Chapter:

Biochemistry

Aminoacids, Proteins & Nucleic Acids

Prepared By:

M Junaid Sahoo

Lecturer Chemistry in HED (Govt.College)

Chemistry with MJS

Chemistry Preparation by MJS

Amino Acids

The proteins in all living species from bacteria to humans, are made up of 20 amino acids.

Amino acids contain two group

Amino group = $-NH_2$

Carboxylic group = $-COOH$

Classification Of Aminoacids:

Aminoacids can be classified in various ways.

(i) Either Acidic, Basic or Neutral

(ii) Either Non-polar OR polar R group.
- polar → +vely charged
- polar → -vely charged

(iii) Essential or NON Essential -

(iv) α- β- γ, (6) dalta Aminoacids-

✓ Classification-A (AT pH = 7)

- Acidic Aminoacids: (2 → out of 20 A.Acid)
  - having polar side chain $-COOH$ group > $-NH_2$ group

e.g glutamic Acid, Aspartic acid etc.

- Basic Amino acids: (3 → out of 20)

  ↓ having polar side chain

  Amino groups > carboxylic group

  e.g. Arginine, lysine, ~~etc~~, Histidine

- Neutral Amino acids: (15 out of 20)

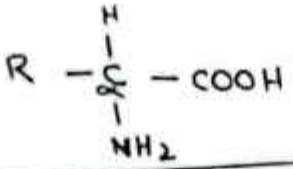
  ↓ (may have polar or NON polar side chain)

  Amino groups = carboxylic group

✓ classification- B :

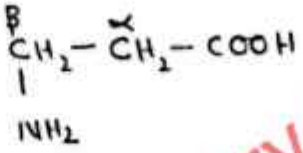
General formula

∴ α-Amino Acid

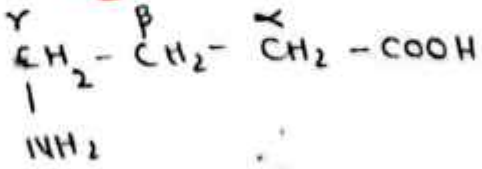


∴ Almost all naturally occuring Amino acids are α-A·Acids

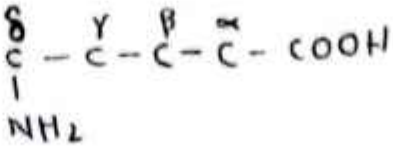
∴ β-Amino acid



∴ γ- Amino acid



∴ δ- Amino acid



Classification- C :

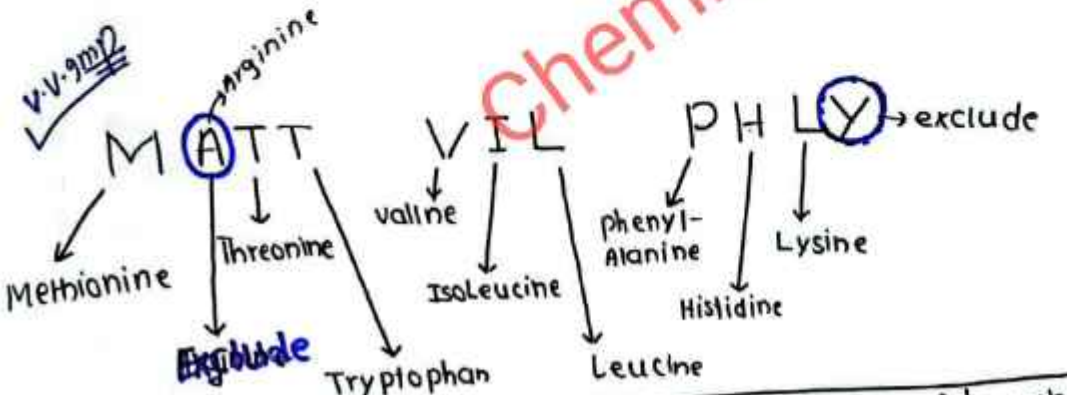
(i) Essential Aminoacids : (Out of 20 → 9 are essential Amino acids)

↓

which can not be prepared by our body.

→ defficiency of essential Amino acids may cause diseases

: Trick to learn essential-Aminoacids:



NOTE: Arginine is non-essential Aminoacid which is called a (conditionally-essential Amino acid)

(ii) NON- Essential Amino acids :

↓

Which can be synthesized through our body called non-Essential Amino acids

→ Left 11 Amino acids are called NON-Essential but out of 11 → 6 Amino acids are conditionally essential Amino acids.

: Conditionally Essential Aminoacids: → (Also in NON-essential catagory)

(Are six)

↓

Their synthesis can be limited under special pathophysiological conditions such as prematurity in the infant or individuals in severe catabolic distress or sometimes during illness.

✓: NON essential Amino Acids: → (11 out of 20)

TRICK to learn: conditionally essential Amino acids

AGG PTC GAAAS

AGG → Glutamine, Arginine, Glycine

PTC → proline, Tyrosine, Cysteine

GAAAS → Glutamate, Alanine, Asparagine, Aspartate, serine

NOTE

Arginine is a non-essential A.Acid which is called a conditionally-essential amino acid. Arginine is abundant in protamines and histones- both proteins associated with Nucleic Acids and was 1st isolated in 1895 from Animal horn

Classification-D: → (classification based on polarity & Non polarity of side chain (R))

4-catogories

∴ NON polar = 9 ✓

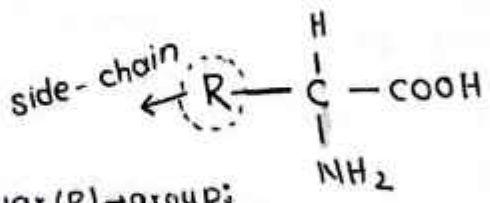
∴ polar = 11 ✓

~~Polar~~

(i) Neutral NON-polar Amino acids: → (9)

(Hydrophobic)

General Formula



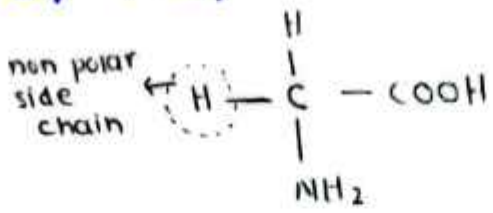
TRICK for NON-polar (R) → group:

GAPP → Glycine, Alanine, phenyl-Alanine, proline

VIL → valine, Leucine, Isoleucine

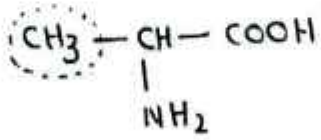
MAT → Methionine, Tryptophan (exclude A)

Glycine : (G) → Gly → major A. Acid found in gelatin → sweet taste



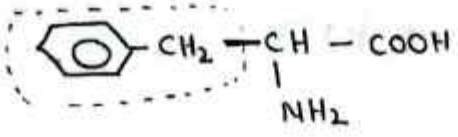
∴ only Amino acid which has no-chiral carbon
∴ simplest Aminoacid

Alanine : (A) → Ala



- Simplest A. Acid after glycine.
- It convert glucose into Energy
- Eliminate excess toxins from your liver.

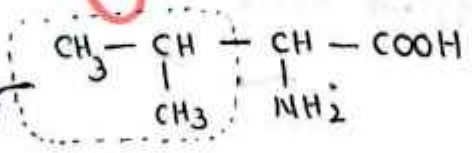
phenyl Alanine : (F) → Phe



- → classified as aromatic aminoacid.
- It is found in mother milk & no. of foods.
- It is studied for its effects on depression, pain & skin disorder.

valine : (V) → Val

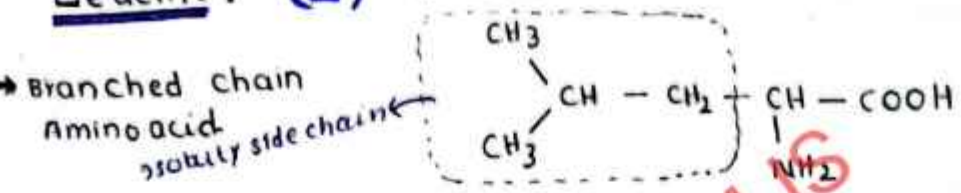
→ Branched chain Amino acid



- First isolated from casein in 1901 by Emil Fischer
- The name comes from valaric acid (5-C)

Leucine: (L) → Leu

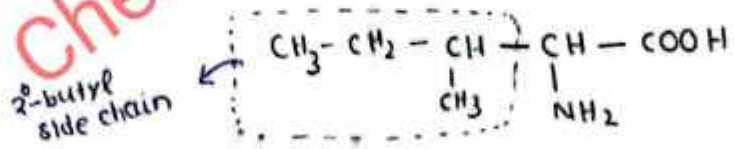
→ Branched chain Amino acid



isobutyl side chain

- It is encoded by the codons UUA, UUG, CUU etc.

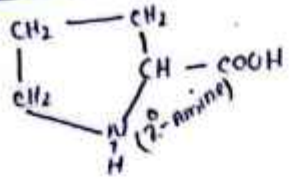
ISO-Leucine: (I) → Ile

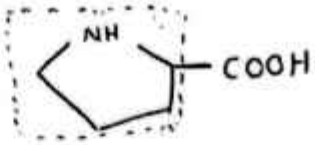


2°-butyl side chain

- An essential Amino acid bic most animals can not synthesize branched-chain aminoacids
- particularly recommended to professional athletes & body builders
- primary function is to boost up energy level

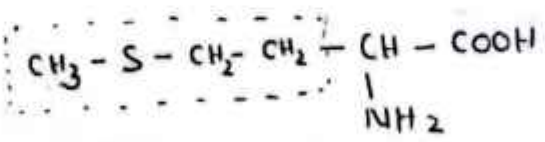
proline: (P) → Pro





- → contains a 2°- amine group, referred to as an α- imino acid
- plays important Role in molecular Recognition particularly intracellular signalling.

