



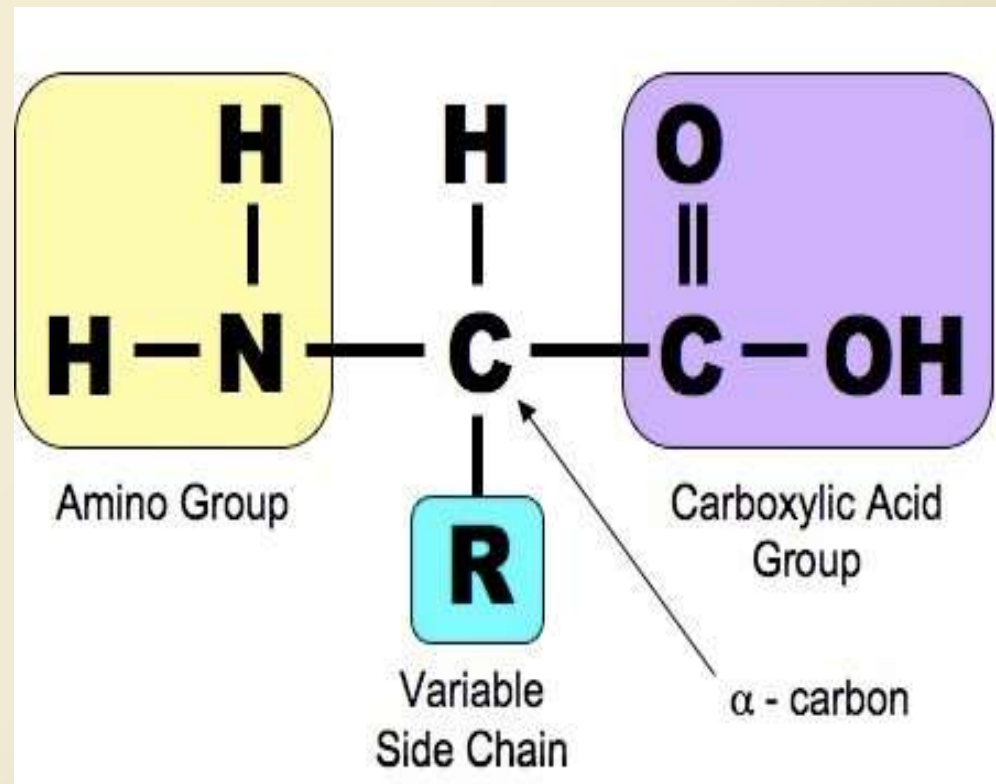
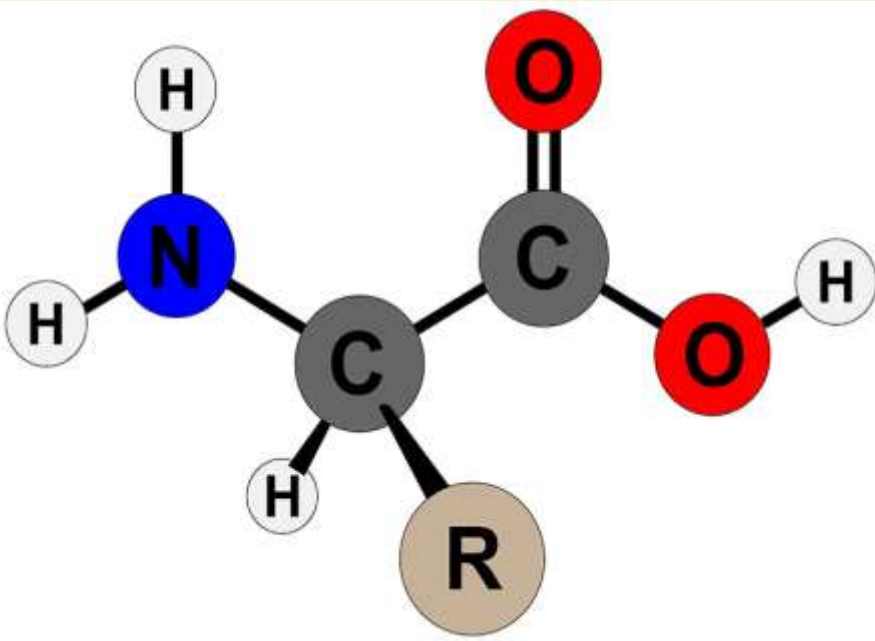
AMINO ACIDS

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Department of Microbiology
Shivaji Science College, Nagpur

STANDARD AMINO ACIDS

- ❑ Amino acids are the ‘building blocks of proteins’.
- ❑ There are 20 standard amino acids called as ‘magic 20’.
- ❑ The structures of 20 amino acids are discussed along with their abbreviations, symbols and properties.
- ❑ As the R group (side chains) of the amino acids are variable, hence the R groups are highlighted in the following slides for all the amino acids.

