AMINO ACIDS

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Bsc; Msc

Proteins

- Paramount importance in biological systems
- Play major structural and functional aspects of the body
- Polymers of amino acids linked by peptide bonds

- 300 amino acids in nature. Only 20 in human body
- Most are alpha (α). Proline is not
- Amino group attached to the same carbon atom to which the carboxyl group is attached

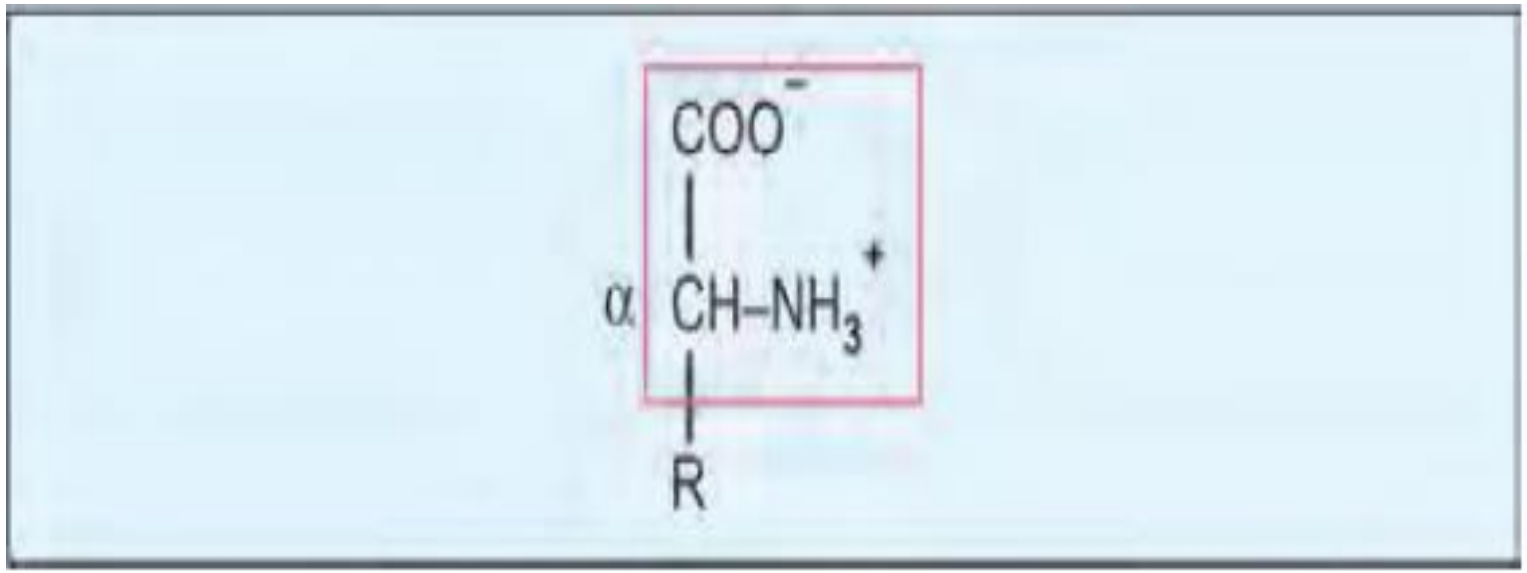


