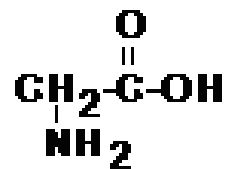# Amino Acids and Proteins

Proteins functions

- **Most abundant and functionally diverse group of molecules**
- **Indispensable for life**
- **Have several diverse functions:**
  - **Catalytic functions [enzymes]**
  - **Receptor [insulin receptor]**
  - **Structural function [collagen]**
  - **Transport [haemoglobin, myoglobin]**
  - **Protective functions [immunoglobulins]**
  - **Hemostasis [clotting factors]**
  - **Hormonal functions [insulin, glucagon, GH]**
  - **Control of gene expression [transcription factors]**
  - **DNA packing [histones]**
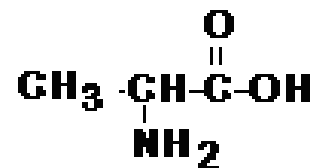 - **Act as buffers**

Amino Acids - Proteins

Amino acids are the building blocks of proteins. Proteins are natural polymers of successive amino acids

There are 20 different amino acids that make up human proteins

$$CH_2-C-OH$$

Glycine

Alanine

Two common amino acids found in proteins

Amino Acid Functions

1. **Amino acids are the building blocks of proteins**

2. **Some amino acids and their derivatives function as neurotransmitters, hormones and other regulators**

        Examples Include

   **L-dopamine**

                Epinephrine

                Thyroxine

Amino Acids

- 20 naturally occurring amino acids
- 12 can be synthesized in the body
- 8 'essential' amino acids have to be obtained from food
- Amino acid polymers form proteins
- The properties of each amino acid are determined by its specific side chain (R –groups)
- R-groups vary in structure , size , electric charge and solubility in water from one amino acid to other.
- Amino acids names are often abbreviated as either 3 letters or single letters .
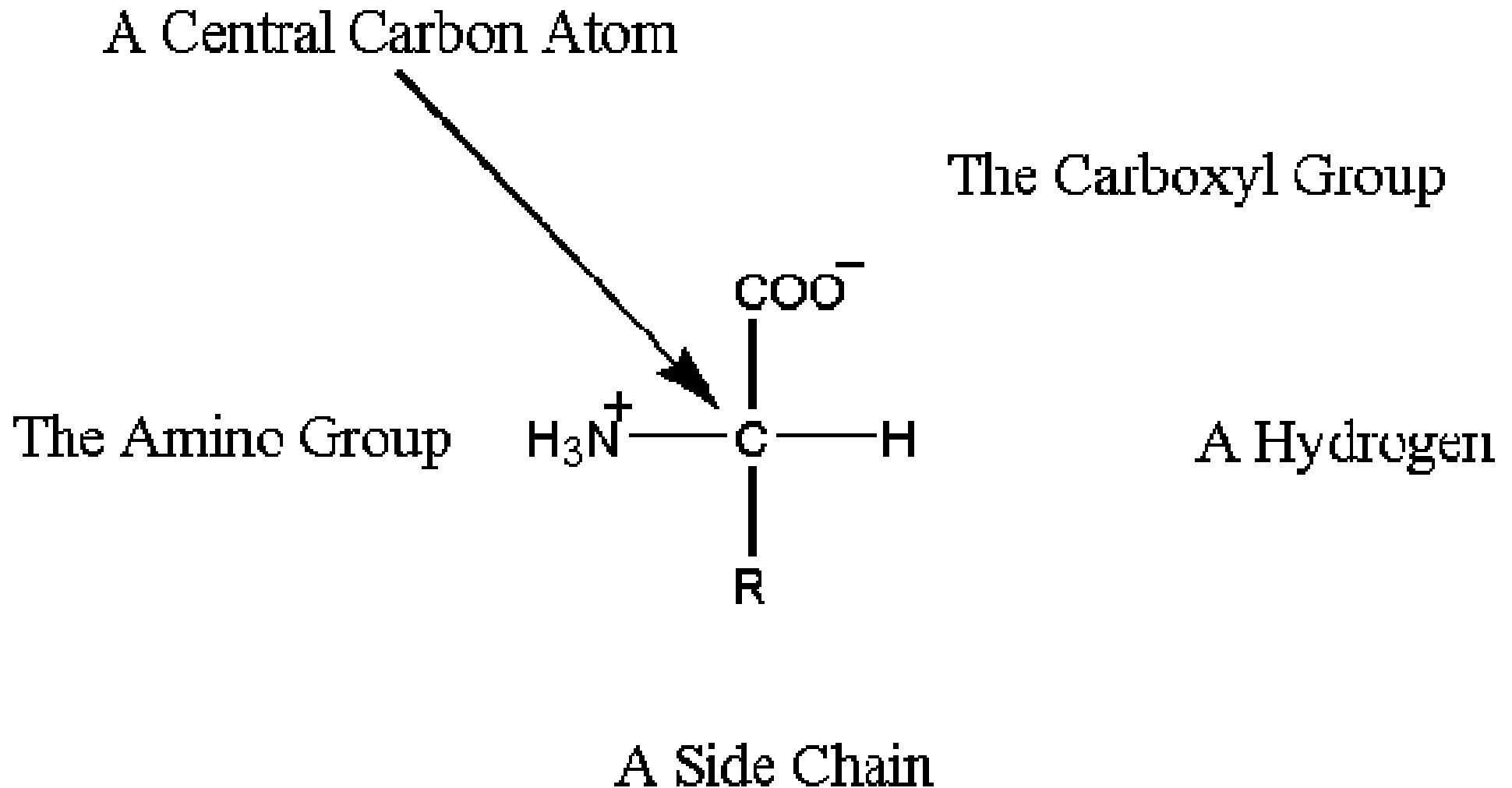
A Free amino acid