Methionine: (M) → Met

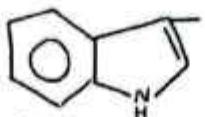


- side chain functions as a methyl group donar
- produce cystein & other Sulphur-containg Aminoacids

Tryptophan: (W) → Trp

- Its purpose is to balance the N in adults & growth in infants

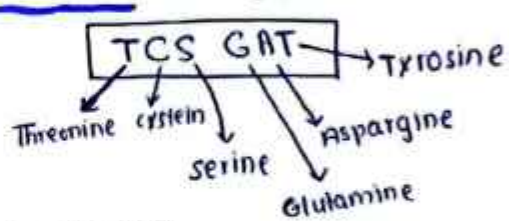
→ Aromatic Amino acid -



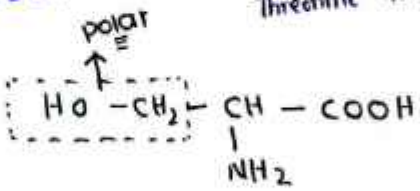
- It creates niacin → which create neurotransmitter serotonin

---

(ii) Neutral polar Amino-acids: → (6)

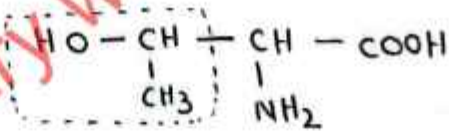


Serine: (S) → Ser



- It is found at the active site of many enzymes.
- Important in metabolism & participates in the biosynthesis of purines & pyrimidines
- It is precursor to several A.acids e.g glxeine cysteine & Tryptophan in bacteria.

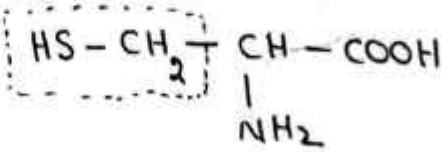
Threonine: (T) → Thr



- Named for its similarity to the sugar threose
- It supports CNS, cardiovascular, liver & Immune Functioning

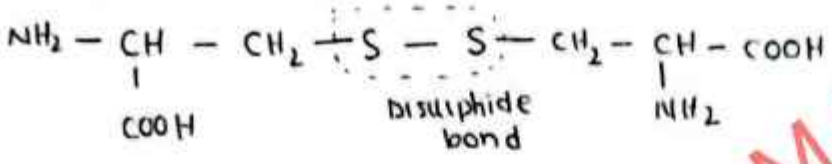
Cysteine: (C) → Cys

- play imp. role in communication btw immune systems cells

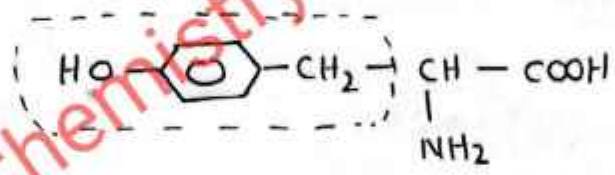


- oxidation of two cysteine molecules linked by di-sulphur bond → yields cystine

Cystine



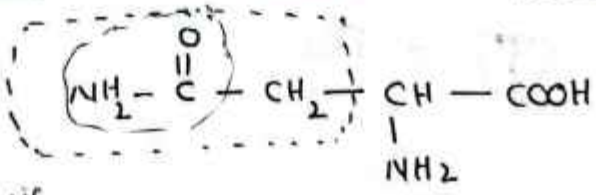
Tyrosine : (Y) → Tyr



- Aromatic Amino acid-
- play imp. Role in photosynthesis-
- produce brain chemical that help nerve cells communicate.

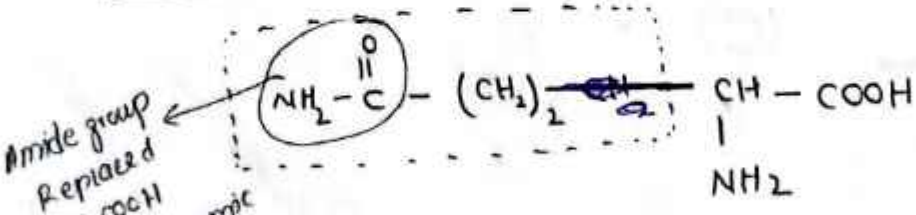
★ Asparagine: (N) → Asn

↳ 1st A.Acid that was isolated in 1806 → was found in asparagus juice.



- It is amide of aspartic acid
- play imp. Rule in the synthesis of NH
- Required for the development & Function of the brain

Glutamine: (Q) → Gln



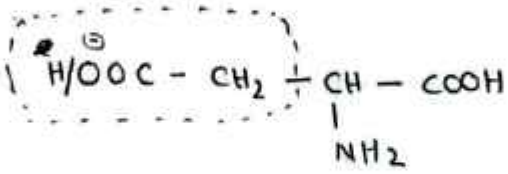
- Amide of Glutamic acid
- critical part of immune system
- play imp. Role in intestinal health.

(iii) Acidic polar Amino acids: → (2)

↓

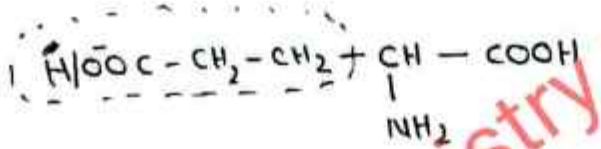
Amino acids with −vely charged R− Group

Aspartic acid: (D) → Asp



- carboxylic groups are ionized at physiological PH; Also known as aspartate
- play imp. Role in Harmone production & release

Glutamic acid: (E) → Glu



- carboxyl groups are ionized at physiological PH; Also known as Glutamate
- important Neurotransmitter.

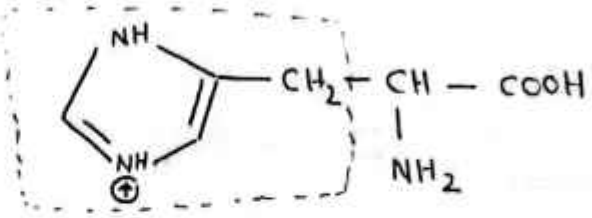
★ Classification of 20 Amino acids:

- → Acidic A.A = 2
- → Basic A.A = 3
- → Neutral A.A = 15
- → polar A.A = 11
- → Non-polar A.A = 9
- → Essential A.A = 9
- → Non-essential A.A = 11
- → α- A.A (all are α A.A) = 20
- → Optically inactive = 1 (Glycine)
- → Aromatic A.A = 3
- → Alephatic A.A = 17
- → Ring containing = 5
- → S- containing A.A = 2

(iv) Basic polar Amino-acids: → (3)

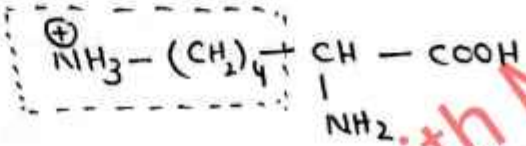
↓ Amino acids with +vely charged R-group

Histidine:



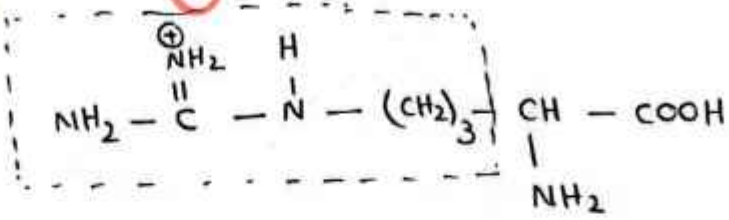
- has imidazole F. group.
- imidazole → common participant in enzyme catalysed Reaction
- It is vital in hemoglobin.

Lysine:



- Elevated in blood level cause disease called Hyperlysinemia

Arginine:



- Almost as strong base as NaOH
- ~~Hyperlysinemia is caused by the deficiency of enzym~~
- It is precursor for the synthesis of NO play imp. Role in Regulation of blood pressue
- imp. Role in the Removal of NH_3 from the body.

✓ configuration:

All amino acids except Glycine has chiral carbon has configuration and found in two forms (i) L-form (ii) d-form

NOTE

IMP ✓ The Amino acids found in proteins are (L- Amino acids)

✓ : physical properties:

(i) Amino acids are colourless, crystalline substances having sweet taste.

(ii) They melt with decomposition at higher temperature (more than 200°C)

(iii) They are soluble in H_2O but insoluble in organic solvent

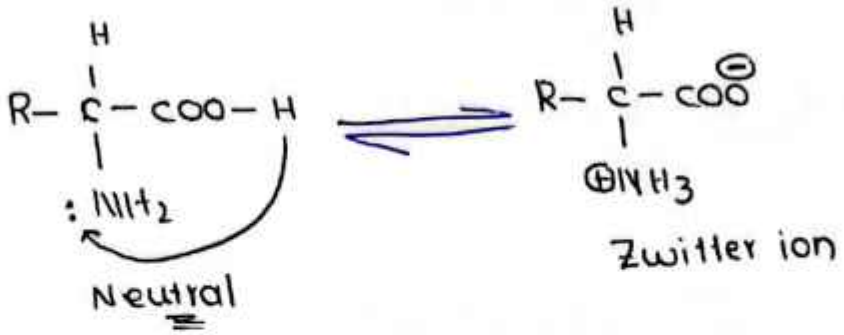
(iv) optical Activity:

Except Glycine All α- Amino acids are optically active and have a chiral centre They have two optical isomers called enantiomers (d & l form)

(v) Zwitter ion & Iso electric point:

$-NH_2$ group is basic & -COOH group is acidic. In Neutral solution it exists as an internal ionic form called a Zwitter ion where proton of COOH group transfer to

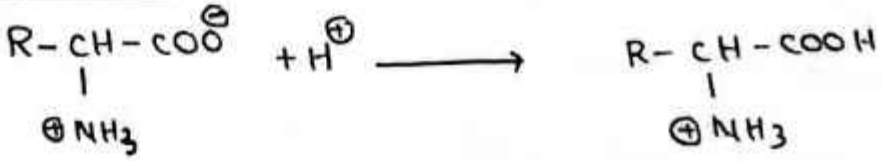
$-NH_2$ group to form inner salt Also called dipolar ion



