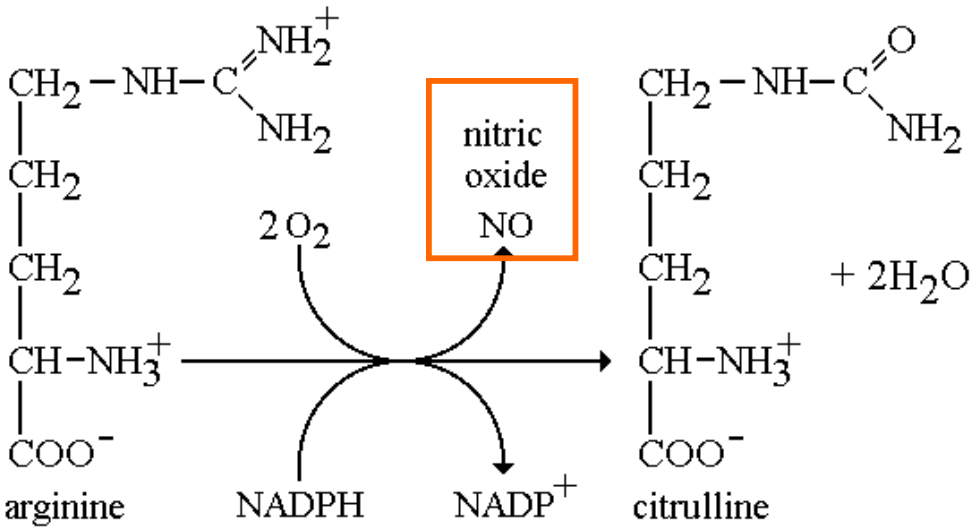
glutamate

glutamine

Participation of amino acids in the synthesis of nitrogen containing substances

Arginine: -Glu
-Urea
-creatine
-Pro
-NO

nitrogene-monoxide synthesis:



- ✓ enzyme: nitrogen-monoxide-synthase
  3 izoform: neuronal, endothelial, inducible
- ✓ biological role: vasodilatator, free radical (immune function), neuro-transmitter, tissue mediator

Participation of amino acids in the synthesis of nitrogen containing substances

Phenylalanine -Tyr

-T3 & T4

-DOPA

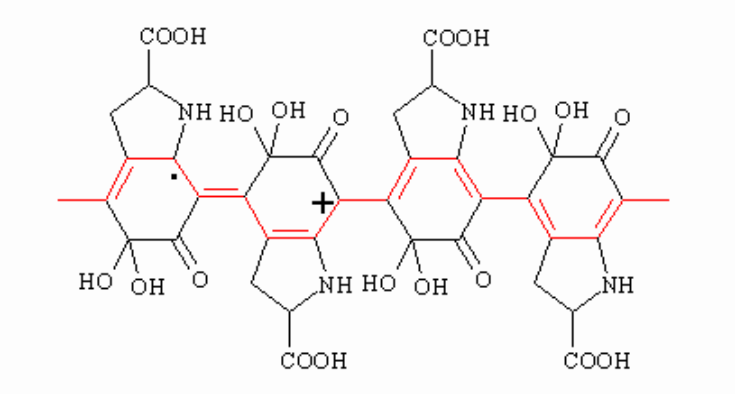
-Dopamine

-Noradrenalin

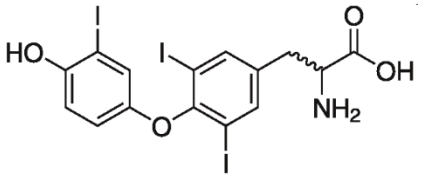
-Adrenalin

-Melanine

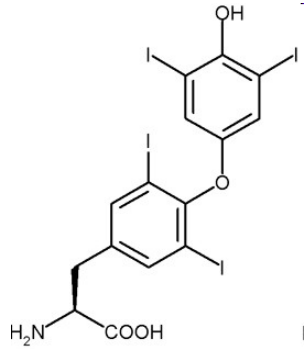
melanine pigment



thyroid hormons:



trijód-tironin (T3)

