Degradation of amino acids

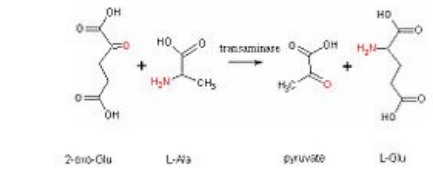
There are **20** (21 if we count selenocysteine as well) **essential proteinogenic amino acids** that can be inserted into **protein** molecules in the process of translation . The catabolism of their carbon skeletons covers approximately 10-15% of our body's energy requirements. Amino acids can also serve as **substrates** (precursors) for the **biosynthesis of** other nutrients – **carbohydrates (gluconeogenesis) and** lipids**.**

Removal of the amino group

We perceive the removal of the amino group as a key step in amino acid catabolism. Nitrogen from amino groups cannot be used for energy production and must be removed from our body. This happens on the one hand by its conversion to urea (about 95%), which is subsequently excreted from the body in urine, and on the other hand by its release in the tubular cells of the kidneys from glutamine as **NH_3/NH_4^+** (about 5 %).

Transamination of amino acids

Transaminations are freely reversible reactions catalyzed by transaminases (aminotransferases). During transamination, the amino group of an α-amino acid is exchanged with the oxo group of a 2-oxo acid – a 2-oxo acid is formed from the amino acid, and an amino acid is formed from the original 2-oxo acid.



Transamination of amino acids

During the reaction, **the amino group** is transported bound to the cofactor pyridoxal phosphate (PLP, a derivative of vitamin B6), which transfers it **to an oxoacid** (formation of a Schiff base).

Most amino acids undergo transamination during their degradation . As specific examples of transaminases, we can cite aspartate aminotransferase (AST) and alanine aminotranferase (ALT), which are commonly determined to detect potential **damage to liver cells**.

The resulting 2-oxoacids (oxaloacetate and pyruvate) are involved in the energy metabolism of cells. But there are also exceptions, e.g. threonine, which is not directly transaminated at all during its degradation.

Conversion of glutamate / glutamine

The conversion of the carboxyl group of glutamate (in the side chain) to the amide group of glutamine is catalyzed by the cytosolic enzyme glutamine synthetase. In addition to the enzyme, the reaction requires **ATP** and **NH_4^+**. This reaction serves in CNS cells as the main Tato reakce slouží v buňkách CNS jako hlavní **detoxification mechanism** removing toxic NH_3 from brain tissue. The emerging **glutamine** is the most important transport form of amino nitrogen (ammonia) in the blood - it ensures transport from extrahepatic tissues via the blood to the liver and kidneys. It has **the highest plasma concentration** of all amino acids – 0.6 mmol/l (alanine – 0.3 mmol/l). We "store" two amino groups/ammonia in its molecule. Glutamine can bring in **ammonia** to various **biosyntheses** – e.g. to the formation of purine

The release NH_3 rom glutamine is catalyzed by the mitochondrial enzyme glutaminase (hydrolytic deamination, abundant in hepatocytes and kidney tubule cells). The resulting **ammonia** is involved **in the urea cycle** in the liver mitochondria , and is excreted **in the urine**in the kidneys, where it serves as its buffer.

Oxidative deamination

During oxidative deamination, with simultaneous release of NH_3, the amino group is transformed **into a keto group**. Glutamate is the only amino acid that is deaminated at a sufficient rate in the human body. The transformation is catalyzed by **glutamate dehydrogenase** stored in the matrix of mitochondria, mainly of liver cells.

Glutamát + NAD^+ → α-ketoglutarate + NH_4^+ + NADH + H^+

The resulting NH_4^+ enters the urea cycle and α-ketoglutarate can be used in transaminations or in the Krebs cycle. The mentioned reaction is fully reversible – we can synthesize **glutamate** from α-KG and NH_4^+.

At the conclusion of this part, we can therefore state:

- **that most amino acids undergo transamination** during their degradation;
- most **amino nitrogen** from amino acids is directly or indirectly ultimately concentrated in the **glutamate/glutamine** molecule.

It is subsequently released from them in the glutaminase and glutamate dehydrogenase reactions.