Zwitter ion is dipolar charged but overall electrically neutral, → contains both +ve & -ve char

(vi) Acidic & Basic character:

Basic character: → Acceptance of H^+



Acidic character: → donation of H^+

Preparation of Amino Acids:

1) Amination of α-halo acids:

✓ $[R-CH_2COOH + Br_2 \xrightarrow{P} R-\underset{Br}{CH}-COOH + HBr]$

$$R-\underset{X}{\overset{\alpha}{C}H}-COOH + 2NH_3 \longrightarrow R-\underset{NH_2}{CH}-COOH + NH_4X$$

Example

① $CH_3-\underset{Br}{CH}-COOH + 2NH_3 \longrightarrow CH_3-\underset{NH_2}{CH}-COOH + NH_4Br$

α-bromo propionic acid

(Alanine)

② $\underset{Br}{CH_2}-COOH + 2NH_3 \longrightarrow \underset{NH_2}{CH_2}-COOH + NH_4Br$

Glycine

③ Lab preparation of glycine:

$$\underset{Cl}{CH_2}-COOH + 3NH_3 \xrightarrow{50^\circ C} \underset{NH_2}{CH_2}-COONH_4 + NH_4Cl$$

Ammonium salt of Glycine

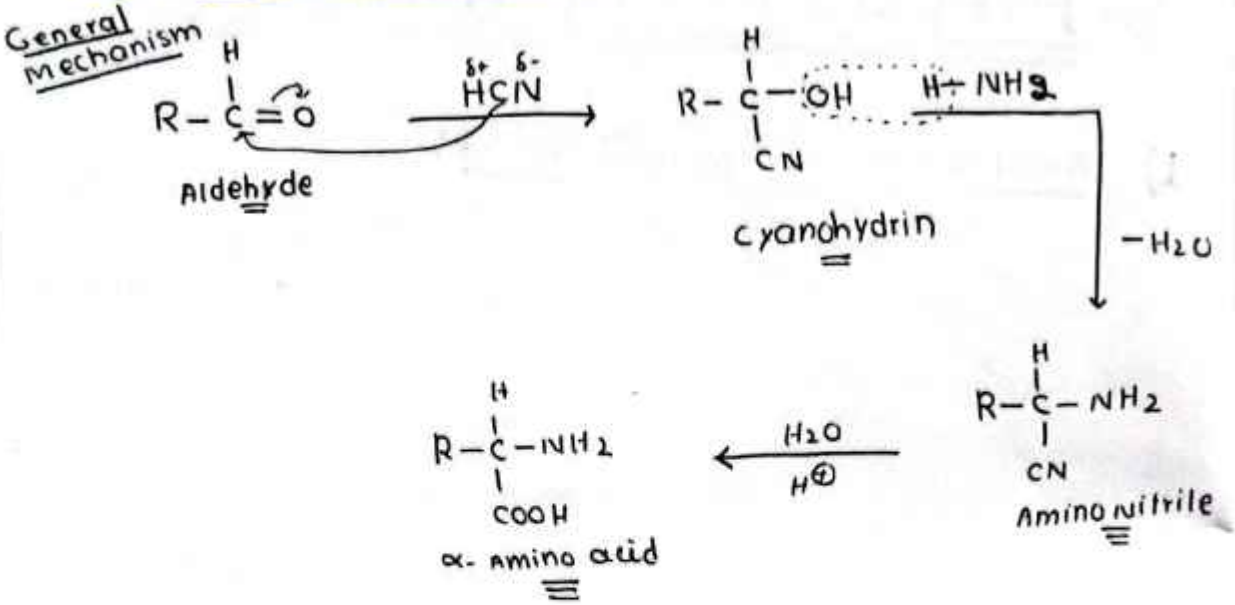
$$2\left[\underset{NH_2}{CH_2}-COONH_4\right] + CuCO_3 \xrightarrow{\text{Boiled}} (NH_2-CH_2COO)_2Cu + (NH_4)_2CO_3$$

$$(H_2N-CH_2COO)_2Cu + H_2S \longrightarrow 2H_2N-CH_2COOH + \underset{\text{Black ppt}}{CuS\downarrow}$$

Glycine

2) Strecker synthesis: (from Aldehydes)

General mechanism



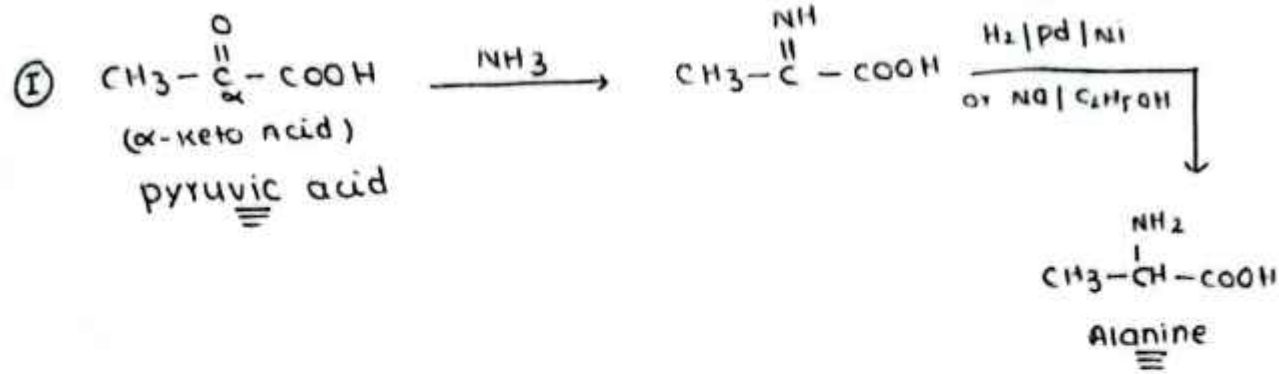
Examples

① $H-CHO$ (Formaldehyde) $\xrightarrow[\text{(ii) } NH_3]{\text{(i) } HCN}$ $CH_2(NH_2)(COOH)$ Glycine

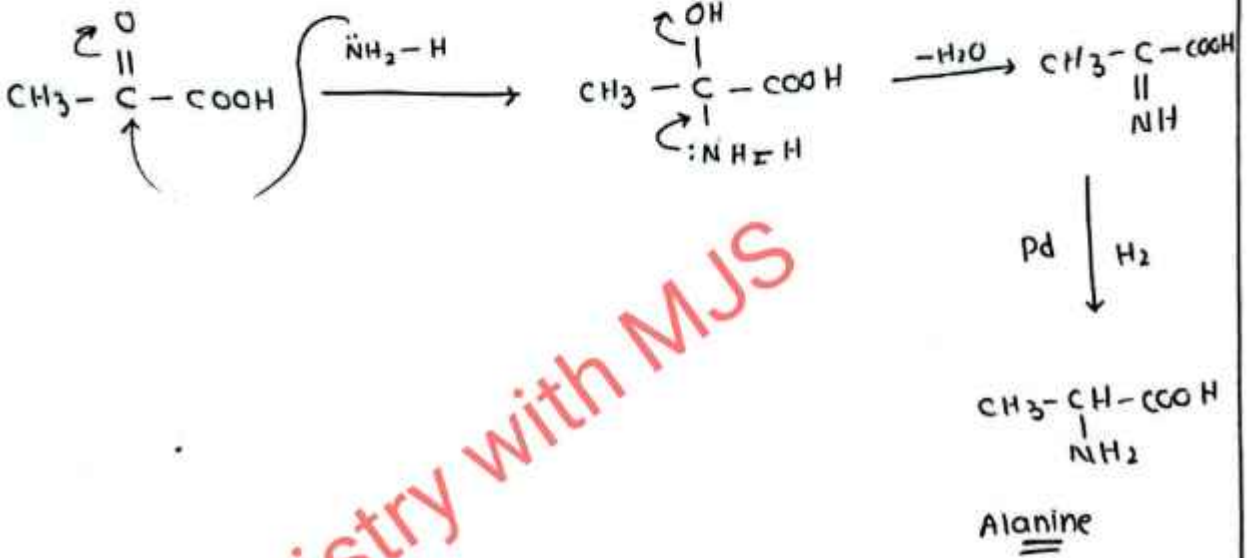
② CH_3-CHO (Acetaldehyde) $\xrightarrow[\text{(ii) } NH_3]{\text{(i) } HCN}$ $CH_3-CH(NH_2)-COOH$ Alanine

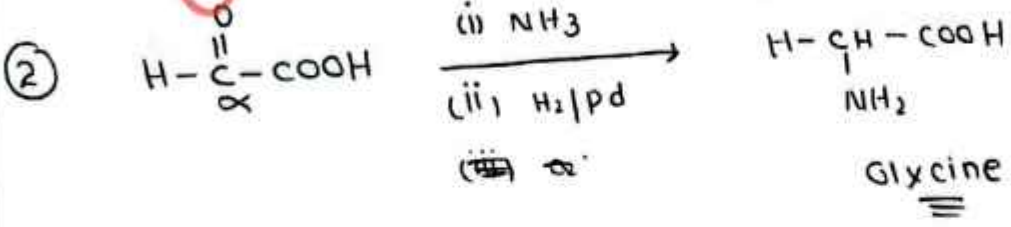
③ $CH_3-CO-CH_3$ (Ketone) $\xrightarrow[\text{(ii) } NH_3]{\text{(i) } HCN}$ ✗ No amino acid Formation