General structure of Amino acid

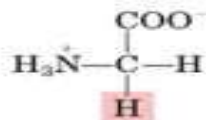


□ Each amino acid is a nitrogenous compound having both **an acidic carboxyl (-COOH)** and a **basic amino (-NH₂)** group. **R** stands for the **side chains** that are different for each amino acid. R can be as simple as a hydrogen atom (H) or a methyl group (-CH₃) or a more complex structure.

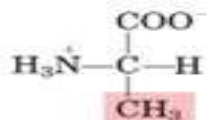
□ The **first carbon is the part of the carboxyl group**. The **second carbon**, to which is attached the amino group, is called the **α-carbon**. The α-carbon of most amino acids is joined by covalent bonds to 4 different groups.

Structures of amino acids

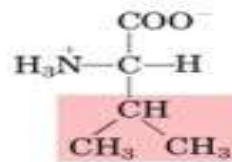
Nonpolar, aliphatic R groups



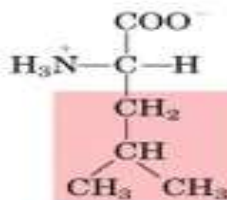
Glycine



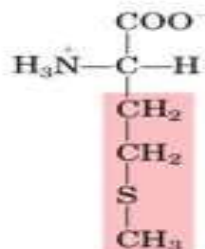
Alanine



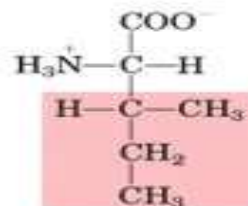
Valine



Leucine

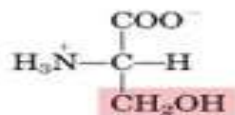


Methionine

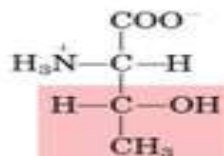


Isoleucine

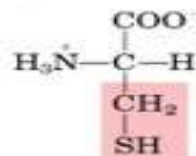
Polar, uncharged R groups



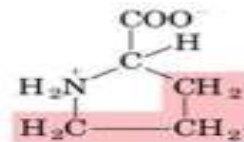
Serine



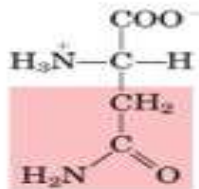
Threonine



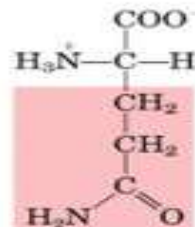
Cysteine



Proline



Asparagine

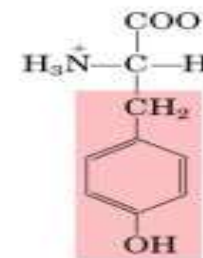


Glutamine

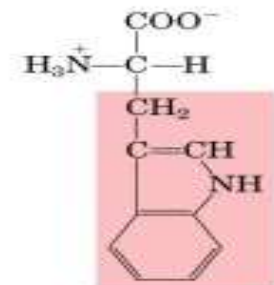
Aromatic R groups



Phenylalanine

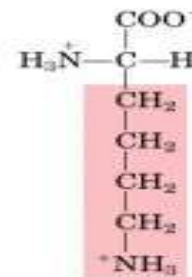