Fig: General structure

CLASSIFICATION OF AMINO ACIDS

Based on structure

A. Aliphatic amino acids

Monoamino monocarboxylic acids

Simple amino acids: Glycine, Alanine

Branched chain amino acids: Valine, Leucine, Isoleucine

Hydroxyamino acids: Serine, Threonine

Sulfur-containing amino acids: Cysteine, Methionine

Amino acids with amide group: Asparagine, Glutamine

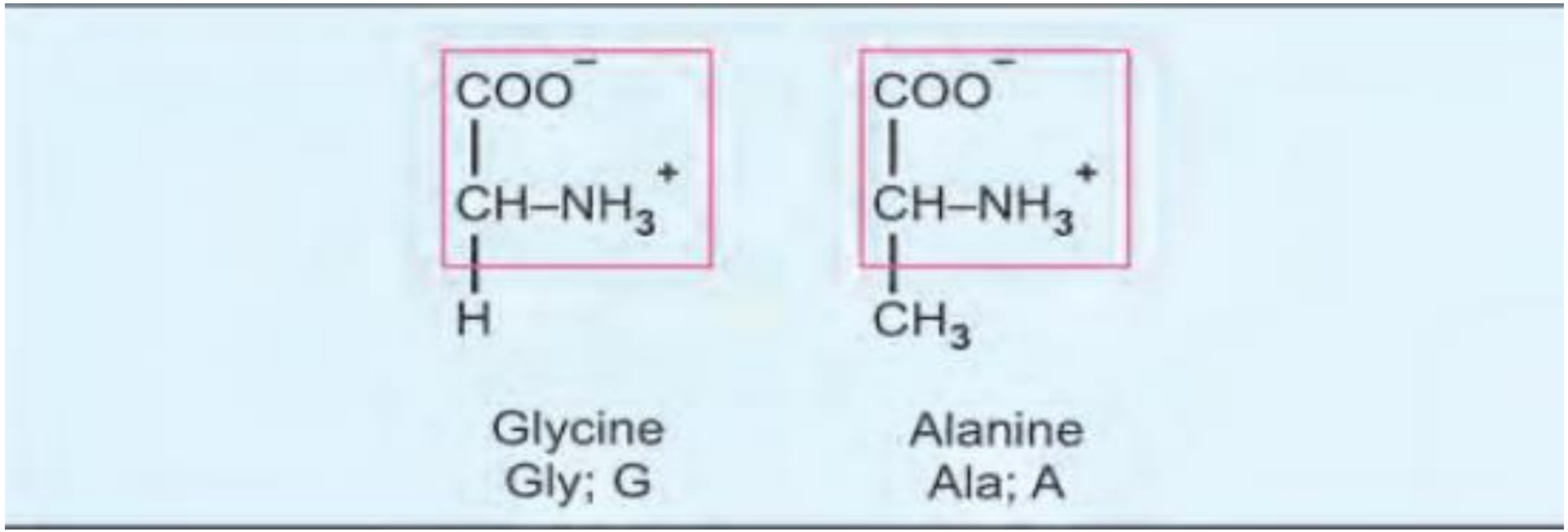


Fig: Simple amino acids