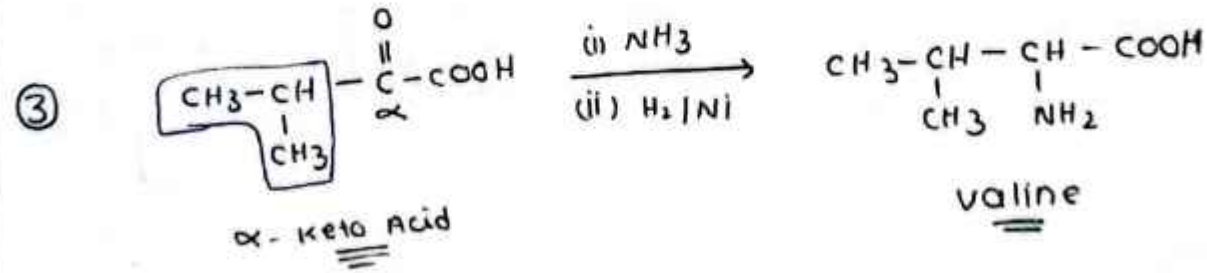
3) Koop Synthesis: (from α-keto acids)



Mechanism

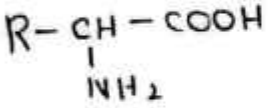




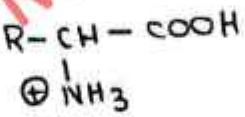


CHEMICAL PROPERTIES OF AMINO ACIDS

Amino acids are amphoteric in nature. Depending on PH of the solution A. Acids can donate or accept proton

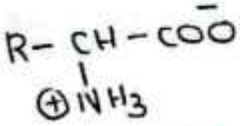


(Neutral)



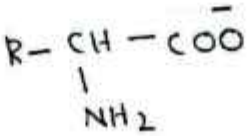
PH=0

(cation is fairly acidic medium)



(PH=7)

(Zwitter ion in neutral medium)



PH=11

(Anion is fairly Basic solution)

- When an ionized form of Amino acid is placed in an electric field, it will migrate towards the opposide electrod depending upon PH OF the medium

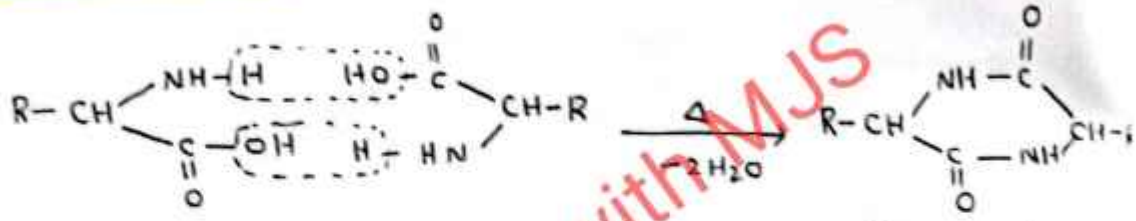
→ AT low PH:
+ve ions move towards cathode.

→ AT High PH:
-ve ions moves toward anode

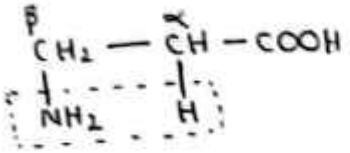
→ AT PH=7: → called Isoelectric point.
Zwitter does not move toward any electrode.

1) Effect of Heat:

* α- Amino acids:



* β- Amino acids:

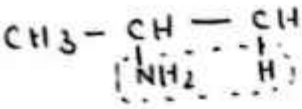
① 

(β- amino propionic acid)

$\xrightarrow[-NH_3]{\Delta}$ $CH_2=CH-COOH$ (Acrylic acid)

↓

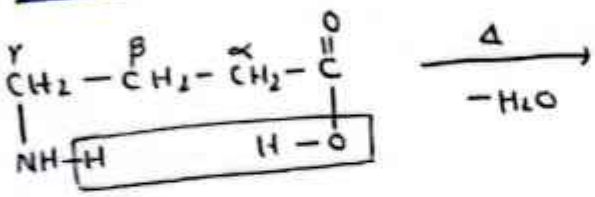
α-β-unsaturated Acid

② 

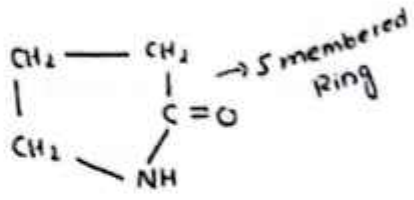
(β- Amino butyric acid)

$\xrightarrow[-NH_3]{\Delta}$ $CH_3-CH=CH-COOH$ (Crotonic Acid)

* γ- Amino acids:



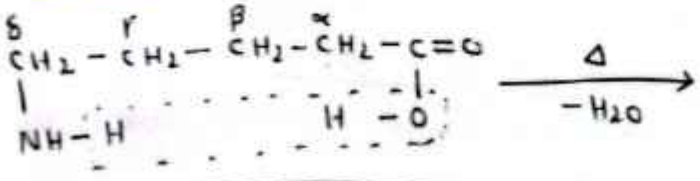
(γ- Amino butyric Acid)

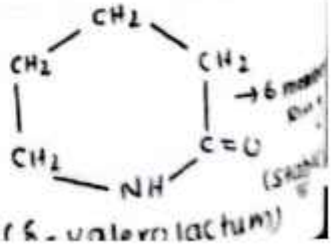


(γ- butyro Lactam)

(Stable)

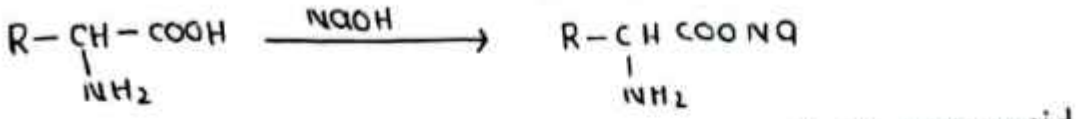
* δ- Amino acids:





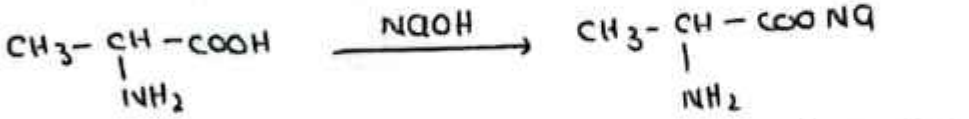
(δ- valero lactum)

2) With Bases:



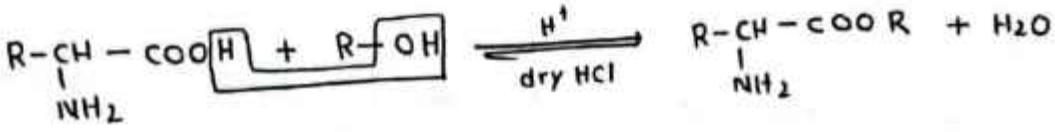
Sodium salt of Aminoacid

Example

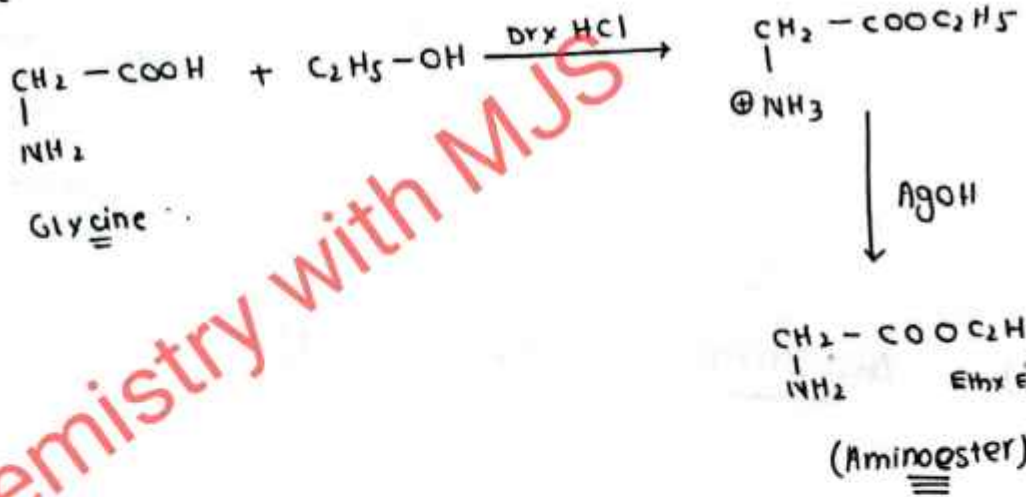


(Alanine) (Sod. Salt of Alanine)

3) Esterification:



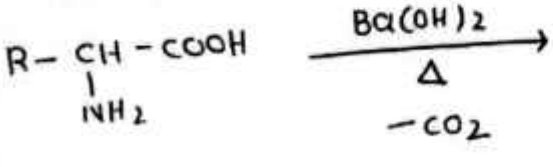
Example



Glycine

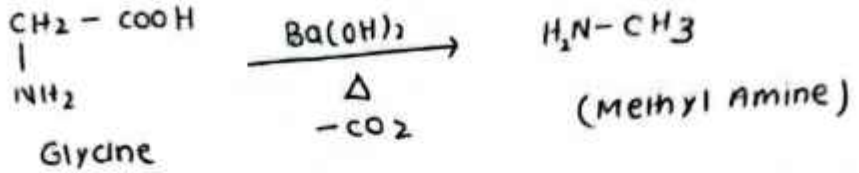
(Aminoester)

4) Decarboxylation:

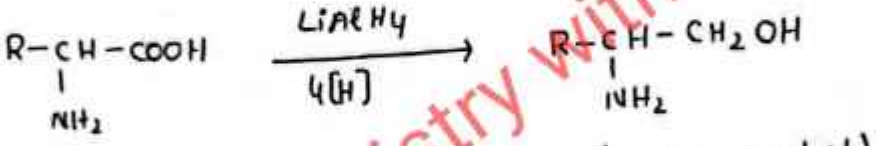


Amine

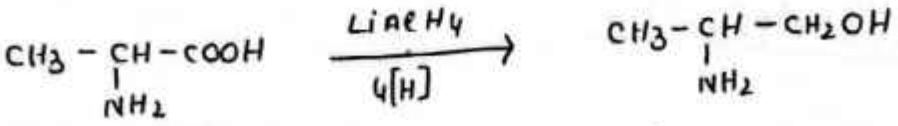
Example



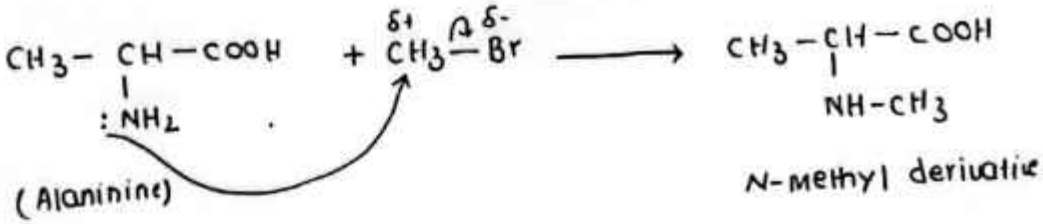
5) Reduction of Amino acids:



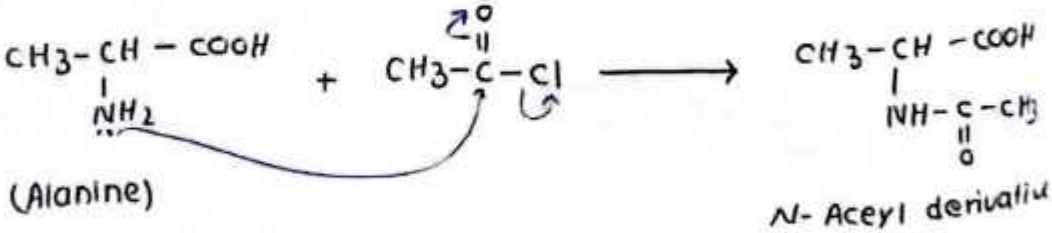
Example



6) Alkylation of Amino Acids: ($E^{\oplus}$ - substitution)



7) Acylation of Amino Acids:



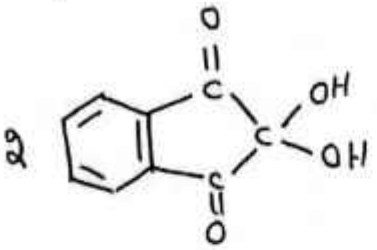
✓: Tests for Aminoacids & proteins:

There are 6 tests for the detection of Functional groups in Amino acids & proteins

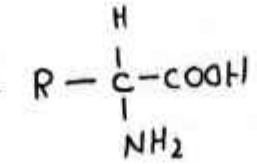
(i) ✓ Ninhydrin test.
(ii) Biuret test -
(iii) Xanthoproteic test.
(iv) Millon's test.
(v) Hopkins-Cole Test.
(vi) Nitroprusside test.

I) Ninhydrin test:

This test is given by All proteins & Aminoacids. when they are boiled with a dil. solution of ninhydrin a violet colour is produced.

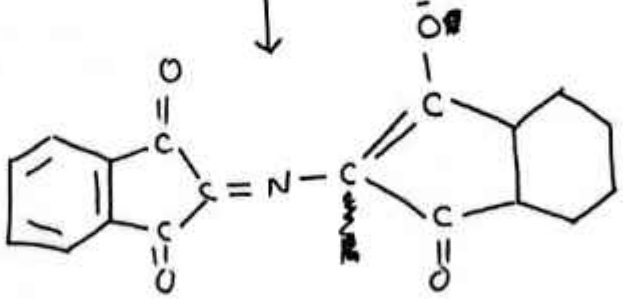


(ninhydrin)



• only proline give its yellow colour

Boiling



(violet complex)

+ $R-\overset{O}{\overset{\|}{C}}-H$

+ CO_2

+ $4H_2O$

2) Biuret test:

On adding a dil. solution of $CuSO_4$ to Alkaline soln. of protein, a violet colour is developed.

- This test is due to the presence of peptide $-\overset{O}{\overset{\|}{C}}-NH$ linkage.

3) Xanthoproteic test:

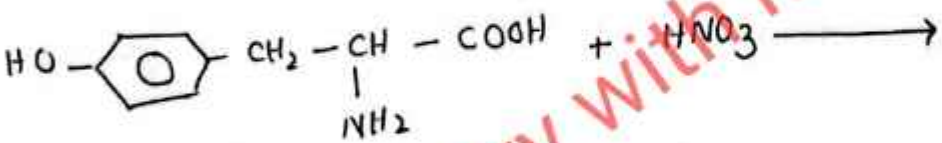
(colour test)

when protein is warmed with conc. HNO_3, a yellow colour is produced

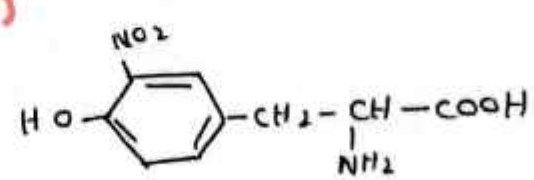
protein + conc. HNO_3 ⟹ yellow colour

NOTE

This test is given by a protein / aminoacids that containing Aromatic / benzene Ring e.g Tyrosine & Tryptophan - Nitration of Aromatic Ring occur and gives yellow product.



Tyrosine



(yellow coloured)

4) Millon's test: → only for tyrosine containing a phenol group

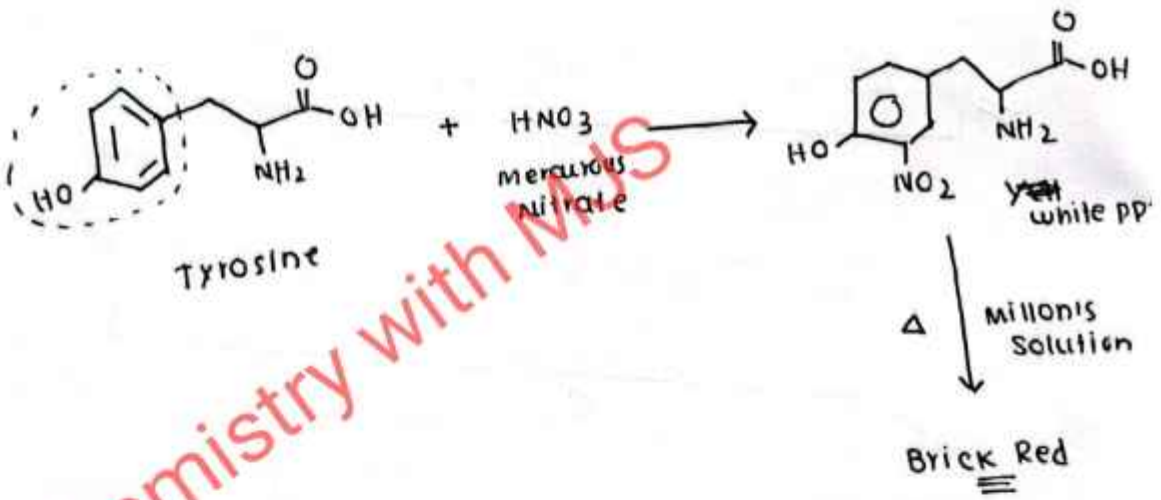
protein + Millons Reagant = white ppt

NOTE:

This test is given by protein/A.acid which yield tyrosine on Hydrolysis

Millon's test = mercurry dissolved in Nitric acid

NOTE: All phenols give +ve Millon's Test



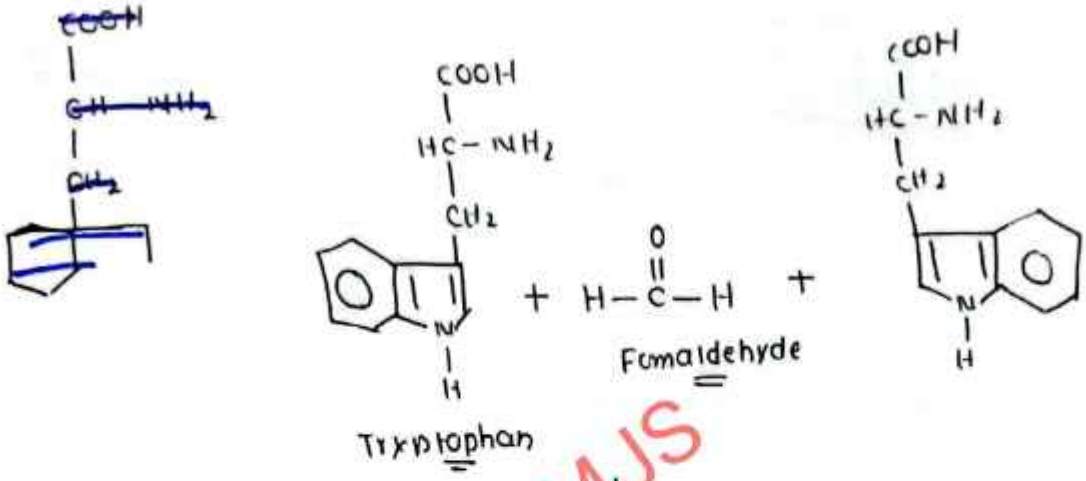
Tyrosine

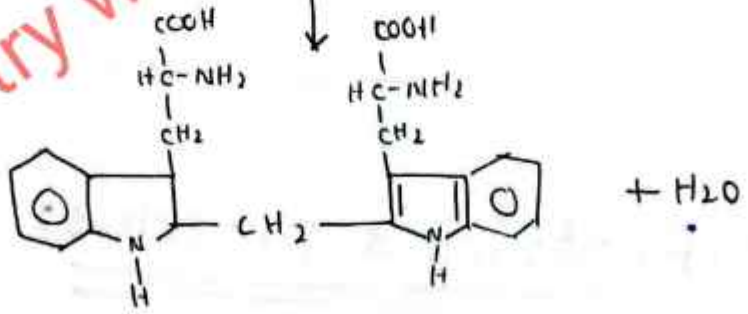
Brick Red

5) Hopkin's - cole test:

↓ used for the detection of specific Amino acid like Tryptophan.