Tyrosine

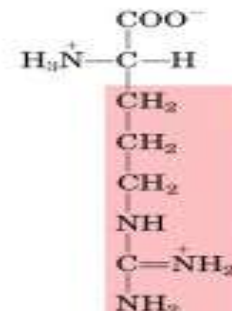


Tryptophan

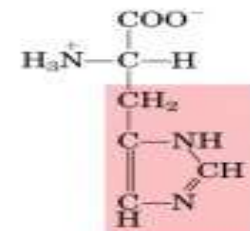
Positively charged R groups



Lysine

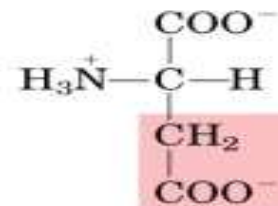


Arginine

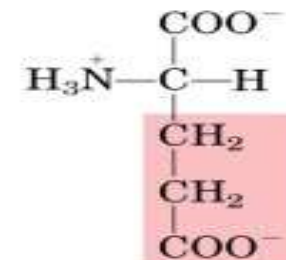


Histidine

Negatively charged R groups



Aspartate



Glutamate

1) **GLYCINE:**

ABBREVIATION: Gly

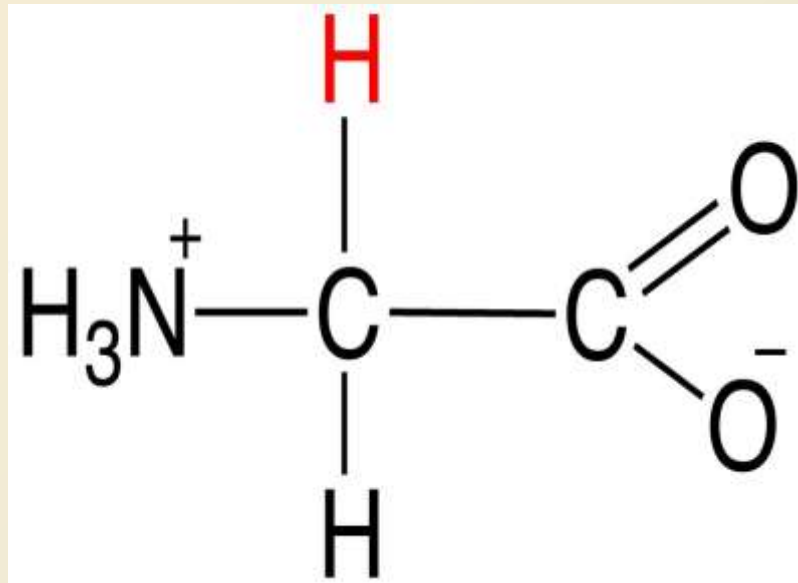
SYMBOL : G

PROPERTY OF R GROUP: Non polar, aliphatic

PROPERTIES:

- simplest amino acid and the only one lacking an asymmetric α -carbon atom.
- Sweet in taste and present in abundance in scleroproteins (keratin, collagen)

STRUCTURE:



2) ALANINE

ABBREVIATION: Ala

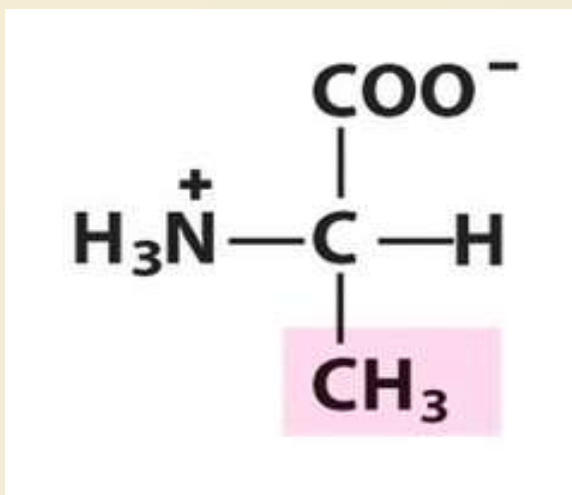
SYMBOL: A

PROPERTY OF R GROUP: Non polar, aliphatic

PROPERTIES:

- first isolated from silk fibroin
- parent substance of all amino acids except glycine.
- least hydrophobic of all 8 amino acids with non polar side chains.

STRUCTURE:



3) **PROLINE:**

ABBREVIATION: Pro

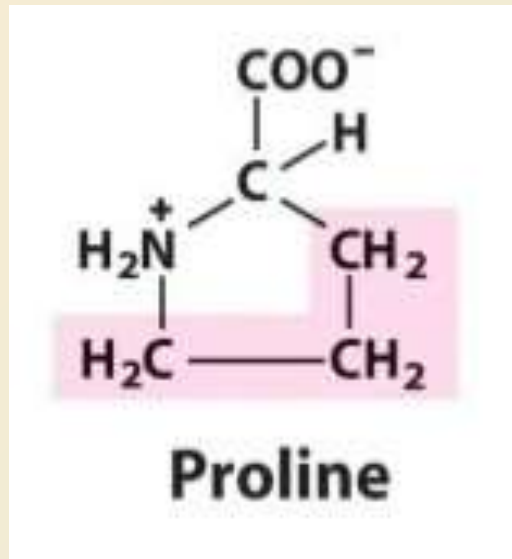
SYMBOL: P

PROPERTY OF R GROUP: non polar, aliphatic

PROPERTIES:

- present in zein from corn and gelatin are relatively high in proline content.
- It is a cyclized derivative of glutamic acid.

STRUCTURE:



4) **VALINE** :

ABBREVIATION: Val

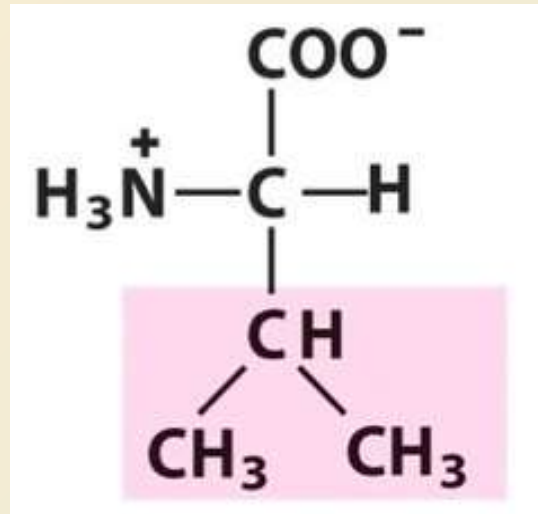
SYMBOL: V

PROPERTY OF R GROUP: Non polar, aliphatic

PROPERTIES:

Widely distributed but rarely occurs in amounts exceeding 10%

STRUCTURE:



5) **LEUCINE:**

ABBREVIATION: Leu

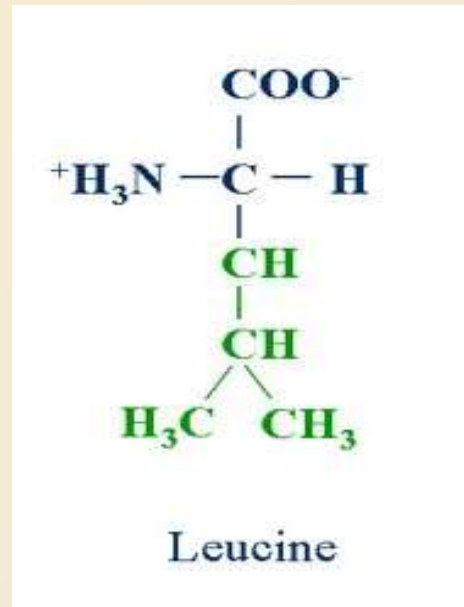
SYMBOL: L

PROPERTY OF R GROUP: Non polar, aliphatic

PROPERTIES:

- Its presence in proteins was shown, by Proust in 1819.
- first isolated from cheese, but later was obtained in purer form from hydrolysates of wool.

STRUCTURE:



6) **ISOLEUCINE:**

ABBREVIATION: Ile

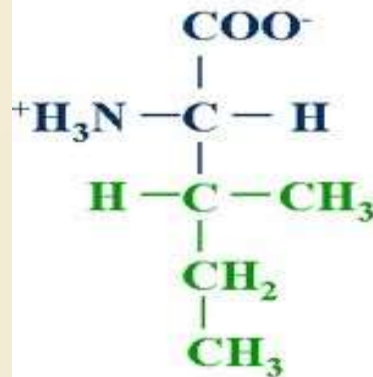
SYMBOL: I

PROPERTY OF R GROUP: non polar , aliphatic

PROPERTIES:

- an isomer of leucine and is also a branched chain amino acid.
- It has 2 asymmetric carbon atoms and thus occurs in 4 stereoisomeric forms.

STRUCTURE:



Isoleucine

7) **METHIONINE:**

ABBREVIATION: Met

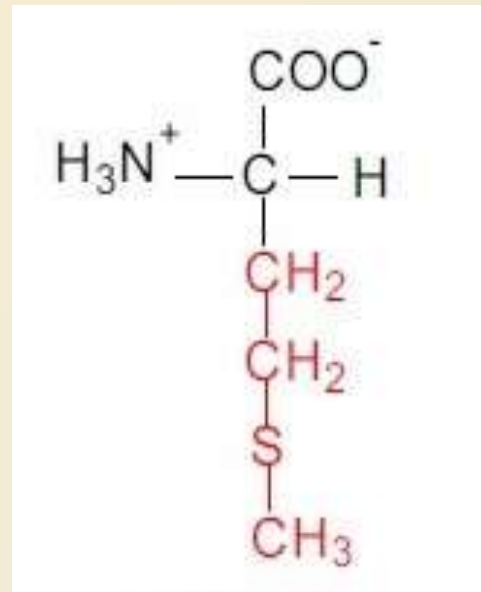
SYMBOL: M

PROPERTY OF R GROUP: non polar, aliphatic

PROPERTIES:

- Possess ether linkage
- Acts as a donor of methyl groups
- Methylation product of homocysteine

STRUCTURE:



8) **PHENYLALANINE:**

ABBREVIATION: Phe

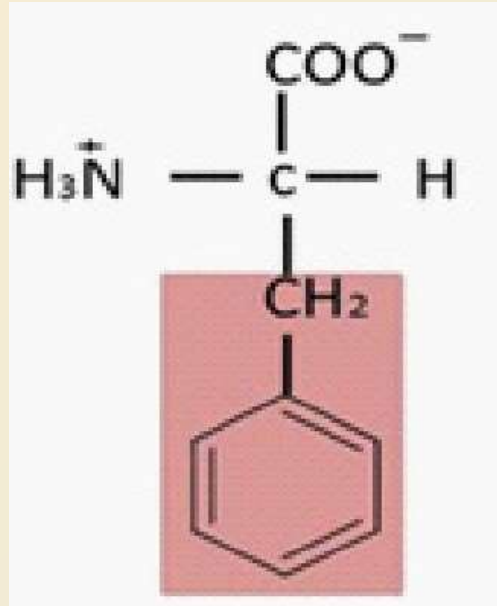
SYMBOL: F

PROPERTY OF R GROUP: Aromatic

PROPERTIES:

- It is one of the two common, clearly benzenoid amino acids and closely resembles tyrosine in structure.
- It also cannot be formed in animals because of its aromatic ring.

