Biochemistry

Amino acids

Proteinogenic amino acids, also known as standard, normal or primary amino acids are 20 amino acids that are incorporated in proteins and that are coded in the standard genetic code (subunit of protein).

Classification of amino acids: -

Amino acids or side chain of them can be classified to different classes depending on their chemical features like: -

- Hydrophobic or hydrophilic character.
- Polar or non polar nature.
- Presence or absence of ionizable group.
- According to the nutrition.

Classified nutritionally into three groups: -

1. **Essential amino acids (8 amino acids):** these are not synthesized in the body and must be taken in diet in amount adequate to support the infant growth or to maintain health in adults, like: -
   (Valine, Leucine, Isoleucine, Phenylalanine, Tryptophan, Lysine, Threonine, Methionine).

2. **Non essential amino acids (12 amino acids):** they can be synthesized by the body.
3. **Semi – essential amino acids:** these are growth promoting factors since they are not synthesized in sufficient quantity during growth.

- This type includes some standard amino acids like (Arginine, Histidine, also Tyr, Cys, Gly, and Glu).
- They become essential in growing children, pregnancy and lacting women.
- Polar (hydrophilic) amino acids are: -
  Arg, Asp, Asn, Cys, Glu, Gln, Gly, His, Lys, Ser and Thr
- Non polar (hydrophobic) amino acids are: -
  Ala, Ile, Leu, Met, Phe, Pro, Trp, Tyr, Val

Note/ amino acids are classified into three groups depending on their reactions: -

1. **Neutral:** aliphatic, aromatic, cyclic and hydroxyl or sulfur containing amino acids:
   (Gly, Ala, Val, Leu, Ile, Phe, Tyr, Trp, Ser, Thr, Cys, Met, Pro)
2. **Acidic:** this class contain 4 standard amino acids: -
   (Asp, Asn, Glu, Gln).
3. **Basic:** this class contain only 3 standard amino acids: -
   (His, Lys, Arg).

- 20 amino acids called “Standard amino acids” occur in almost all proteins & are coded in the DNA.
- Some amino acids may become chemically modified after being assembled in proteins, which called the ***unusual L – α amino acids*** by ***post-translation processing***. The process

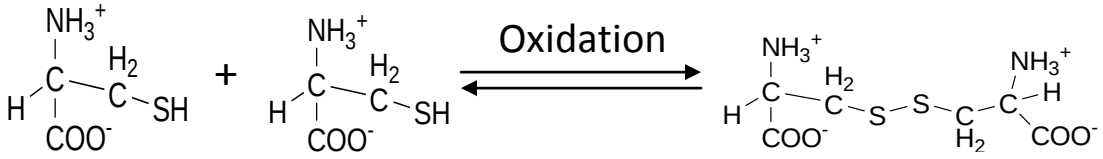
that occurs after formation of the polypeptides backbone, like: -

(Oxidation, phosphorylation, methylation, carboxylation, formylation and acetylation)

- These modifications are important for protein function and structure.

Examples: -

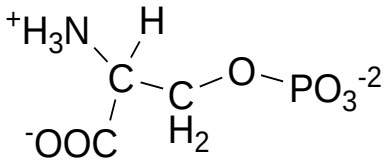
1. **Cystine** which formed by oxidation of the SH groups of the two Cysteines to (– S – S –) disulfide bond.



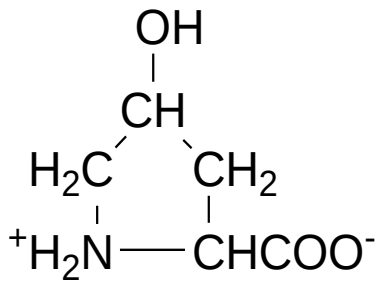
Cystine

Note: oxidation is lose of H from SH
Cysteine → standard
Cystine → unusual

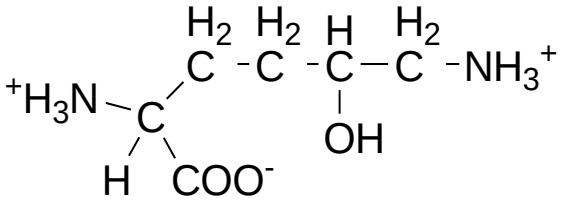
2. **O – PhosphoSerine**: unusual amino acid from standard Serine (Ser).



3. **4 – HydroxyProline**: This amino acid is important for stability of collagen structure.



4. **δ – HydroxyLysine**: Is important for the cross – link in the elastin where highly elastic fibers are needed.



- Important for Desmosine (derivative of 4 Lys residues).

5. **6 – MethylLysine**: is the constituent of myosin, a contractive protein of muscles.

- Some biologically important amino acids that not found in proteins like: -
  (β – Alanine, D – Alanine, γ – Aminobutric acid, D – Glutamic acid, Homoserine ((nithine)), Sarcosine, Thyroxin and Dopamine ((DOPA)))

Functions of amino acids: -

Amino acids perform structural, hormonal and catalytic functions essential for life by forming proteins. It is not surprising that genetic defects in metabolism of amino acids can result in mental retardation and early death.

Also transport defects of amino acids into cells result in excretion of these amino acids in urine; such case called **amino aciduria**.

