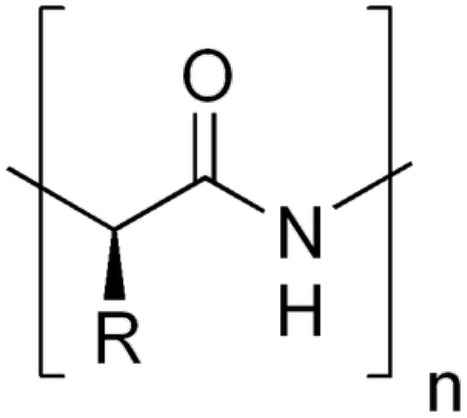
Amino Acids (1.LF UK, NT)

Amino acids are the basic building blocks of proteins. Chemically, they are organic compounds connected to each other by a peptide bond. At least one primary amino group –NH 2 and at the same time at least one carboxyl group –COOH must be present in the amino acid. Chemically, they are substituted derivatives of carboxylic acids.

- 2–100 amino acids (monomers – peptides
- 100 or more amino acids – proteins



Peptide bond

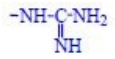
More than 700 different AMKs have been demonstrated in nature. That is why we also divide AMK according to their occurrence:

- amino acids found in all living organisms
  - bound in proteins (21 proteinogenic AMK), peptides or as free AMK
- amino acids found only in some organisms
  - bound in peptides or as free AMK
  - they are not components of proteins

Proteinogenic amino acids, or coded ones, occur in proteins as L-alpha-amino acids (the exception is glycine). This is due to the chemical arrangement that is necessary for biogenic function. Specific types of amino acids, their sequence and spatial structure then give proteins their biological properties.

Structure

- amino group (**-NH_2**, free, substituted)
- carboxyl group (**-COOH**)
- other functional groups
  - hydroxyl **-OH**
  - sulfhydryl (mercapto group) **-SH**
  - sulphide **-S-R**
  - guanidyl



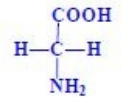
guanidyl

  - phenyl etc.


phenyl

Classification

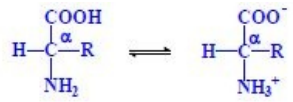
- according to the structure of the side chain and functional groups
- according to side chain polarity
  - polar
  - non - polar
- according to importance in human nutrition
  - essential = the human organism is unable to create them endogenously
    - valin, leucine, isoleucine, phenylalanine, lysine, methionine, tryptophan, threonine
  - conditionally essential = essential in the absence of precursors or immaturity of enzymatic systems
    - arginine, histidine
  - completely non-essential
    - glycine, alanine, serine, cysteine, aspartic acid a asparagine, glutamic acid and glutamine, selenocysteine, tysorine, proline



glycine

Extended classification

- 19 α-amino acid with a primary amino group (-NH_2)

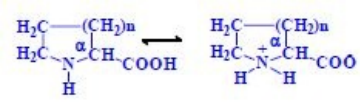


primary amino group

- 1 α-amino acid with a secondary amino group (-NH-)

n=0, pyrrolidin

- 18 amino acids = chiral compounds of the L series
  - trivial names, systematic names, symbols (three-letter, one-letter)



secondary amino group

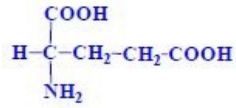
Classification of essential amino acids

By side chain structure and functional groups

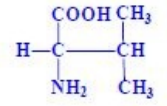
- aliphatic with an unsubstituted chain
  - glycin , alanin , valin , leucin , isoleucin
- aliphatic hydroxyamino acids
  - serin , threonin
- aliphatic sulfur
  - cystein , methionin
- with a carboxyl group in the side chain (monoaminodicarboxylic, acidic)
  - kyselina asparagová , kyselina glutamová
- their monoamides (with a carboxamide group in the side chain)
  - asparagin , glutamin
- with basic groups in the side chain
  - amino group
  - guanidyl group
  - imidazoyl cycle
  - lysin , arginin , histidin
- with an aromatic (heterocyclic) side chain
  - fenylalanin , tyrosin , tryptofan , prolin

According to the polarity of the side chain and its ionic form (in a neutral environment)

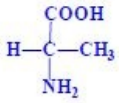
- non-polar, hydrophobic
  - Val, Leu, Ile, Phe, Tyr, Met, Pro;
  - sometimes Gly, Ala, Trp (amphiphilic)
- polar, hydrophilic
  - Ser, Thr, Cys, Asp, Glu, Asn, Gln, Lys, Arg, His
  - Hydrophilic (according to the ionic form of the side chain in a neutral environment)
    - neutral (has no electrical charge): most
    - acidic (negative charge): Asp, Glu
    - basic (positive charge): Lys, Arg, His