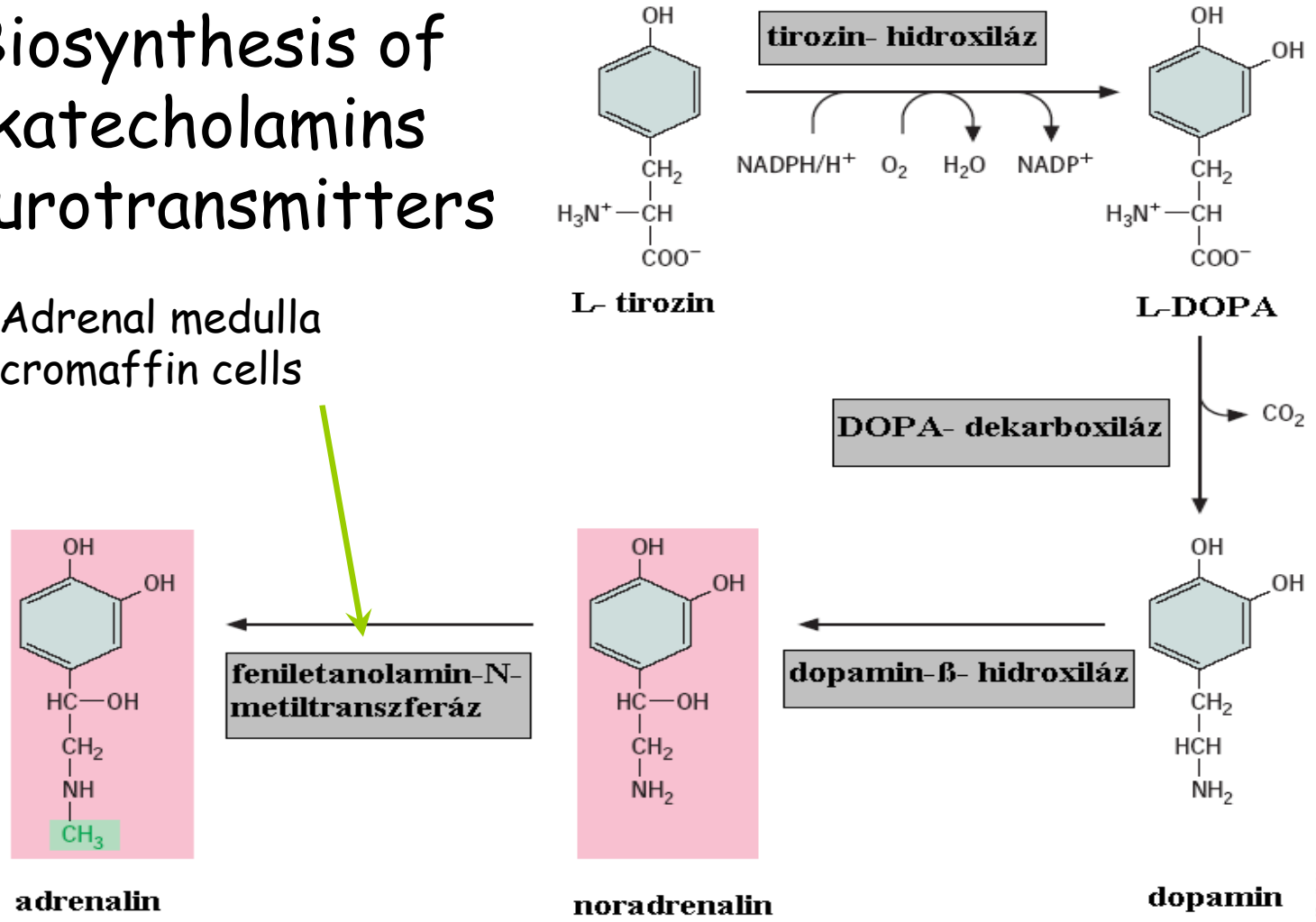


tetrajód-tironin

(tiroxin, T4)

Participation of amino acids in the synthesis of nitrogen containing substances

Biosynthesis of katecholamins neurotransmitters



Participation of amino acids in the synthesis of nitrogen containing substances

Phenilketonuria