STRUCTURE:



9) **TYROSINE:**

ABBREVIATION: Tyr

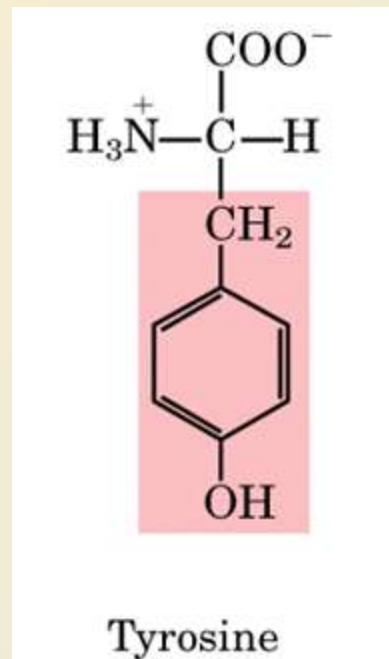
SYMBOL: Y

PROPERTY OF R GROUP: Aromatic

PROPERTIES:

- aromatic amino acids isolated from cheese.
- Phenolic group is weakly acidic and destroyed during acid hydrolysis.

STRUCTURE:



10) **TRYPTOPHAN**

ABBREVIATION: Trp

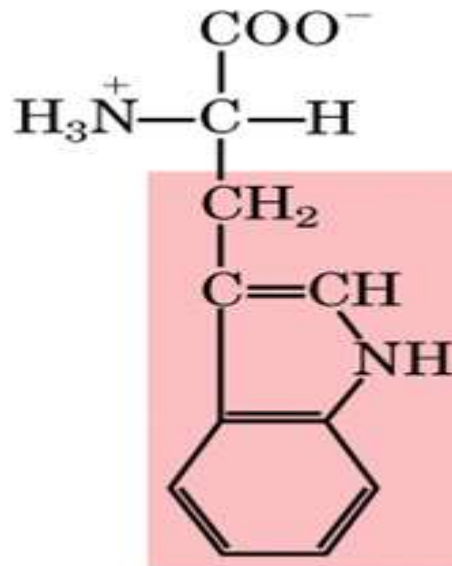
SYMBOL: W

PROPERTY OF R GROUP: Aromatic

PROPERTIES:

- It was discovered in 1901 .
- Tryptophan is the most complex amino acid found in proteins. It is a heterocyclic amino acid and is a derivative of indole.

STRUCTURE:



Tryptophan

11) **SERINE**

ABBREVIATION: Ser

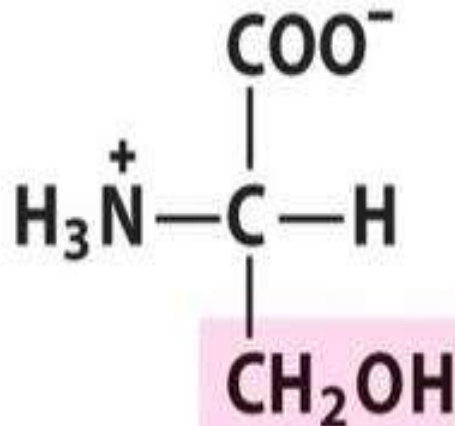
SYMBOL: S

PROPERTY OF R GROUP: Polar, uncharged

PROPERTIES:

- first obtained from silk protein, sericin.
- contains an alcoholic hydroxyl group which participates in ester formation.

STRUCTURE:



12) **THREONINE:**

ABBREVIATION: Thr

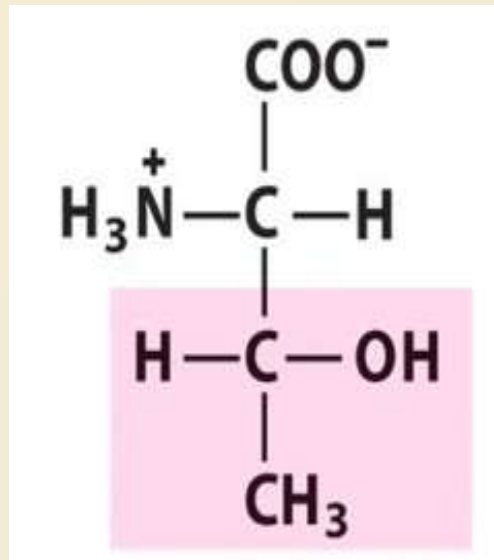
SYMBOL: T

PROPERTY OF R GROUP: Polar, uncharged

PROPERTIES:

- next higher homologue to serine.
- Consists of 2 asymmetric carbon and 4 stereoisomeric forms.

STRUCTURE:



13) **CYSTEINE:**

ABBREVIATION: Cys

SYMBOL: C

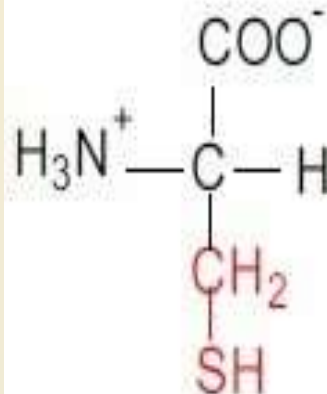
PROPERTY OF R GROUP: Polar , uncharged

PROPERTIES:

- contains sulfhydryl (SH) group which is quite reactive and easily dehydrogenated. When it is dehydrogenated (i.e., oxidized), two molecules join to form the amino acid cystine.