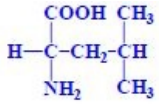
glutamic acid



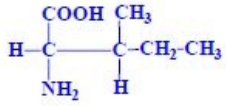
valin



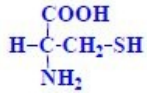
alanine



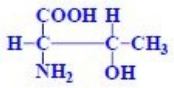
leucine



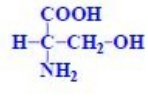
isoleucine



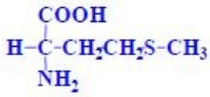
cysteine



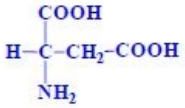
threonine



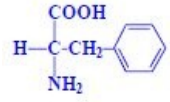
serine



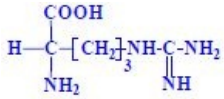
methionine



aspartic acid



phenylalanine



arginine

Representatives

Derivatives of basic proteinogenic amino acids

- the emergence of specific modifications
  - L-cystin (CySSCy)
  - 4-hydroxy-L-prolin (Hyp)
  - 5-hydroxy-L-lysin (Hyl)
  - 3-methyl-L-histidin
  - O-phospho-L-serine

Other non-protein amino acids

N-substituted α-amino acids

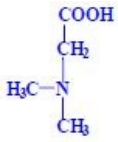
- N-methylglycin (sarkosin) , N,N-dimethylglycin , N,N,N-trimethylglycin
- L-carnitine (3-hydroxy-4-trimethylaminobutyrate, vitamin Bt)
- ß-alanine (3-aminopropionová kyselina) , γ-aminobutyric (4-aminobutyric) acid (GABA)

Sulfur amino acids

- S-alk(en)yl-L-cysteiny , S-alk(en)yl-L-cysteinsulfoxidy

Basic amino acids and related compounds

- L-ornithin (n = 2)
- L-citrulline (n = 2, karbamoylderivát ornithinu)
- creatine-phosphate



N,N-dimethylglycine

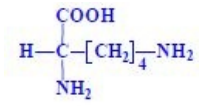
Aromatic amino acids

- tetrajodthyronin (thyroxin), R = R1 = R2 = R3 = I
- 3,4-dihydroxy-L-fenylalanin (DOPA)

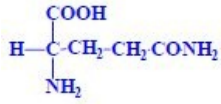
Essential Amino Acids

foods deficient in certain amino acids

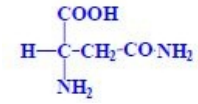
- Lys − cereals (plant proteins in general)
- Met − milk, meat
- Thr − wheat, rye
- Trp − casein, corn, rice



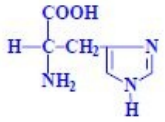
lysine



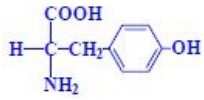
glutamine



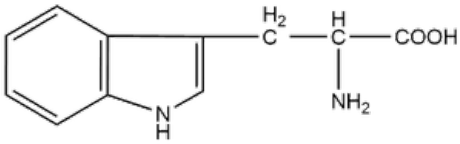
asparagine



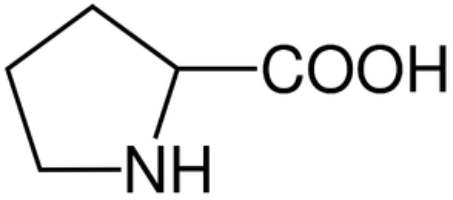
histidine



tyrosine



tryptophan



proline

Physico-chemical properties

Physico-chemical properties

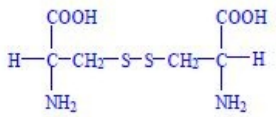
- acid-base (pK and pI)
- optical
- sensory

Acid-base properties (Gly)

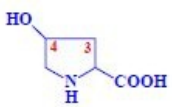
ion I_1 (kation)	ion I_2 (amfion)	ion I_3 (anion)
free charge +1	free charge 0	free charge -1
pH < 2	pH ≈ 6	pH > 10

Dependence of the ionic forms of Gly on pH

cation (I_1) → amphion (I_2) → anion (I_3)



L-cystine



4-hydroxy-L-proline

Optical properties

- Gly = exception
- majority = chiral atom C_{α}... 2 optical isomers (enantiomers)
- some 2 chiral centers... Ile, Thr, Hyp, CySSCy

L- and D-amino acids, L-amino acids = (S)-stereoisomers, *výjimka*: L-cysteine = (R)-stereoisomer