Common to all α-amino acids of proteins

$$^+H_3N—C_\alpha—COOH$$

H (above C_α)

R (below C_α)
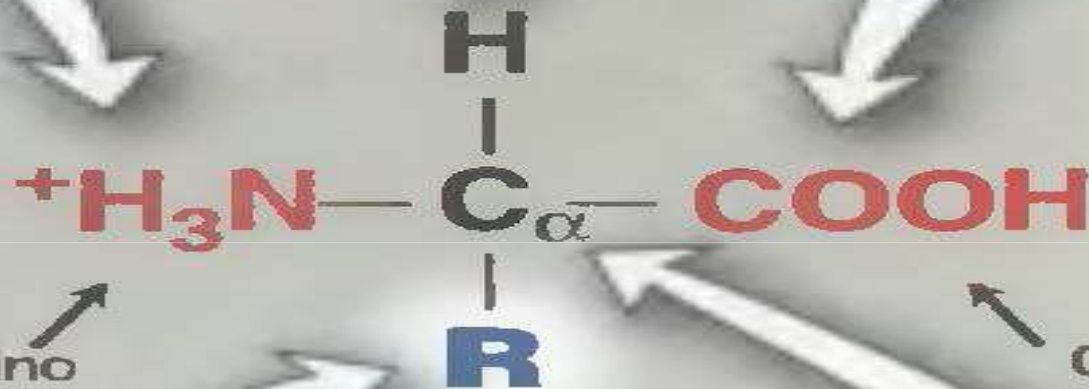
Amino group

Carboxyl group

Side chain is distinctive for each amino acid.

α-Carbon is between the carboxyl and the amino groups.

Amino Acid Structure
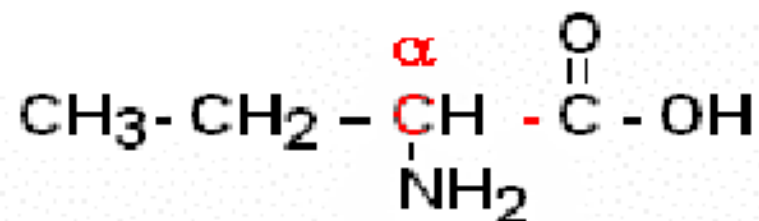
Amino acids may be characterized as α, β , or γ amino acids depending on the location of the amino group in the carbon chain.