- Fibrous proteins such as keratin from hair are especially rich in cystine (12%).

STRUCTURE:



14) ASPARGINE

ABBREVIATION: Asn

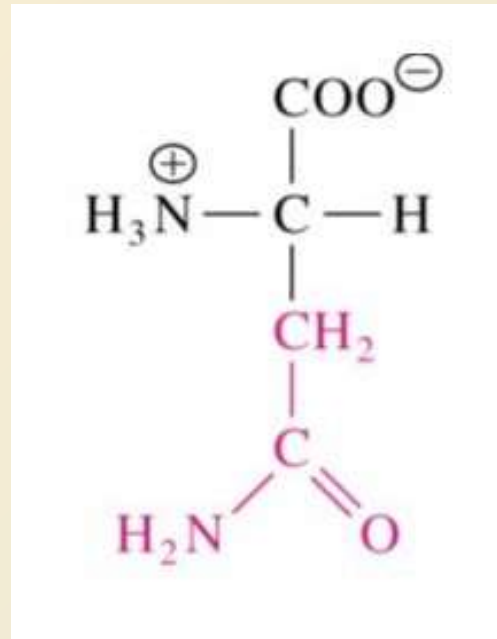
SYMBOL: N

PROPERTY OF R GROUP: Polar, uncharged

PROPERTIES:

- Isolated from *Asparagus* plant and hence named.
- β -amide of aspartic acid.

STRUCTURE:



15) **GLUTAMINE**

ABBREVIATION: Gln

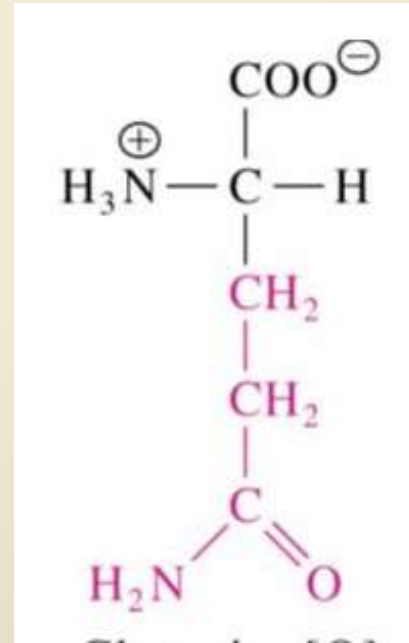
SYMBOL: Q

PROPERTY OF R GROUP: Polar, uncharged

PROPERTIES:

- It is the homologue of asparagine.
- γ -amide of glutamic acid and has been isolated from proteins after enzymic hydrolysis. Free glutamine is found in many animal and plant tissues.

STRUCTURE:



16) **LYSINE**

ABBREVIATION: Lys

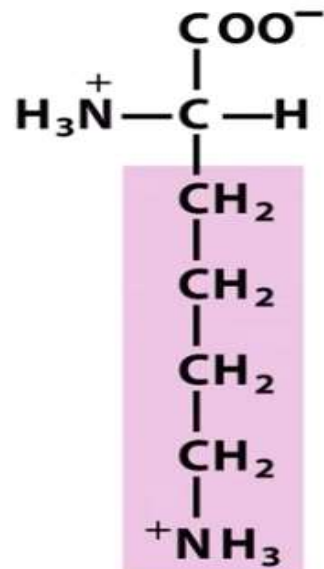
SYMBOL: K

PROPERTY OF R GROUP: Positively charged

PROPERTIES:

- Possess second amino group at ϵ -position. Lysine is generally abundant in animal proteins.
- Pulses contain good amount of lysine whereas cereals lack in it

STRUCTURE:



17) ARGININE

ABBREVIATION: Arg

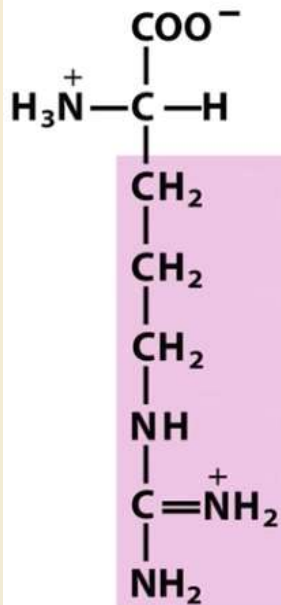
SYMBOL: R

PROPERTY OF R GROUP: Positively charged

PROPERTIES:

- Abundant in highly basic proteins of the cell nucleus (histones) and in sperm proteins, such as the protamines.
- Possess guanidinium group, hence more basic than lysine.