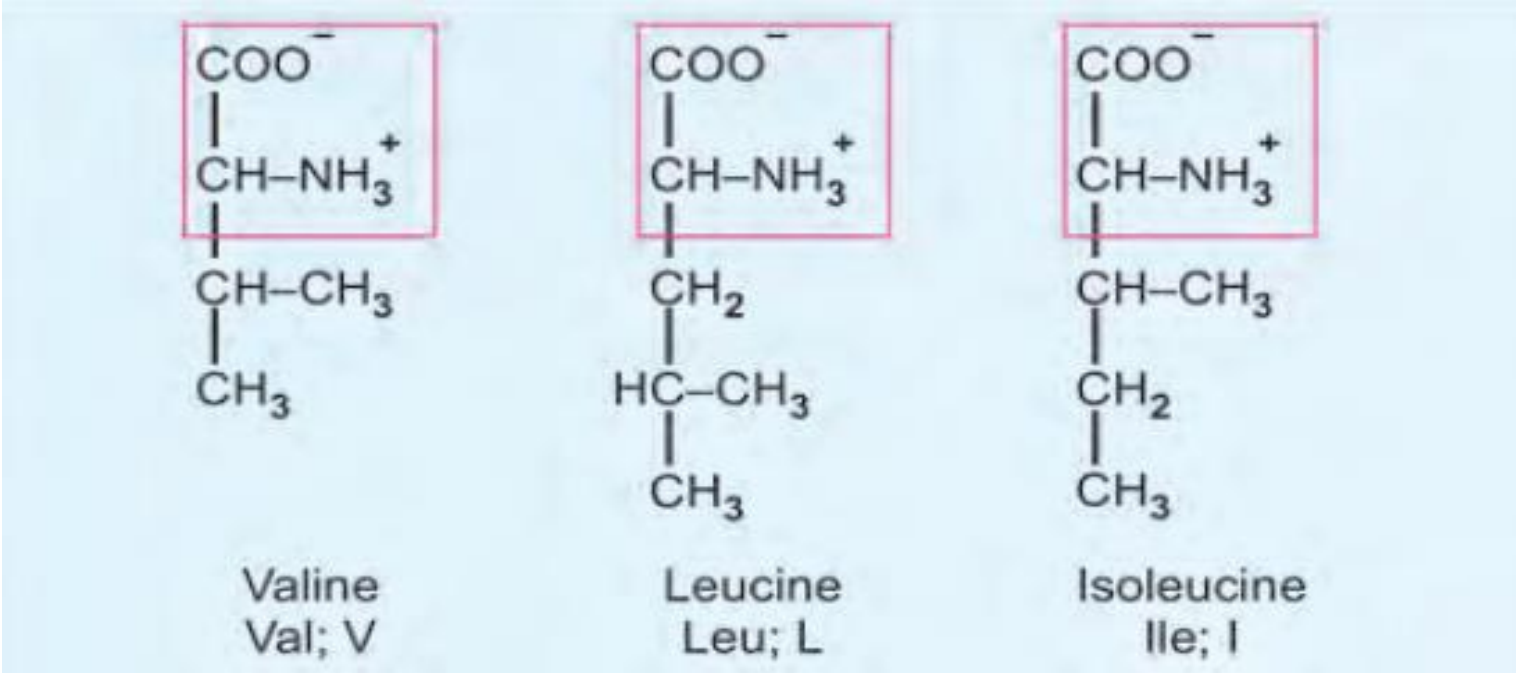


Fig: Branched chain amino acids

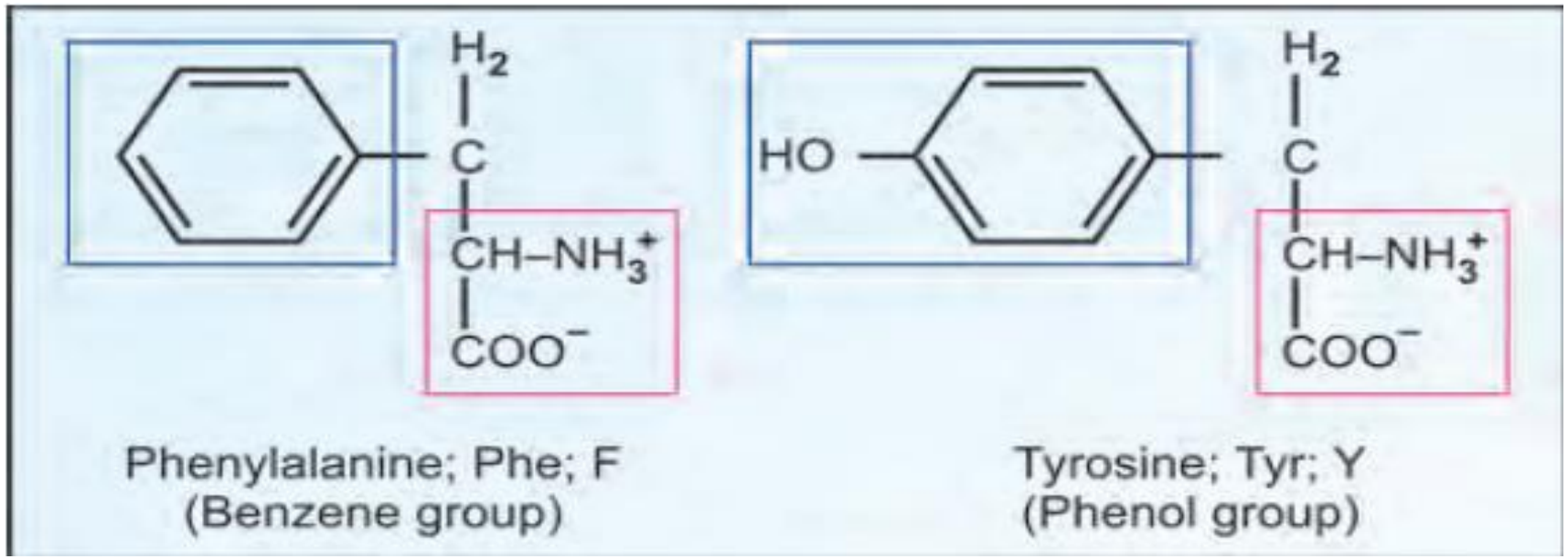
Fig: Hydroxyamino acids

Fig: Sulfur-containing amino acids

Fig: Amino acids with amide groups

Fig: Mono amino dicarboxylic acids: Aspartic acid, Glutamic acid

Fig: Dibasic monocarboxylic acids: Lysine, Arginine



B. Aromatic amino acids: Phenylalanine, Tyrosine

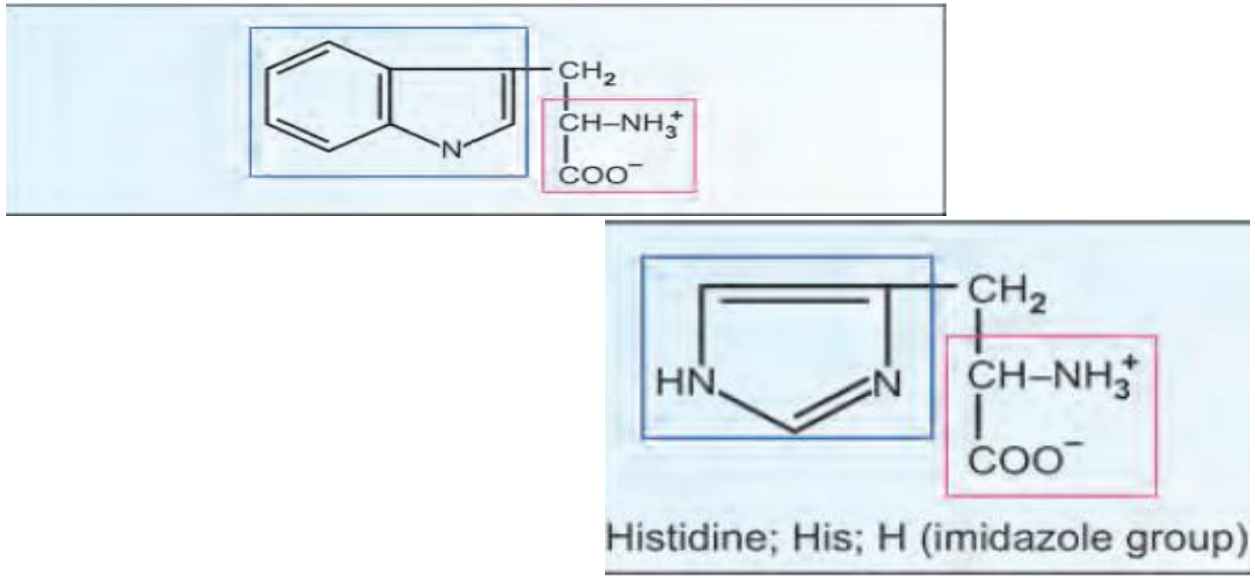
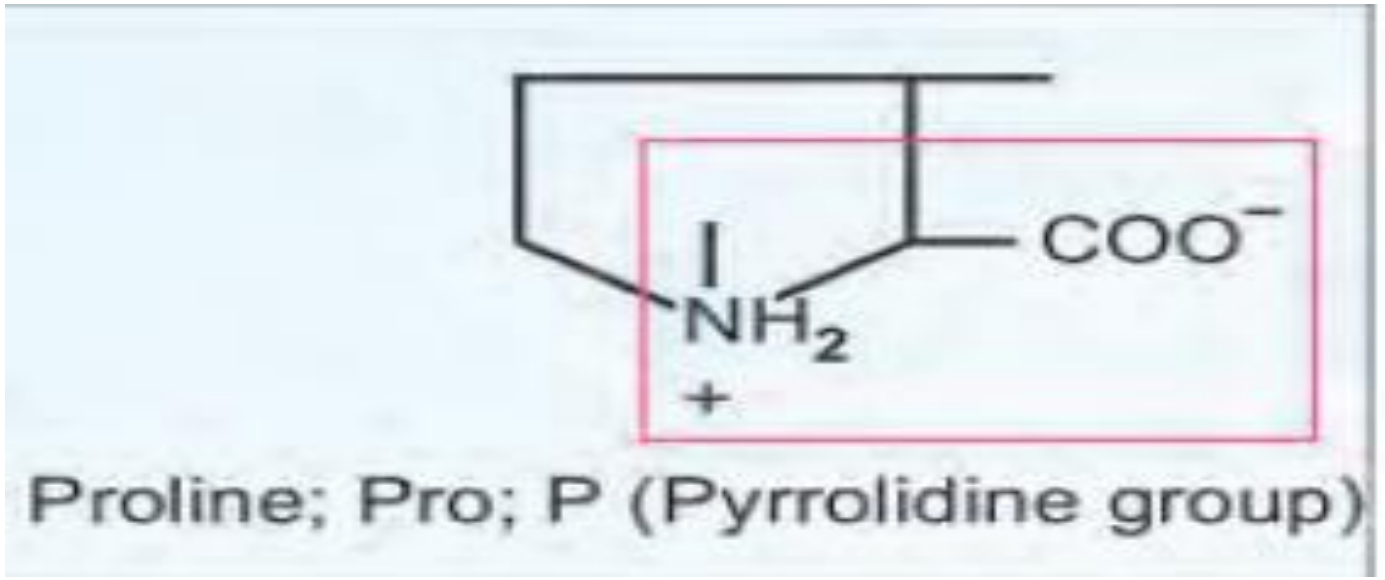