⇒ ON adding conc. H_2SO_4 down side containing a solution of protein/A.acid, a violet colour is observed



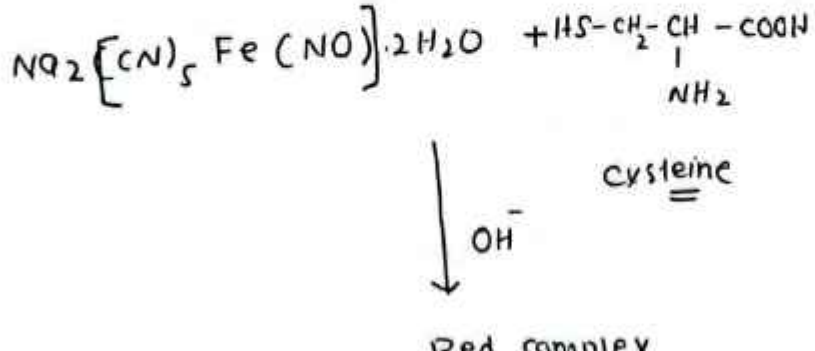


Violet colour

6) Nitroprusside test:

↓

It is specific for proteins / Aminoacids having sulphur (-SH) group e.g Cysteine & Cystine gives a Red colour called "Morner test"



7) Molisch's test: → Generally this test used for carbohydrate.

This test is given by those proteins which contain carbohydrate Residue.

∴ Alc. soln. of α-napthol + conc. H_2SO_4 + Glyco-protein

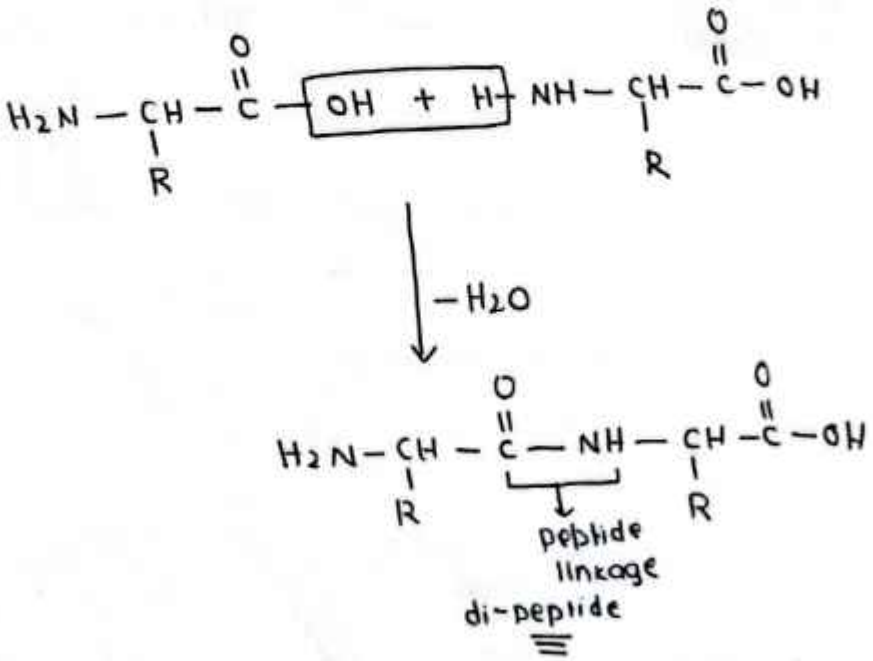
↓

Violet Ring

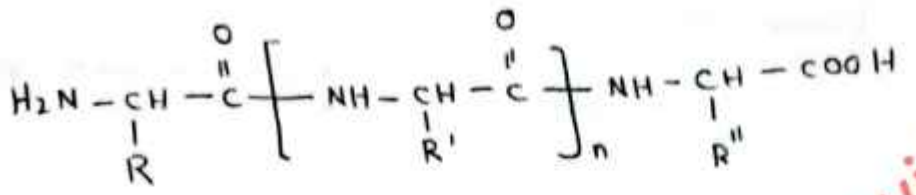
:Peptides

The bond b/w two amino acids called peptide bond and thus elimination of a water molecule occur and peptide formation occur.

peptides are classified; di, tri, tetra or penta peptides.



polypeptide: → when a large no. of A.Acids combine



(polypeptide)

Hydrolysis OF proteins:

simple proteins are hydrolysed by acids, alkalies or enzymes to produce amino acids

Hydrolysis order:

protein → proteose → peptone → polypeptide → simple peptide → mixture of A. Acids

∴ peptide bonds = Peptides − 1

polypeptide:	proteins
① It is single linear chain of upto 50 Amino-acids.	① It consist of one or more polypeptides (more than about 50 A. Acids
< 50 A. Acids	> 50 A. Acids
• mol.wt upto 10000 Dalton.	• mwt > 10000 Da
② unbranched chain	② complex Structure
③ formed from A. Acids	③ formed from polypeptides
④ composed of peptide bonds	④ composed OF several types OF bond e.g peptide bonds, disulphide bonds, ionic bond & vanderwals

How to Draw All Amino Acids Structures Easily

(Learn series)

① Glycine

② Alanine

③ Valine

④ Leucine

⑤ Isoleucine

⑥ Proline

★ Acidic A. Acids & Their Derivatives

⑦ Aspartic acid

⑧ Aspargine

⑨ Glutamic acid

⑩ Glutamine

Basic A. Acids

⑪ Lysine

⑫ Histidine

⑬ Arginine

Aromatic A. Acids

⑭ Phenyl Alanine

⑮ Tyrosine

⑯ Tryptophan

Sulphur containing & Their Resembling

⑰ Cysteine

⑱ Serine

⑲ Threonine

⑳ Methionine

BEST OF LUCK

Proteins

- proteins are macromolecules of Amino acids together by peptide Bond.
- 20 amino acids commonly found in proteins.
- proteins are molecules having a very high Molecular weight, ranging from 5000 to several Millions.

Functions:

- All Enzymes are proteins.
- Transport of molecules e.g Hemoglobin (carrier of O_2) & Lipoproteins (carrier of Lipids)
- Structural Significance e.g cell membrane made up of Lipoproteins & skin, bones (collagen)
- Harmones are proteins e.g insuline
- Antibodies (immunoglobulins) protein in nature
- Keratin (skin) → Hair, nails etc
- prothrimbin (Blood eloting)
- Ferritin (storage form of Iron)
- Myosin in muscles & collagen in Tendens.

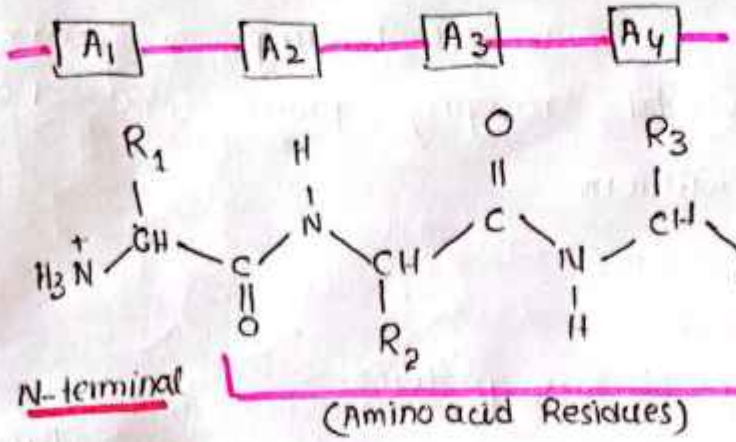
:Conformation of proteins:

protein in its native state has a 3-D Structure known as conformations.

1. primary structure:

- Order or Arrangement of A.Acids in poly-peptide chains.
- covalent bond is responsible for primary structure.
  ↳(peptide Bond)

No. & Sequence of Amino acids is determined



Sequence of arrangement of Aminoacids is determined by terminal Residue Analysis.

2. Secondary structure:

- Spatial Relationship of Adjacent Aminoacids Residues.
- Hydrogen bonds are Responsible for this structure
  ↳(BIW H of –NH group of one Amino acid Residue & carbonyl oxygen of fourth one)

Two Major conformations

Proline can not form α-helix BIC lack of Hydrogen on proline's nitrogen prevents it to form H-bonding - Also containing irregular Geometry

α- Helix

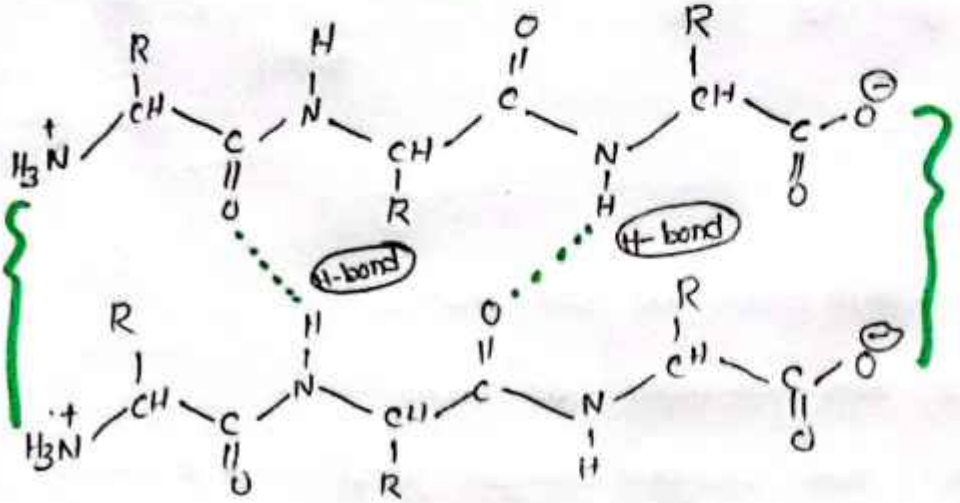
- when side chains in a polypeptides are Bulky
- peptide chains twists into a Right handed or spiral
- complete turn distance = 0.54nm
- Each turn contains = 3.6 A.Acids