α are on the carbon adjacent to the carboxyl group.
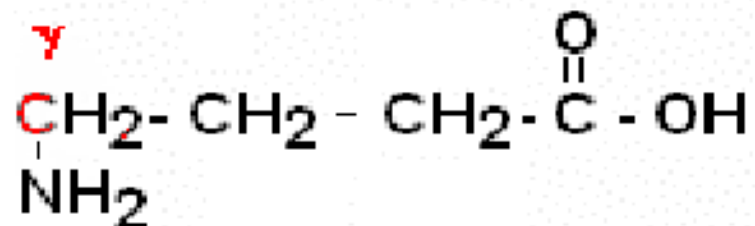
β are on the 2nd carbon

γ on the 3rd carbon from the carboxyl group

$$CH_3 - CH_2 - \overset{\alpha}{\underset{NH_2}{CH}} - \overset{O}{\overset{\|}{C}} - OH$$

α– aminobutanoic acid

$$CH_3 - \overset{\beta}{\underset{NH_2}{CH}} - CH_2 \cdot \overset{O}{\overset{\|}{C}} - OH$$

β – aminobutanoic acid

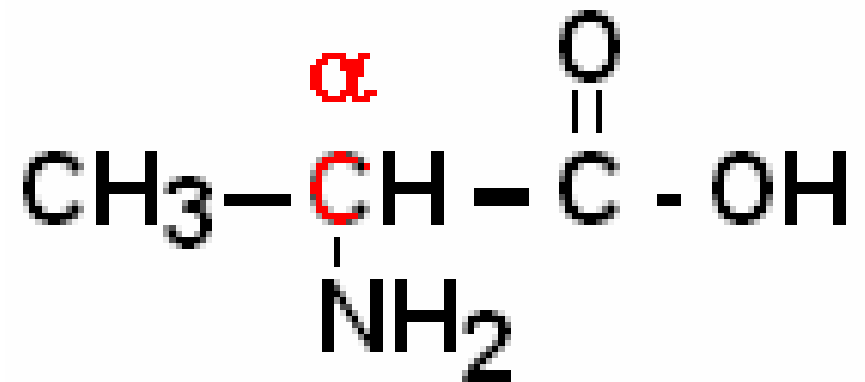$$\overset{\gamma}{\underset{NH_2}{CH_2}} - CH_2 - CH_2 \cdot \overset{O}{\overset{\|}{C}} - OH$$
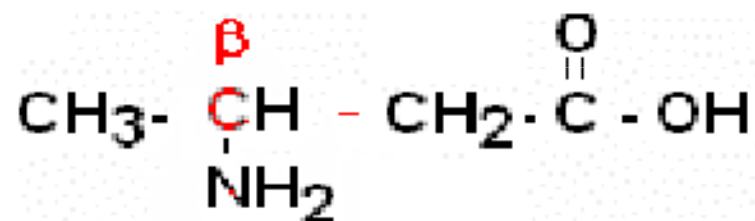
γ– aminobutanoic acid

$\alpha-$ amino acids

Amino acids found in proteins are $\alpha-$ amino acids. The amino group is always found on the carbon adjacent to the carboxyl group

$$CH_3 - \underset{\underset{NH_2}{|}}{\overset{\alpha}{CH}} - \overset{\overset{O}{||}}{C} - OH$$

Alanine is an α amino acid

Classification of Amino Acids

- As the properties of the amino acids and their role in proteins are determined by the side chain , therefore amino acids are classified according :

1 - Structure of side chain

2- Polarity of the side chain

AMINO ACID CLASSIFICATION
Depending on side chain structure

- **Aliphatic side chain**
  - Sulphur – containing side chain
  - Acidic side chain
  - Basic side chain
  - Amide side chain
  - Hydroxylic side chain
  - Imino Side Chain
- **Aromatic side chain**

Name	Symbol	Structural Formula	pK₁	pK₂	pK₃
With Aliphatic Side Chains			α-COOH	α-NH$_3^+$	R Group
Glycine	Gly [G]	H — CH — COO⁻ NH₃⁺	2.4	9.8	
Alanine	Ala [A]	CH₃ — CH — COO⁻ NH₃⁺	2.4	9.9	
Valine	Val [V]	H₃C CH — CH — COO⁻ H₃C NH₃⁺	2.2	9.7	
Leucine	Leu [L]	H₃C CH — CH₂ — CH — COO⁻ H₃C NH₃⁺	2.3	9.7	

Isoleucine	Ile [I]	CH₃
		   CH₂
		     CH — CH — COO⁻
		   CH₃ NH₃⁺
			2.3	9.8	

With Side Chains Containing Hydroxylic (OH) Groups

Name	Abbreviation	Structure			
Serine	Ser [S]	$CH_2-CH-COO^-$, with OH and NH_3^+	2.2	9.2	about 13
Threonine	Thr [T]	$CH_3-CH-CH-COO^-$, with OH and NH_3^+	2.1	9.1	about 13
Tyrosine	Tyr [Y]	See below.			