Fig: Heterocyclic amino acids: Tyrptophan, Histidine



D. Imino acid: Proline

E. Derived amino acids:

I. Derived amino acids in proteins: Hydroxyproline and hydroxylysine

Important components of collagen

Gamma carboxylation of glutamic acid residues-blood clotting processes

In ribosomal proteins and in Histones: extensively methylated and acetylated

II. Derived amino acids not seen in proteins- free in cells: Ornithine, Citrulline, Homocysteine

- All produced during metabolism of amino acids

III. Non-alpha amino acids: Gamma amino butyric acid (GABA) derived from glutamic acid

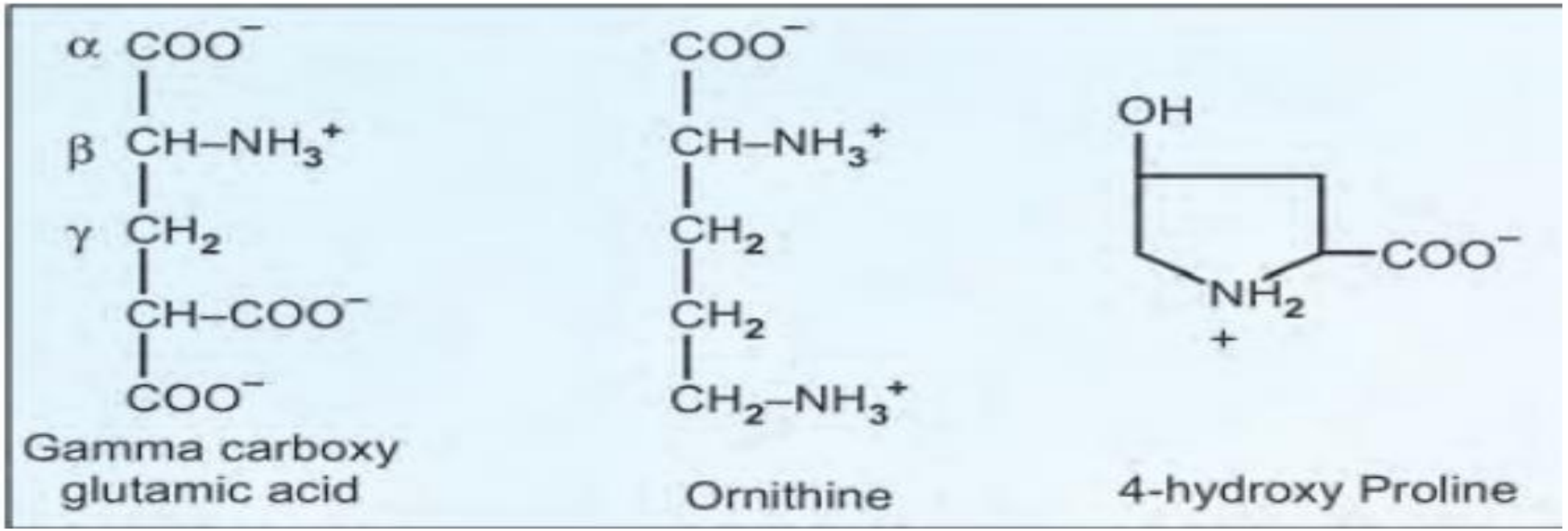


Fig: Some derived amino acids

Name of amino acid	*Special group present*	*3-letter abbre-viation*	*1-letter abbre-viation*	*Mole-cular weight*
Glycine		Gly	G	77
Alanine		Ala	A	89
Valine		Val	V	117
Leucine		Leu	L	131
Isoleucine		Ile	I	131
Serine	Hydroxyl	Ser	S	105
Threonine	Hydroxyl	Thr	T	119
Cysteine	Sulfhydryl	Cys	C	121
Methionine	Thioether	Met	M	149
Asparagine	Amide	Asn	N	132
Glutamine	Amide	Gln	Q	146
Aspartic acid	β-carboxyl	Asp	D	133
Glutamic acid	γ-carboxyl	Glu	E	147
Lysine	ε-amino	Lys	K	146
Arginine	Guanidinium	Arg	R	174
Phenylalanine	Benzene	Phe	F	165
Tyrosine	Phenol	Tyr	Y	181
Tryptophan	Indole	Trp	W	204
Histidine	Imidazole	His	H	155
Proline (imino acid)	Pyrrolidine	Pro	P	115

TABLE: Common amino acids

Special groups:

- Arginine- guanidinium group
- Phenyl alanine-Benzene
- Tyrosine-Phenol
- Tryptophan-Indole
- Histidine-Imidazole
- Proline- Pyrrolidine

Based on Side chains

A. Non polar side chains: Alanine, Valine, Leucine, Isoleucine, Methionine, Proline, Phenylalanine and Tryptophan

Hydrophobic (water repellant) and lipophilic groups

B. Uncharged or non-ionic polar side chains Glycine, serine, Threonine, Cysteine, Tyrosine, Glutamine, Asparagine

Hydrophilic

C. Charged or ionic polar side chains:

Acidic: Aspartic acid and Glutamic acid

Basic: Lysine, Arginine and Histidine

Based on Metabolism

A. Purely ketogenic: Leucine- converted to ketone bodies
B. Ketogenic and glucogenic: Lysine, Isoleucine, Phenylalanine, Tryosine and Tryptophan
C. Purely Glucogenic: Remaining are purely