D-amino acids = (R)-stereoisomers

Content

- L-amino acid ie.: (S)-amino acid
- D-amino acid ie.: (R)-amino acid

Diastereoisomers of amino acids

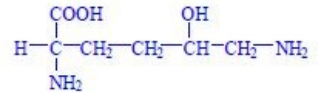
- L-isoleucine (2S, 3S)-isoleucine
- D-isoleucine (2R, 3R)-isoleucine
- L-allo-isoleucine (2S, 3R)-isoleucine
- D-allo-isoleucine (2R, 3S)-isoleucine

Organoleptic properties

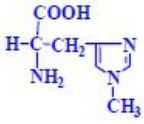
- sweet - Gly, Ala, Thr, Pro
- acidic - Asp, Glu
- bitter - Leu, Ile, Phe, Tyr, Trp
- indifferent - others

Unique properties = umami taste

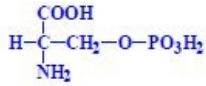
- natrium-hydrogen-glutamát



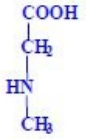
5-hydroxy-L-lysine



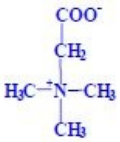
3-methyl-L-histidine



O-phospho-L-serine



sarkosine

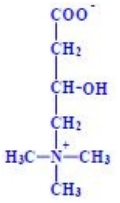


N,N,N-trimethylglycin

Links

Related articles

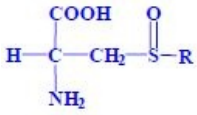
- Peptidy (1. LF UK, NT)
- Bílkoviny (1. LF UK, NT)
- Aminokyseliny, peptidy, bílkoviny (1. LF UK, NT)



L-carnitine

Sources

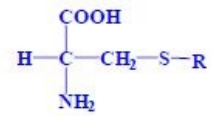
- LF1. *2. AMINOKYSELINY, PEPTIDY, BÍLKOVINY* [online]. [cit. online]. <https://el.lf1.cuni.cz/p51525121/>.



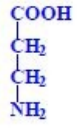
S-alk(en)yl-L-cysteinesulfoxid

Použitá literatura

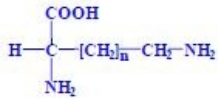
- VELÍŠEK, Jan – HAJŠLOVÁ, Jana. *Chemie potravin 2.* 3. edition. 2009. ISBN 978-80-86659-17-6.
- SVAČINA, Štěpán – ET AL.,. *Klinická dietologie.* 1. edition. 2008. ISBN 978-80-247-2256-6.



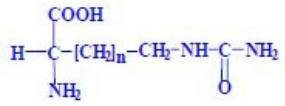
S-alk(en)yl-L-cysteine



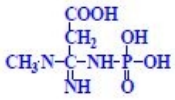
ß-alanine



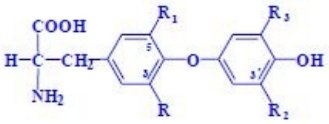
L-ornithine



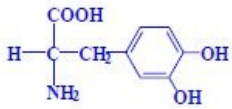
L-citrulline



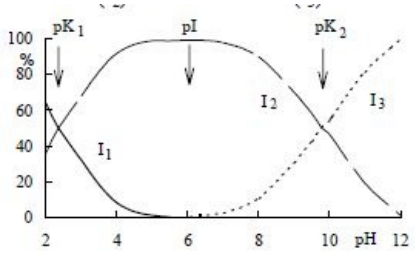
creatine phosphate



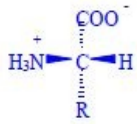
thyroxine



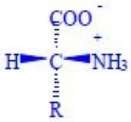
DOPA



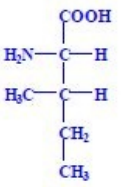
Graph gly-ph



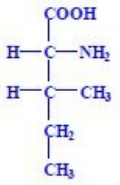
L-amino acid



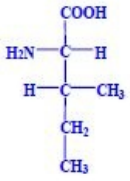
D-amino acid



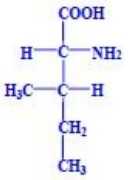
L-isoleucine



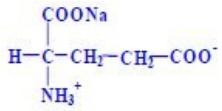
D-isoleucine



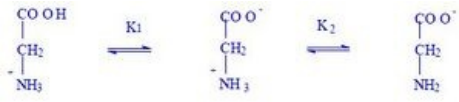
L-allo-isoleucine



D-allo-isoleucine



sodium hydrogen glutamate



Gly on pH