STRUCTURE:



18) HISTIDINE

ABBREVIATION: His

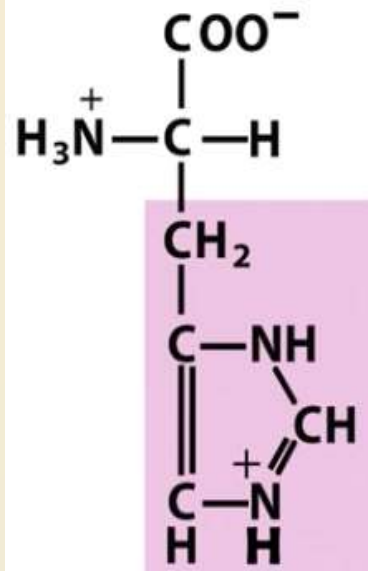
SYMBOL: H

PROPERTY OF R GROUP: Positively charged

PROPERTIES:

- It contains a weakly basic imidazolium R group.
- Hemoglobin, protamines and histones contain relatively large amounts.

STRUCTURE:



19) **ASPARTATE**

ABBREVIATION: Asp

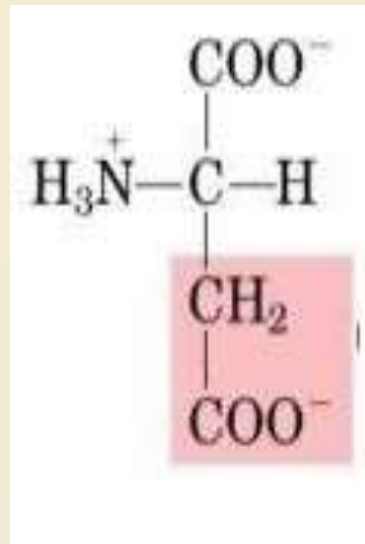
SYMBOL: D

PROPERTY OF R GROUP: negatively charged

PROPERTIES:

- Its presence in protein was discovered by Ritthausen in 1868.
- It is the parent compound of asparagine.

STRUCTURE:



20) **GLUTAMATE**

ABBREVIATION: Glu

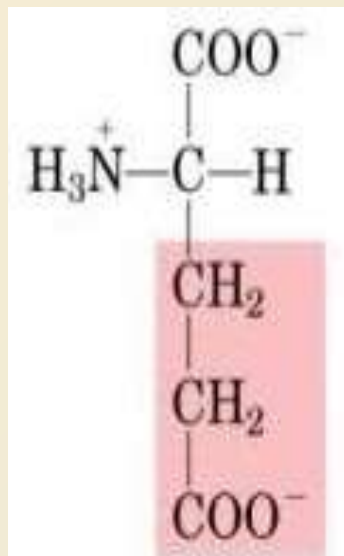
SYMBOL: E

PROPERTY OF R GROUP: Negatively charged

PROPERTIES:

- Its presence in protein was discovered also by Ritthausen in 1866.
- It was found in wheat gluten, hence so named. It is the parent compound of glutamine and occurs widely in proteins.

STRUCTURE:



UNCOMMON AMINO ACIDS

In addition to the 20 amino acids, proteins may contain residues created by modification of common residues already incorporated into a polypeptide. The few uncommon acids are listed below:

1) 4-hydroxyproline

PROPERTIES: found in plant cell wall proteins and also found in collagen.

2) 5-hydroxylysine

PROPERTIES: found in collagen, a fibrous protein of connective tissue

3) 6-N-Methyllysine

PROPERTIES: Constituent of myosin, a contractile protein of muscle

4) γ -carboxyglutamate

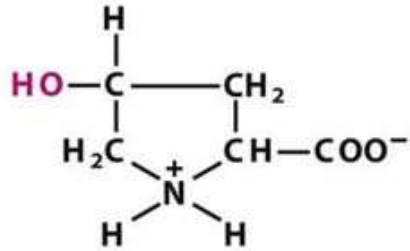
PROPERTIES: found in the blood clotting protein prothrombin and in certain other proteins that bind Ca^{2+} as part of their biological function.

5) Desmosine

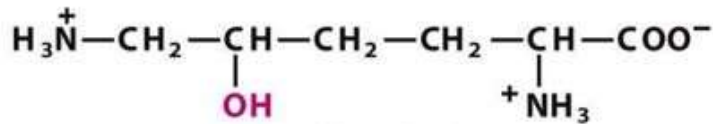
PROPERTIES: a derivative of four Lys residues, which is found in the fibrous protein elastin.

6) Selenocysteine

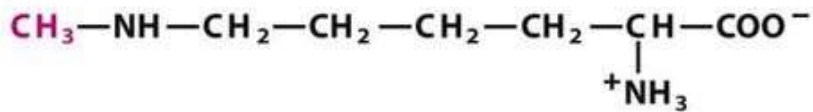
PROPERTIES: contains selenium rather than the sulfur of cysteine.