β- pleated sheet

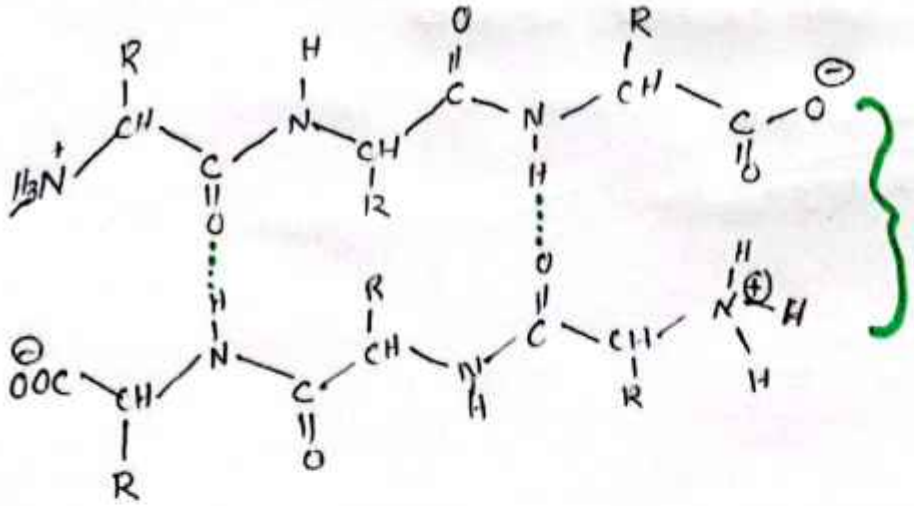
↳structure Formed BIW two or more separate polypeptide chains.

β-pleated sheet

- parallel β-sheets
  - Two polypeptide chains in the same direction
- Anti-parallel β-sheets
  - Two polypeptide chains in opposite Direction



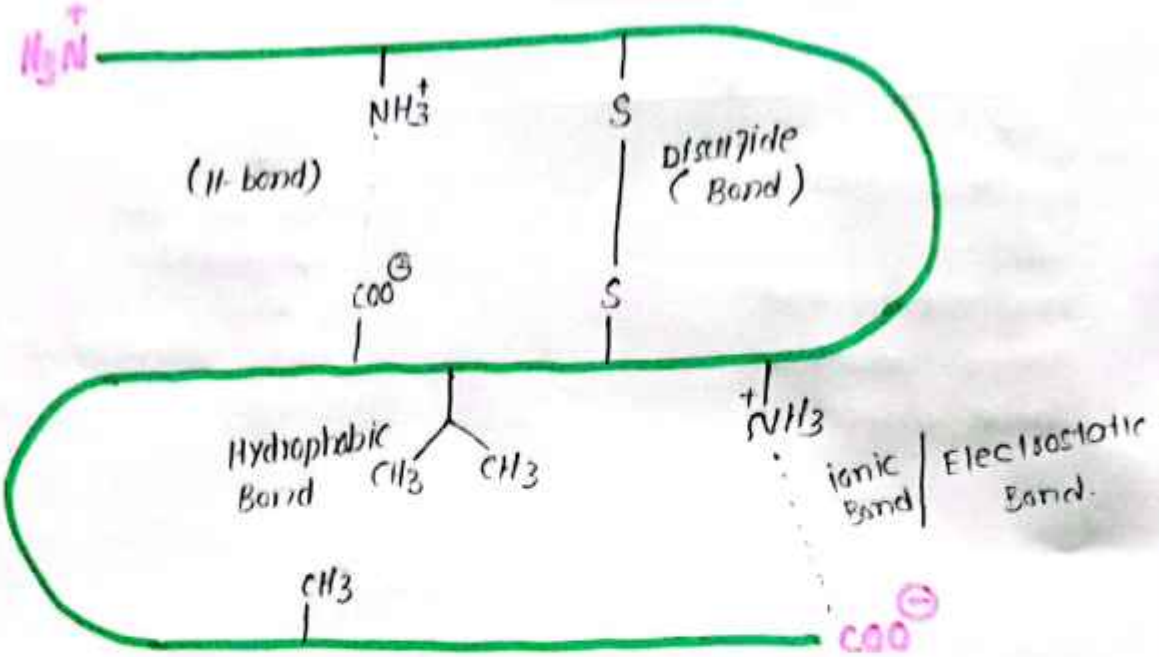
parallel β-pleated SHEET



Anti-parallel β-pleated SHEET

3. Tertiary Structure:

- High Folding & Bending of long peptide chains
- Final Rearrangement OF polypeptide chain
- Bonds Responsible
  - H-bonds
  - Ionic Bonds
  - Hydrophobic
  - Di-sulfide



H-bond = within chain OR BIW chains

Hydrophobic = BIW non-polar side chains

Ionic bond = BIW oppositly charged group in side chains

Disulfide = BIW cysteine residues

Fibrous & Globular proteins are tertiary

α-keratin → collagen → elastin → Myoglobin.

4. Quaternary Structure:

- Many proteins are composed of several polypeptide chains called subunits. Each subunit contains its own independent 3-D conformation.
- Aggregates of poly-peptide sub-units.

Bonds Responsible:

1. H-bonds
2. Electrostatic bond
3. Hydrophobic bond

Examples:

* insuline → 2 subunits
* Globin of Haemoglobin → 4 subunits.

Classification of proteins

Simple proteins
- Albumins
- Globulins
- Basic proteins
  - Globins
  - protamines
- Acidic proteins
  - Gliadins
  - Glutelins
- Scleroproteins
  - Keratin
  - Collagen
  - Elastin

conjugated proteins
- Lipoproteins
- phosphoproteins
- Glycoproteins
- Metalloproteins
- Nucleoproteins

Derived proteins
- primary Derived proteins
- Secondary Derived proteins

1) Simple proteins: → on Hydrolysis yield only Amino acids.

Albumins & Globulins:
- Both coagulated by heat
- Both present in blood, Milk & egg.
- Albumin soluble in water while globulin Soluble in salt Solution.
- Albumin M.wt = 68,000 Da while Globulins 150,000 Da

Globins: (Basic protein) → Histone protein
- constituent is Histidine (Basic A.Acid)
- Forms Haemoglobin when combine to heme.

Glutelins: (Acidic protein)

- Rich in Acidic aminoacid (glutamic acid)
- present in cereals.
- Soluble in dil. acids & alkalies.

Keratins:

- found in hair, nails, enamel of teeth & out-layer of skin
- Rich in cysteine (A. Acid) → sulfide bond
- Hydrophobic amino acids → insoluble
- Genetic defect in keratin causes skin diseases
  e.g Hyperkeratosis

Collagens:

- Formed by connective tissues cell called Fibroblasts.
- contain 30% of total body proteins (Most Abundant protein of body)
- consist of 3 polypeptide chains, each chain contains 1050 A. Acids → Held together by Hydrogen bonds
- composition:
  33% glycine + 10% proline + 10% Hydroxyproline + 1% Hydroxylysine
- collagen diseases:
  Scurvy → deficiency of vitamin C
  Osteogenesis imperfecta: → mutation in gene that coads for α-chain of collagen

Elastin: Connective tissue protein)

- Rubber like
- present in lungs, Blood vessels, elastic ligament
- formed by 4 polypeptide chains

2) Conjugated proteins:

phosphoproteins:

- protein + phosphate group

Examples:

- Casein: Milk protein
- Vitellin: egg yolk protein

Lipoproteins:

- protein + Lipid part
- plasma lipo proteins
- transport the lipids in blood
- passes through the substances in cell membrane

Glycoproteins:

- Carbohydrate part + protein

Examples:

- Blood Group, Enzymes, Mucin
- proteoglycans (cell membrane)

Nucleo proteins:

proteins + Nucleic Acid (DNA OR RNA)

Examples:

Chromosomes, Ribosomes

Metalloproteins:

Iron: Haeme → iron containing
e.g Hemoglobin
myoglobin
cytochromes
ferritin
Transferrin

copper:
ceruplasmin → Cu containing
↳ in plasma protein
Erythrocuprein: → Cu
↳ in Red cells

Zinc:
insuline harmone
Carbonic Anhydrase

3) Derived proteins:

- Primary Derived proteins
  - Denaturating proteins
    - Examples:
      1. Coagulated Albumins & Globulins
      2. Gelatin derived by boiling of collagen
- Secondary Derived proteins
  - Hydrolytic protens
    - proteins → proteoses → peptones → polypeptides → aminoacids.

TECHNIQUES FOR SEPARATION OF PROTEINS & Amino Acids:

- Chromatography
- Dialysis
- Electrophoresis
- precipitation
- Ultracentrifugation.

Good Luck
MJs

:Nucleic Acids:

- Nucleic Acids are the poly-Nucleotides
- 1st were demonstrated in the Nuclei of pus cells in 1868 & in sperm cells in 1872 by Friedrich Miescher, called Nuclein.
- present in every living cell as well as in viruses
- Essential substance of genes (Role in the transfer of genetic information.
- Typical strand of Human DNA contains approx. 10^8 Nucleotides.
- Direct the synthesis of proteins including Enzymes
- cancer Research involves the extensive study of Nucleic acids.

:Components of Nucleic Acids:

DNA

RNA

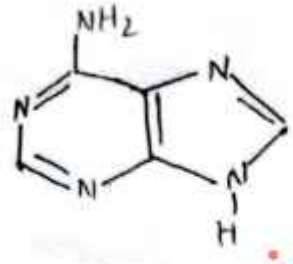
Both DNA & RNA made up of Nucleotide units

:Nucleoside = N-Bases + Sugar

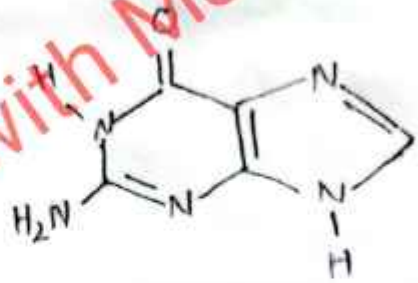
Nucleotide units
- Nitrogenous Bases
  - Purines
    - Adenine
    - Guanine
  - Pyrimidines
    - Cytosine
    - Uracil
    - Thymine
- Sugar unit
- phosphate group.