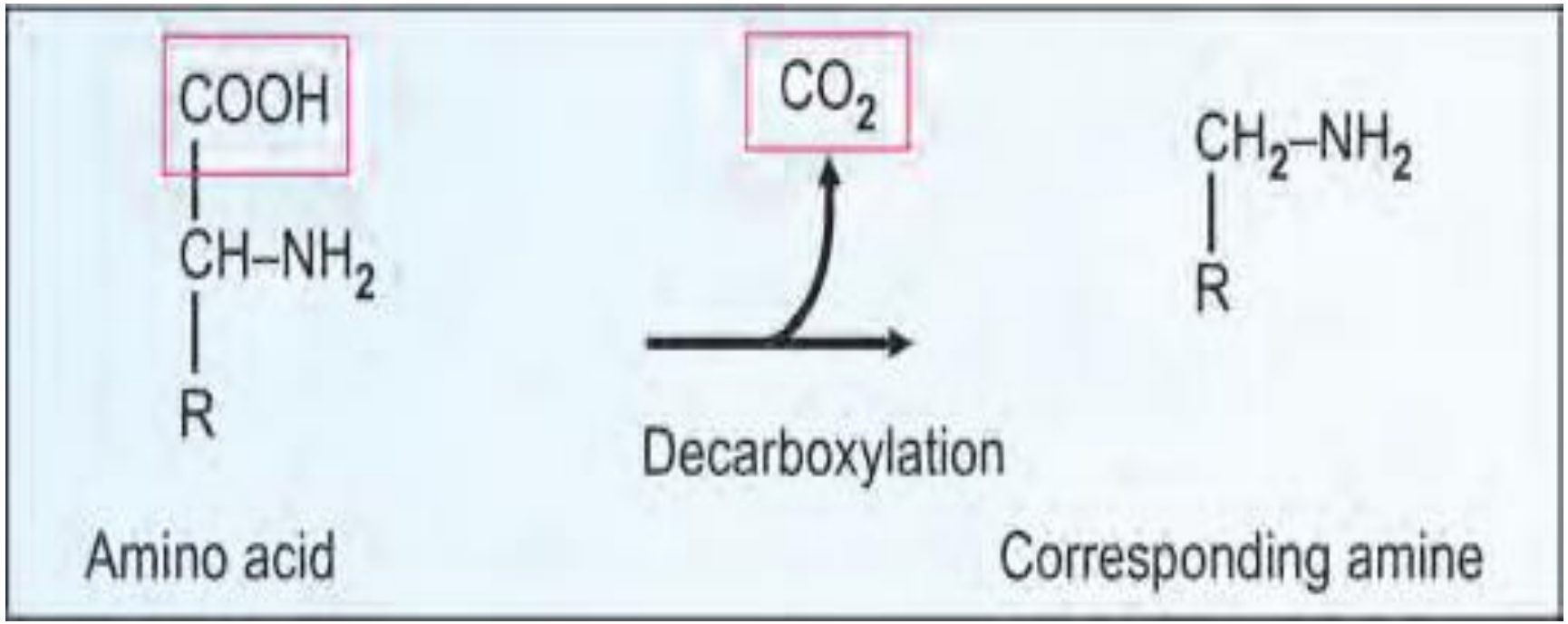
Based of Nutritional Requirements

A. Essential or Indispensable: Isoleucine, Threonine, Lysine, Methionine, Phenylalanine, Tryptophan and Valine
B. Partially essential (semi essential): Histidine and Arginine
C. Non essential: can be synthesized in the body
D. Conditionally essential: Arginine, Glycine, Cysteine, Tyrosine, Proline, Glutamine

General reactions

- Due to Carboxyl group
- Decarboxylation-Alpha decarboxylation to form the corresponding amine
- Histidine undergoes decarboxylation to give Histamine and carbon dioxide
- Glutamic acid gives Gamma amino butyric acid (GABA) and carbon dioxide

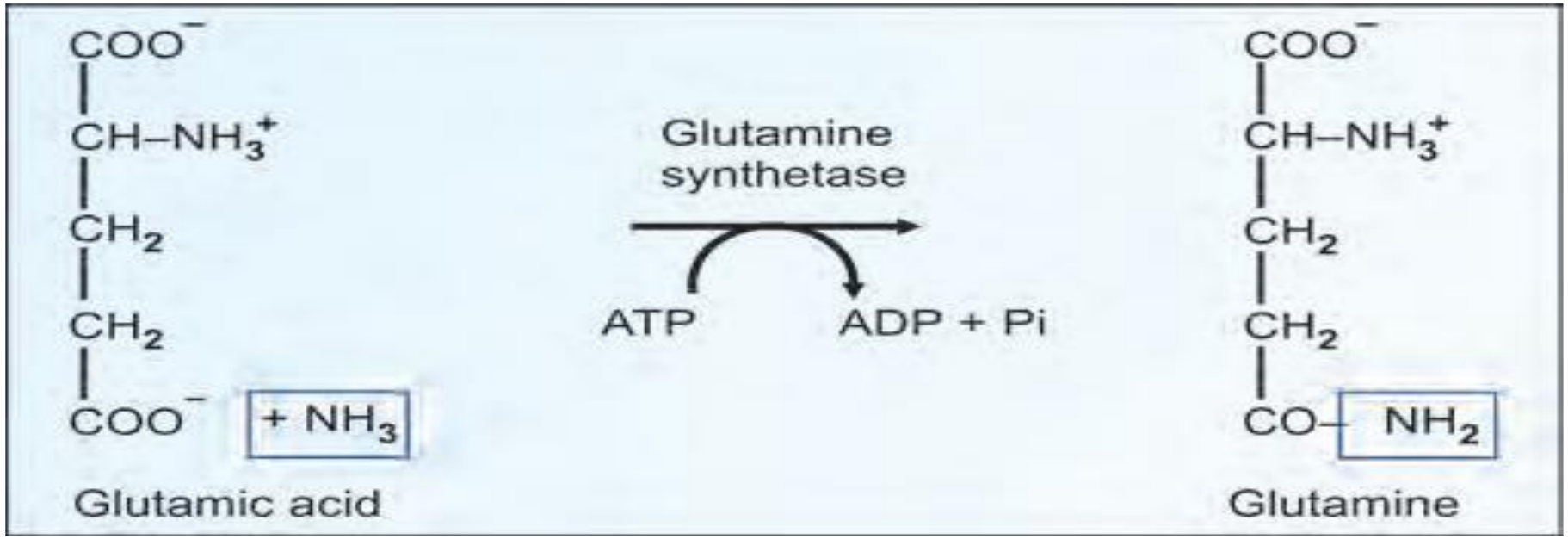
DECARBOXYLATION



Amide formation- COOH group of dicarboxylic amino acids (other than alpha carboxyl combines with ammonia to from an amide)

- Aspartic acid + NH_3 gives Asparagine
- Glutamic acid +NH_3 gives Glutamine
- Amides are also components of protein structure
- Amide group of glutamine- source of nitrogen for nucleic acid synthesis