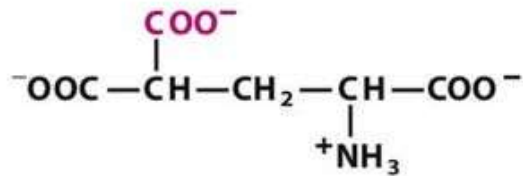
4-Hydroxyproline



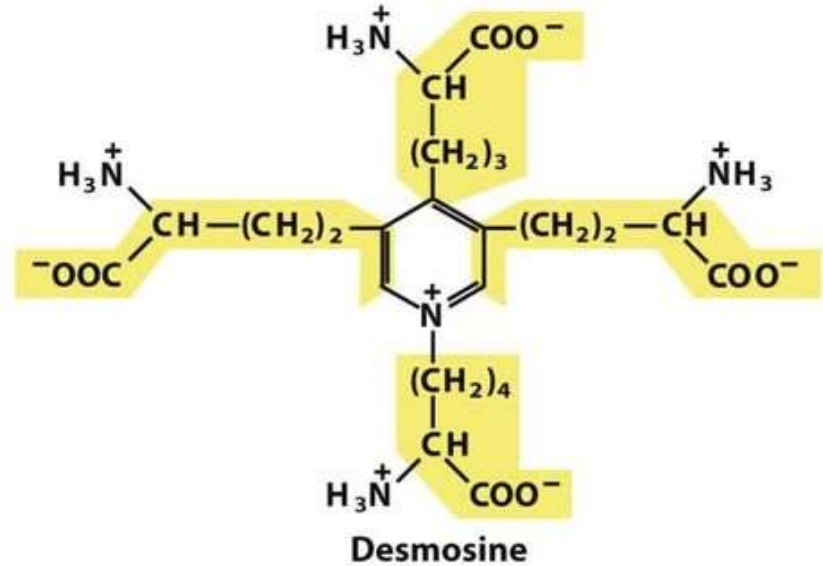
5-Hydroxylysine



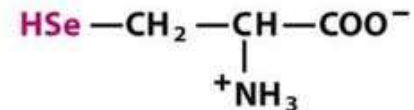
6-N-Methyllysine



γ -Carboxyglutamate



Desmosine



Selenocysteine

Figure 3-8a

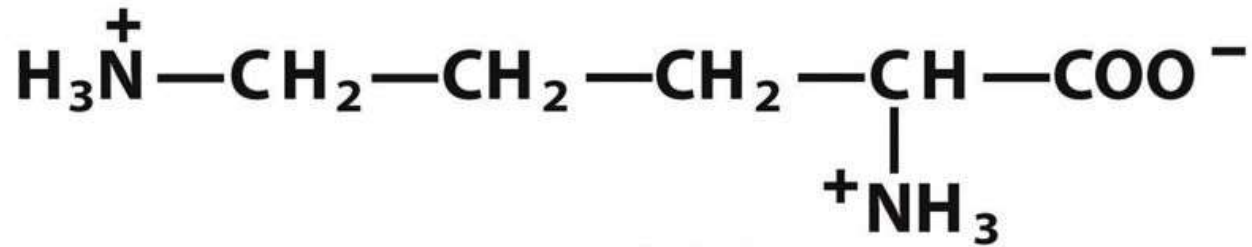
Lehninger Principles of Biochemistry, Fifth Edition

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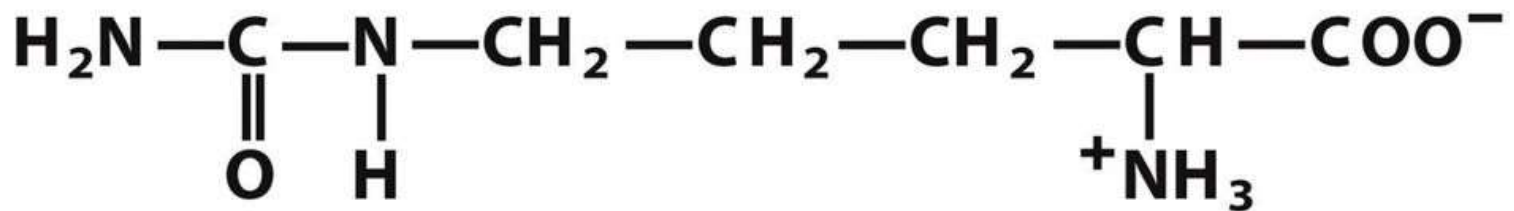
❑ Some 300 additional amino acids have been found in cells. They have a variety of functions but are not all constituents of proteins.

❑ **Ornithine** and **citrulline** deserve special note because they are key intermediates (metabolites) in the biosynthesis of arginine and in the urea cycle.

The structures of ornithine and citrulline are as follows:



Ornithine



Citrulline

Figure 3-8c

Lehninger Principles of Biochemistry, Fifth Edition

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SHORTCUTS TO REMEMBER AMINO ACIDS:

GAVLIMP – Non polar R groups

FYW – Aromatic R groups (Flowers for Your Wife)

STNQC – uncharged but polar R groups (Quality Control on StaTioN)

HKR – Positively charged (HrithiK Roshan)

DE – Negatively charged