With Side Chains Containing Sulfur Atoms

Name	Abbreviation	Structure			
Cysteine	Cys [C]	$CH_2-CH-COO^-$, with SH and NH_3^+	1.9	10.8	8.3
Methionine	Met [M]	$CH_2-CH_2-CH-COO^-$, with $S-CH_3$ and NH_3^+	2.1	9.3	

With Side Chains Containing Acidic Groups or Their Amides

Name	Abbreviation	Structure			
Aspartic acid	Asp [D]	$^-OOC-CH_2-CH-COO^-$, with NH_3^+	2.0	9.9	3.9
Asparagine	Asn [N]	$H_2N-C(=O)-CH_2-CH-COO^-$, with NH_3^+	2.1	8.8	
Glutamic acid	Glu [E]	$^-OOC-CH_2-CH_2-CH-COO^-$, with NH_3^+	2.1	9.5	4.1
Glutamine	Gln [Q]	$H_2N-C(=O)-CH_2-CH_2-CH-COO^-$, with NH_3^+	2.2	9.1	

With Side Chains Containing Hydroxylic (OH) Groups

Serine	Ser [S]	$CH_2-CH-COO^-$, with OH and NH_3^+	2.2	9.2	about 13
Threonine	Thr [T]	$CH_3-CH-CH-COO^-$, with OH and NH_3^+	2.1	9.1	about 13
Tyrosine	Tyr [Y]	See below.			

With Side Chains Containing Sulfur Atoms

Cysteine	Cys [C]	$CH_2-CH-COO^-$, with SH and NH_3^+	1.9	10.8	8.3
Methionine	Met [M]	$CH_2-CH_2-CH-COO^-$, with $S-CH_3$ and NH_3^+	2.1	9.3	

With Side Chains Containing Acidic Groups or Their Amides

Aspartic acid	Asp [D]	$^-OOC-CH_2-CH-COO^-$, with NH_3^+	2.0	9.9	3.9
Asparagine	Asn [N]	$H_2N-C(=O)-CH_2-CH-COO^-$, with NH_3^+	2.1	8.8	
Glutamic acid	Glu [E]	$^-OOC-CH_2-CH_2-CH-COO^-$, with NH_3^+	2.1	9.5	4.1
Glutamine	Gln [Q]	$H_2N-C(=O)-CH_2-CH_2-CH-COO^-$, with NH_3^+	2.2	9.1	

ALIPHATIC AMINO ACIDS

Monoamino-monocarboxylic acids
- Glycine [Gly; G]
- Alanine [Ala; A]
- Isoleucine [Ile; I]
- Valine [Val; V]
- Leucine [Leu; L]

Hydroxy-monoamino-monocarboxylic acids
- Serine [Ser; S]
- Threonine [Thr; T]

Monoamino-dicarboxylic acids
- Aspartic acid [Asp; D]
- Glutamic acid [Glu; E]

Monoamino-dicarboxyl-co-amides
- Asparagine [Asn; N]
- Glutamine [Gln; Q]

Diamino-monocarboxylic acids
- Arginine [Arg; R]
- Lysine [Lys; K]   - Hydroxylysine
- Ornithine

Sulphur-containing amino acids
- Cysteine [Cys; C]   - Cystine
- Methionine [Met; M]

Heterocyclic amino acids
- Tryptophan [Trp; W]
- Histidine [His; H]
- Proline [Pro; P]   - Hydroxyproline

AROMATIC AMINO ACIDS

- Phenylalanine [Phe; F]
- Tyrosine [Tyr; Y]
- Tryptophan [Trp; W]