AMIDE FORMATION

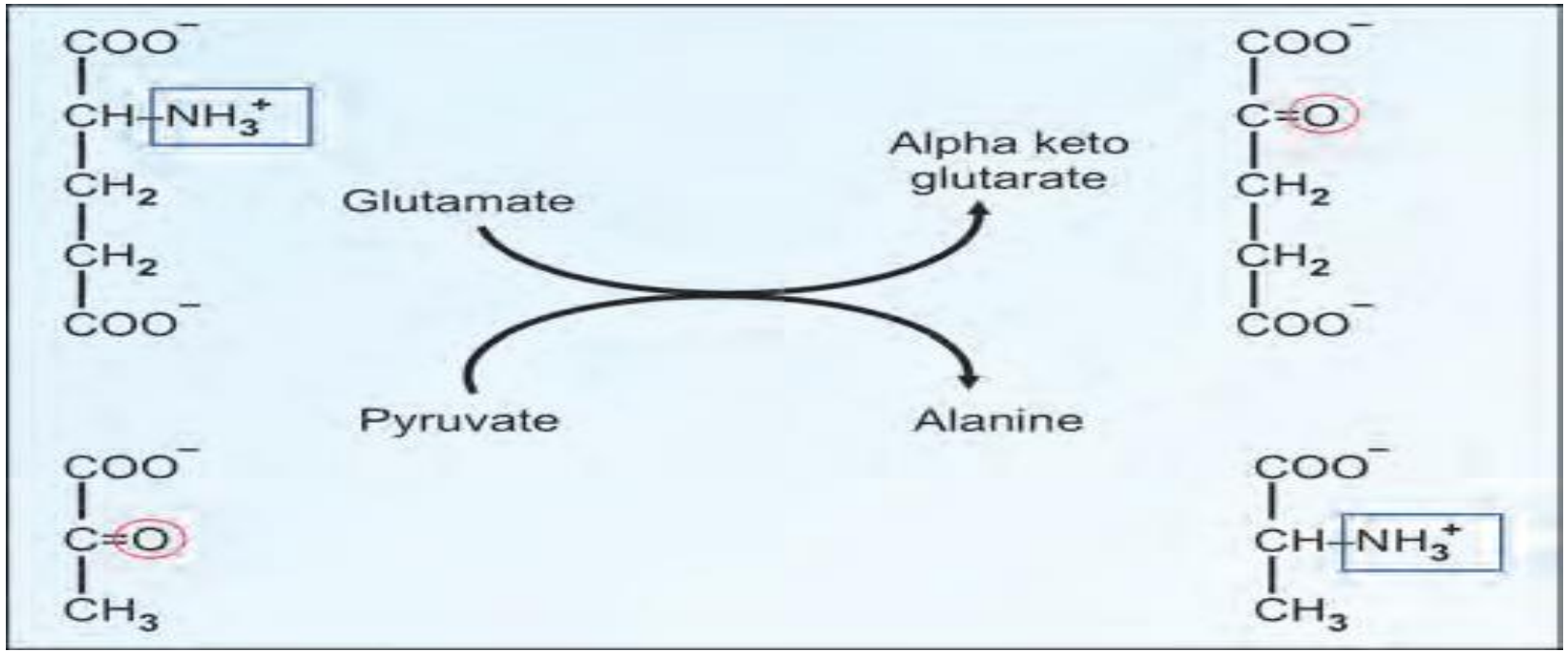


Due to Amino group

Transamination-Alpha amino group transferred to alpha keto acid to form the corresponding new amino acid and alpha keto acid

Important reaction- interconversion of amino acids and synthesis of non essential amino acids

TRANSAMINATION



Oxidative Deamination

Alpha amino group removed to form corresponding keto acid and ammonia.