Nitrogenous Bases:

purines:



Adenine
(6-Aminopurine)



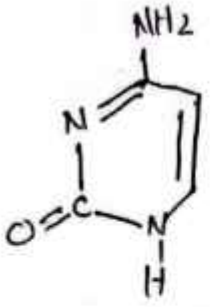
2-amino-6-oxy purine
(Guanine)

Both Adenine & Guanine Found in Both DNA & RNA.

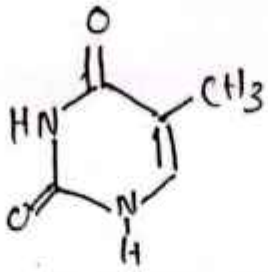
~~Uric~~ pyrimidine & purines undergo Keto-enol tautomeric shifts.

pyrimidines:

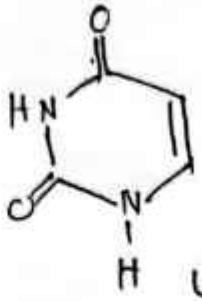
↳ in DNA (cytosine & thymine
↳ in RNA (cytosine & Uracil)



cytosine

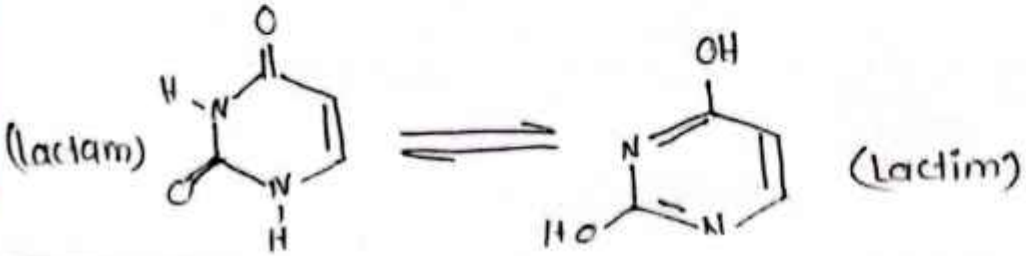


Thymine



Uracil

Keto Form of uracil called Lactam
Enol Form of uracil called Lactim



(lactam) (Lactim)

Nucleosides:

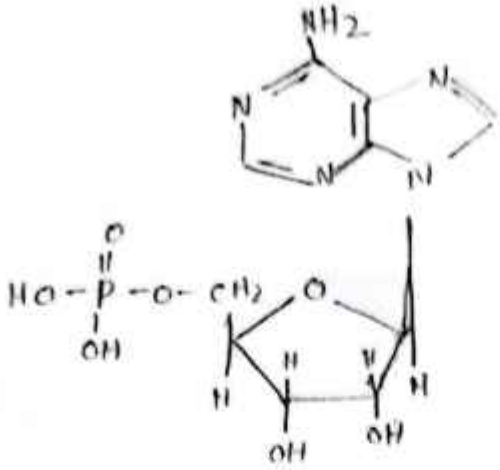
- Nitrogenous Base + Sugar unt = Nucleoside
  ↓
  pentose Sugar
- RiboNucleosides = Nit. Base + pentose-D-Ribose
- Base linked to Sugar through Glycosidic Bond.
- Nucleosides are more water soluble than the free Bases BIC OF hydrophilicity of Sugar moiety.
- pyrimidine Nucleosides are Also resistant to acid Hydrolysis.
- purines Nucleosides are easily hydrolyzed in acid to yield the free base & pentose.

* Cytidine = cytosine + pentose
* Uridine = Uracil + pentose
* Adenosine = Adenosine + pentose
* Guanosine = Guanosine + pentose

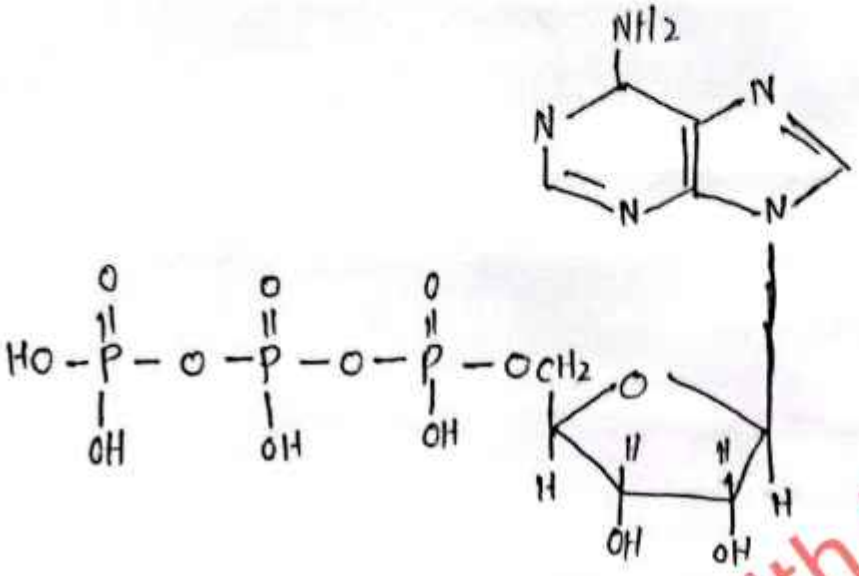
Nucleotides:

N-Base + Sugar unit + phosphoric acid

AMP ADP ATP



AMP



ATP

Adenosine $\xrightarrow{\text{Endo}}$ AMP $\xrightarrow{\text{Endo}}$ ADP $\xrightarrow{\text{Exclo}}$ ATP

ATP $\xrightarrow{\text{Exo}}$ cells

1 mole of ATP $\longrightarrow$ ADP + phosphate

$-30\ KJ/mol$

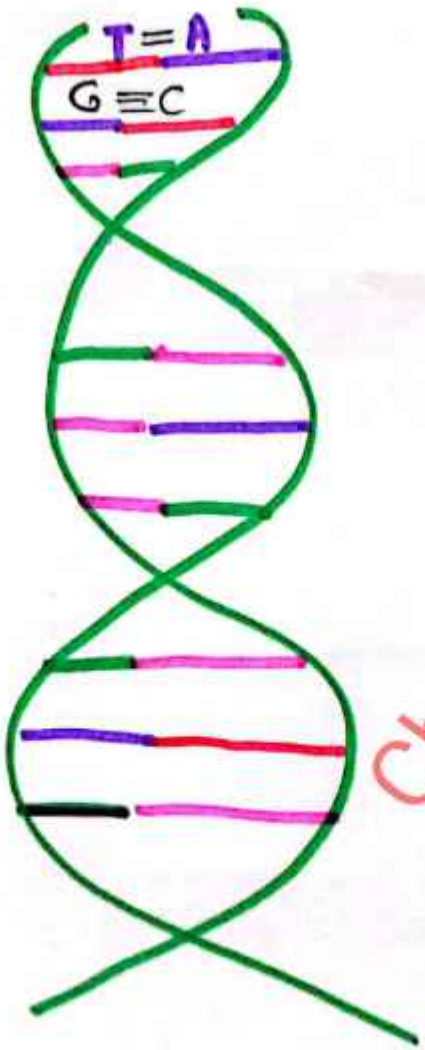
↳ E release

Nucleic Acids are poly-nucleotides

- polymers of Ribonucleotides $\longrightarrow$ RNA
- polymers of Deoxyribonucleotide $\longrightarrow$ DNA

Fundamental structure of DNA:

- DNA consists of two polynucleotides strands wound together to form a long, helical structure called DNA Double Helix
- Strands Run in opposite direction.
- Two strands are held together by Hydrogen bonds.
- DNA copied itself through DNA polymerase Enzyme.



T= A
G≡C

DNA- Directed protein Biosynthesis:

Transcription

DNA ⟶ m RNA

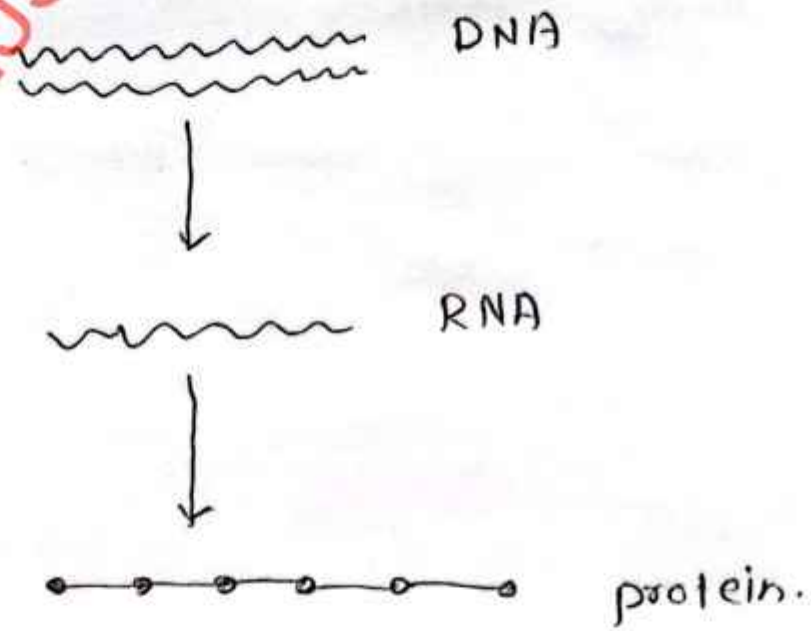
↳ single strand

Translation

m RNA ⟶ Ribosomes

↓

protein.



Good Luck

MJS