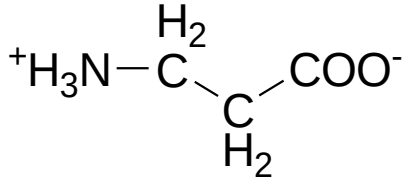
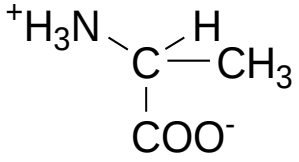
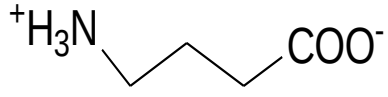
In addition to their roles in proteins amino acids and their derivatives participate in **intracellular functions** as: -

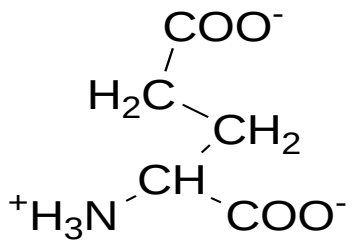
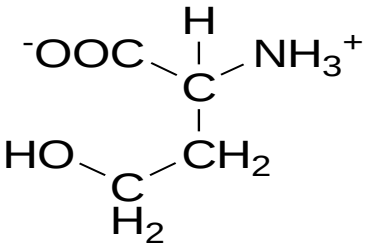
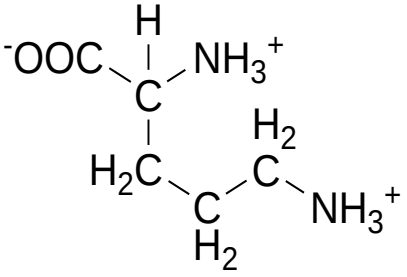
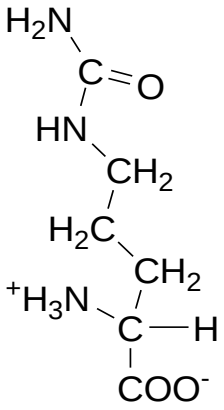
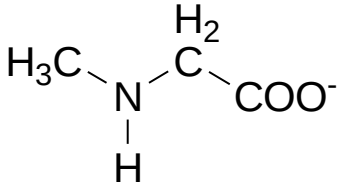
A. Some amino acids are converted to carbohydrates and are called ***glycogenic amino acid***.
   Note: these glycogenic amino acids can be converted to glucose when it need in a process known as ***gluconeogensis*** such as (Asp, Ala, Cys, and Thr).
   Other amino acids can be converted to ***ketonebodies*** and are called by ***ketogenic*** such as (Leu and Lys), exclusively converted to acetyl Co A.
   Other amino acids can be converted to glucose and ketone bodies such as (Tyr, Ile, Phe and Trp).
B. Specific amino acids give rise to specialized
   a) Tyrosine forms hormones such as thyroid hormones (T_3, T_4), epinephrine, norepinephrine and melanin pigment.
   b) Tryptophan can synthesize a niacin vitamin.
   c) Glycine, Arginine and Methionine synthesize creatine.
   d) Glycine and Cysteine help in synthesize bile salts.
   e) Glutamate, Cysteine and glycine synthesize Glutathione (GSH) which is important for several enzymes.
   f) Histidine changes to Histamine.

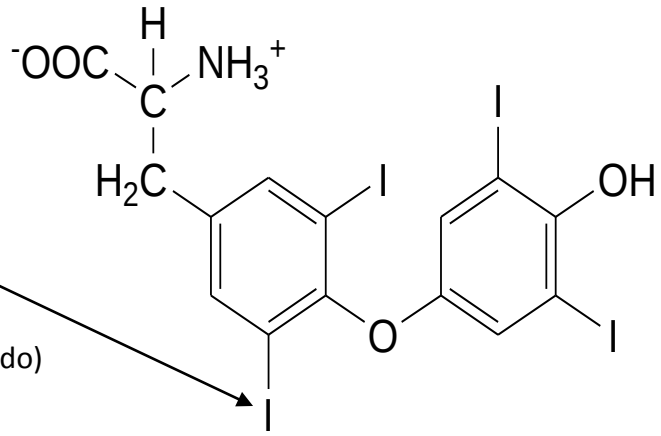
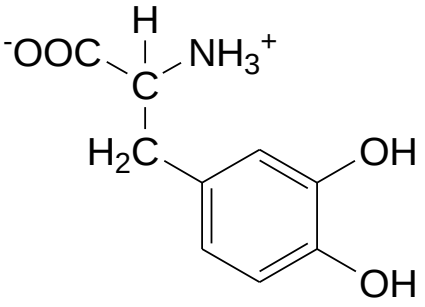
g) Glycine is used for synthesis of heme porphyrins.
h) Pyrimidines and purines used several amino acids for their synthesis such as (Asp and Glu) for pyrimidine, and (Glu, Asp, Gln and Ser) for purine synthesis.
i) Some amino acids such as (Glu and Cys) are used as detoxifcants of specific substances.
j) Methionine acts as active Methionine (δ – adensyl – Methionine) to transfer methyl group to various substances by transmethylation.

Note: Cys and Met are source of sulphur for the sulphur compound in the body.

Some biologically important amino acids not found in protein (non standard amino acids): -

Name	Formula	Biochemical source & function
β – Alanine		Found in co – enzyme A & in vitamin pantothenic acid & in some important natural peptides.
D – Alanine		Present in polypeptides, antibiotics & in some bacterial cell walls.
γ – amino butyric acid		Brain, other animal tissues, functions as neurotransmitter.

D – Glutamic acid		In polypeptides & in some microorganisms (bacterial cell walls).
Homoserine		In many tissues, an intermediate in amino acid metabolism.
Ornithine Citrulline (metabolites of urea cycle)	 	In many tissues & an intermediate in Arginine synthesis.
Sarcosine		In many tissue, intermediate in amino acid synthesis.

Thyroxin (T_4) If we remove (I) the result is T3 (tri – iodo, Tetra – iodo)		Thyroid gland is thyroid hormone.
Dopamine (DOPA)	 Dihydroxyphenylalanine	A precursor of catecholamine (epinephrine or norepinephrine), a precursor of pigment melanin, deficiency in <u>Parkinson disease</u>.
Taurine		Bile salt