Glutamic acid most common amino acid to under go this reaction

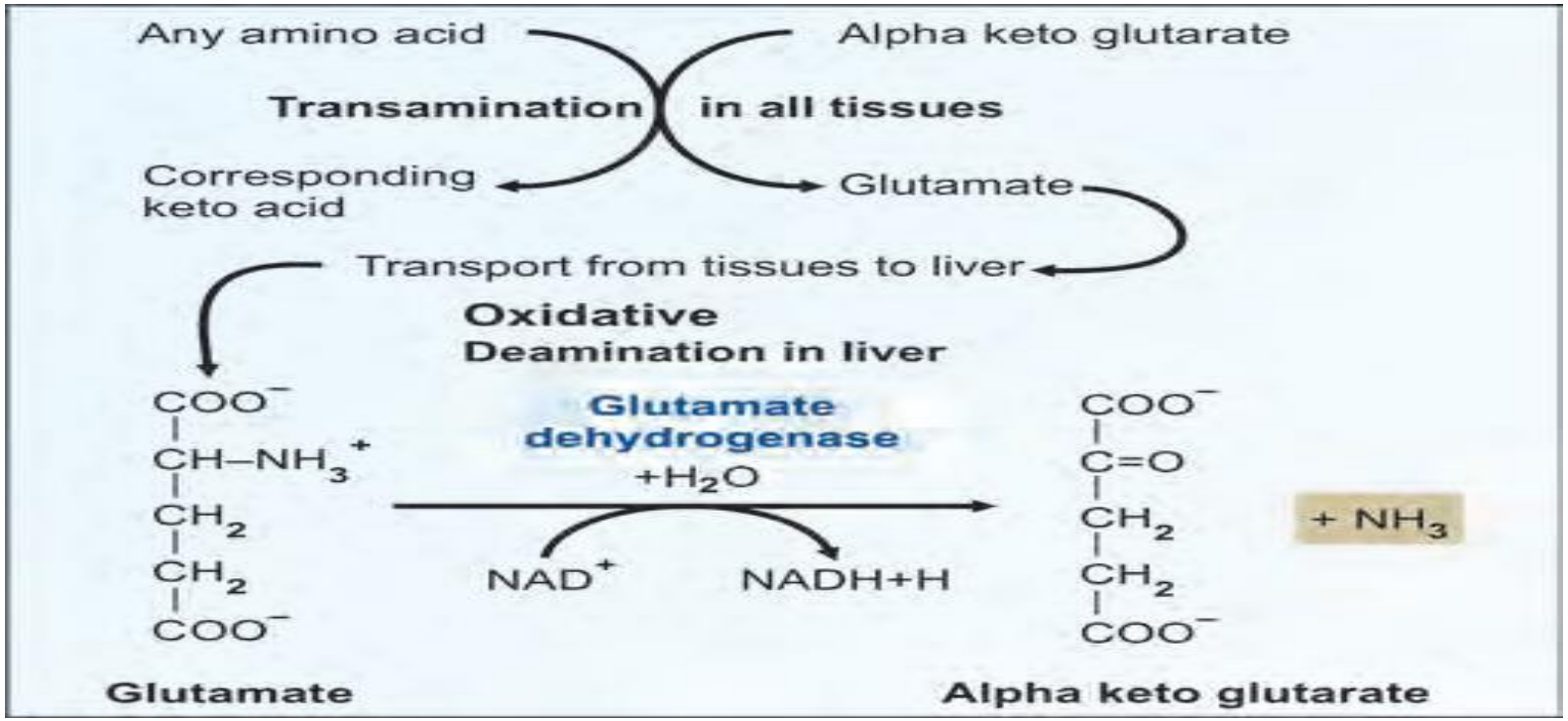


Fig: Transamination + deamination = transdeamination

Formation of Carbamino Compound

Carbon dioxide adds to the alpha amino group to form carbamino compounds

Mechanism for transport of carbon dioxide from tissues to the lungs

Due to side chains

Transmethylation

Methyl group of methionine, after activation transferred to an acceptor

Ester formation by the OH group

Hydroxy amino acids form esters with phosphoric acid to give phosphoproteins- O-glycosidic bonds

Similar to formation of glycoproteins

Reaction of amide groups of Glutamine and Asparagine- N-glycosidic bonds with carbohydrates

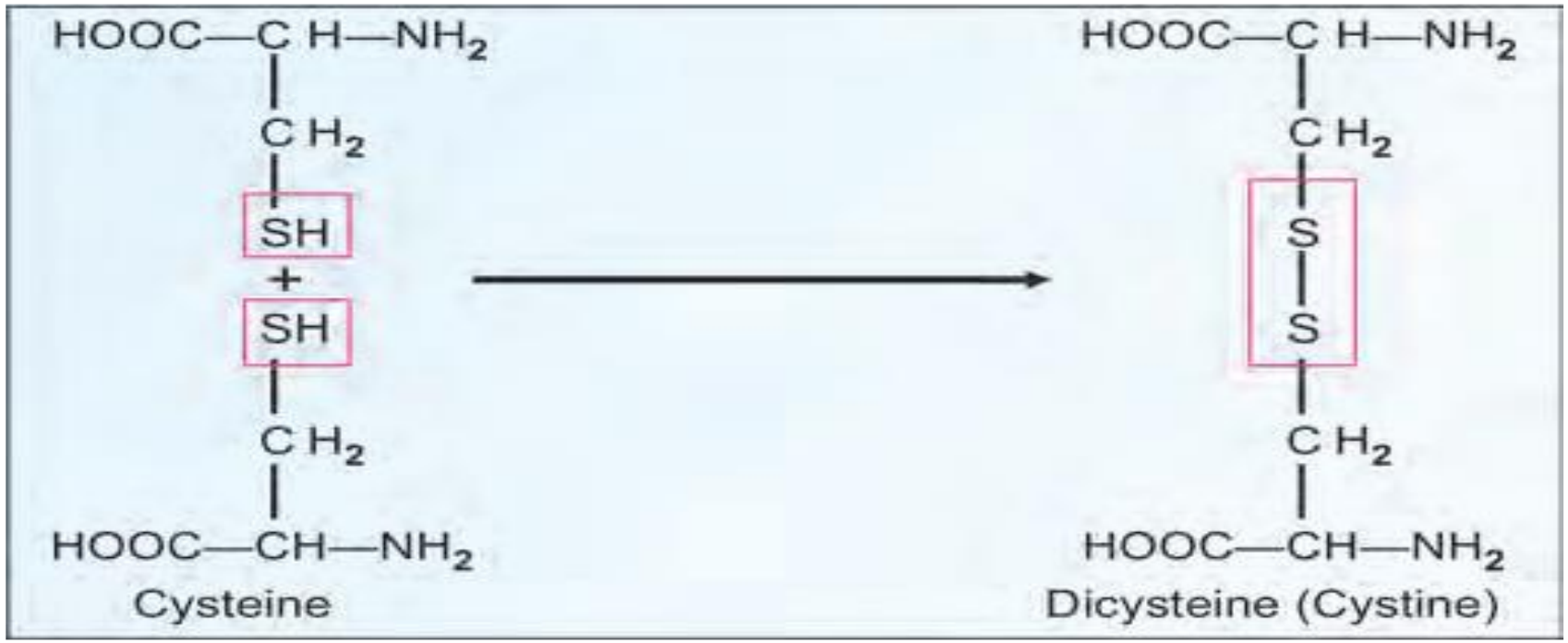
Reaction of SH group

Cysteine forming a disulfide bond with another cysteine residue.

Two cysteine residues connect two polypeptide chains-inter chain disulfide bonds or links

Dimer of two cysteine residues (Cystine or Dicysteine)

FORMATION OF DISULFIDE BRIDGES



Amino acid derivatives of Importance

- Gamma amino butyric acid (GABA)-derivative of glutamic acid and dopamine (derived from tyrosine) is a neurotransmitter
- Histamine synthesized from histidine- a mediator of allergic reactions
- Thyroxine (from tyrosine an important thyroid hormone
- Ornithine and citrulline are derivatives of arginine and are essential for urea synthesis

PEPTIDE BOND FORMATION

Alpha carboxyl group of one amino acid reacts with alpha amino group of another amino acid to form a peptide bond or CO-NH bridge

Proteins are made by polymerization of amino acids through peptide bonds.

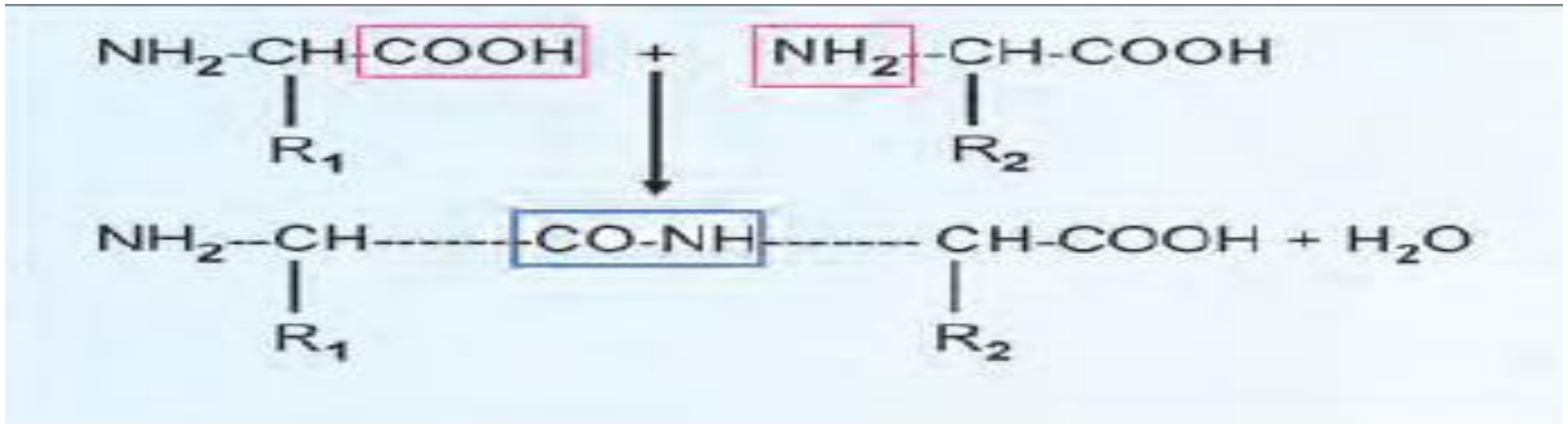


Fig: Peptide bond formation

Reaction	*Answered by specific group*
1. Ninhydrin	Alpha amino group
2. Biuret reaction	Peptide bonds
3. Xanthoproteic test	Benzene ring (Phe,Tyr, Trp)
4. Millon's test	Phenol (Tyrosine)
5. Aldehyde test	Indole (Tryptophan)
6. Sakaguchi's test	Guanidinium (Arginine)
7. Sulfur test	Sulfhydryl (Cysteine)
8. Nitroprusside test	Sulfhydryl (Cysteine)
9. Pauly's test	Imidazole (Histidine)

Table: Colour reactions of amino acids

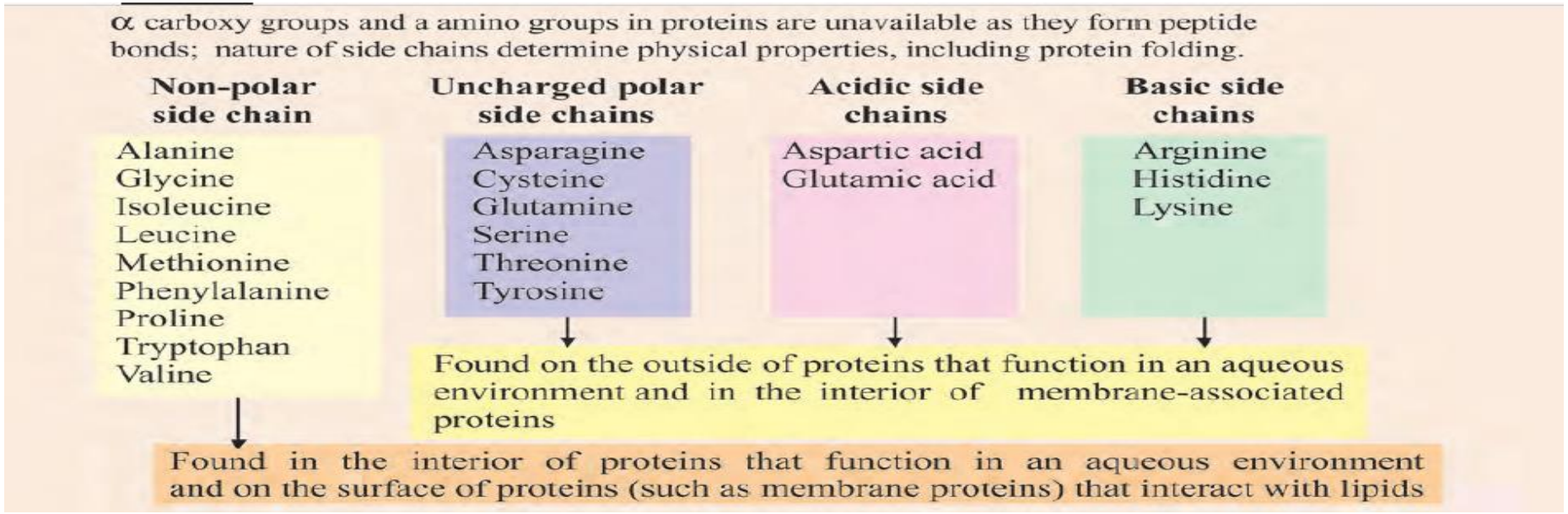


Table: Importance of side chains of amino acids

Selenocysteine-21st amino acid present in human proteins. An amino acid is given the individual status, when it is incorporated as such into proteins during protein biosynthesis, and having a separate codon. Selenocysteine is present in some enzymes. Instead of SH (sulfhydryl) group in cysteine, SeH (selenium) is present in selenocysteine. Abbreviated as SeCys or SeC.

About 25 proteins incorporate selenocysteine.

Pyrrolysine (Pyl)-the 22nd amino acid.

It is a lysine in an amide linkage to substituted-pyrroline-5-carboxylate. Present in methyl transferase enzymes of certain bacteria.

Both SeC and Pyl are encoded by codons that normally function as stop signals.