(B. Tech) Leather Tech. (Model Answer Paper)

4th sem, Mid Semester Examination 2019 (1A)

Bio chemistry of Protein

1.)

Parameter	Cow	Buffalo
1. Diameter of Hair pores.	Uniform	Non-uniform. Both wide and narrow hair pores are present.
2. No. of hair Pores.	So many	less
3. Distribution of hair pores.	Uniform	Random (No sequence)
4. Surface.	Smooth & flat	greasy & uneven because of presence of so many nerve papillae or projections.

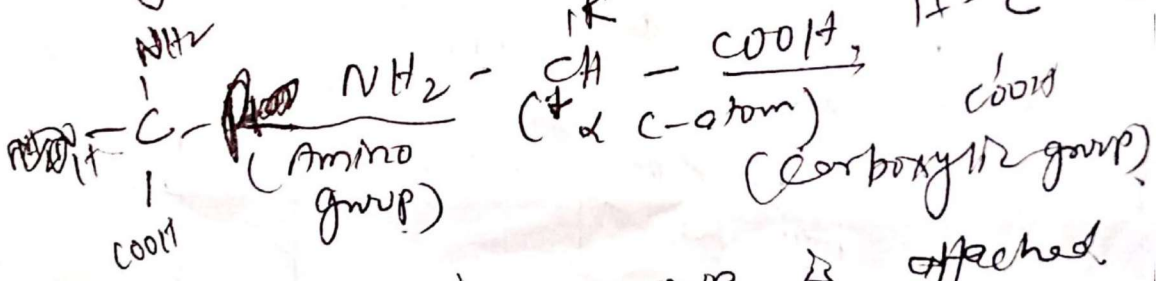
2.

Parameter	Goat	Sheep.
1. Grain surface	Smooth & flat	uneven.
2. ~~Hair~~/wool Pores.	~~Uniform~~ distribution.	Non-uniform distribution.
3. Types of hair/ wool Pores.	Coarse hair Pores (less) Fine hair pores (more) Coarse hair pores arranged in groups of three (trio group) followed by fine hair pores.	Coarse wool pores (so many) & fine wool Pores (diff in their diameter is not as sharp as in case of goat skin) are

2) Classification of Amino acids

1) ~~Aliphatic Amino Acids~~

The Amino acids are classified Accor to their side chain (R) or Alkyl gr Amino. Unit or mer of Protein is α- Amino acids. whose genera formula is



Basic amino group is attached to α C-atom, thatis why it is called α- amino acid.

→ The group "R" in an amino acid is called side chain.

→ one Amino acid differs from another amino acid by their side chain (R) only.

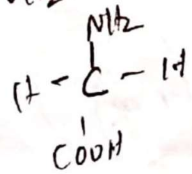
→ These side chains (R) range from single H-atom to complex hydrocarbon group.

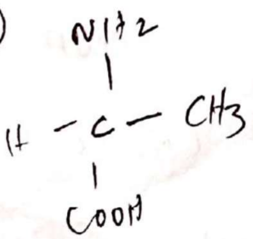
R can be aliphatic, aromatic, basic, acidic, sulphur containing etc.
There are 20 amino acids present in collagen.
→ The physical and chemical properties of individual amino acids are defined by their R group. One amino acid differs from another in the physical & chemical nature of its side chain.
Classified based upon the type of "R" group. (2)

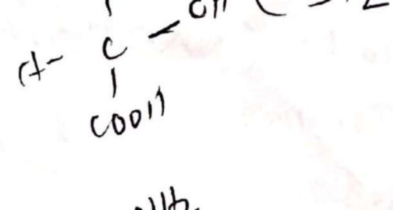
The following is the classification of Amino acids

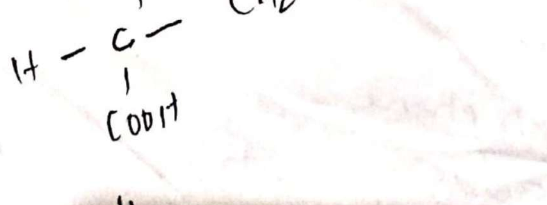
1) Aliphatic Amino acids (5)

a) $NH_2\ CH_2 - COOH$ (glycine) → simplest amino acid.



b)  (Alanine)

c)  (valine)

d)  (leucine)

e) proline

b) Amino acids containing hydr. gro.
1) serine (R – CH_2OH)
2) Tyrosine ($R-CH_2-C_6H_4-OH$)
3) Hydroxy Proline
(3)

c) Basic Amino acids → (R group cont. an extra – NH_2 groups)
Ex. –
1) lysine ($R \rightarrow (CH_2)_4-NH_2$)
2) Arginine
3) histidine.
(3)

d) Acidic amino acids → R groups contain an extra – COOH groups
1) Aspartic acid ($R-CH_2COOH$)
2) Glutamic acid ($R-(CH_2)_2-COOH$
(2)

e) Aromatic Amino acids (R- contain an aromatic group.) → 3
1) Phenyl alanine.
2) Tyrosine
3) Tryptophane

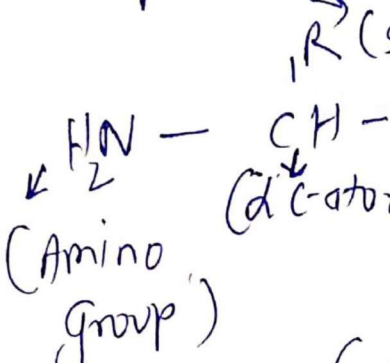
f) Amino acids containing Sulphur group. (1)
cystine.

Define
sion

Define Polypeptides. Detail the three dimensional structure of Protein

Unit of Protein is an amino acid.

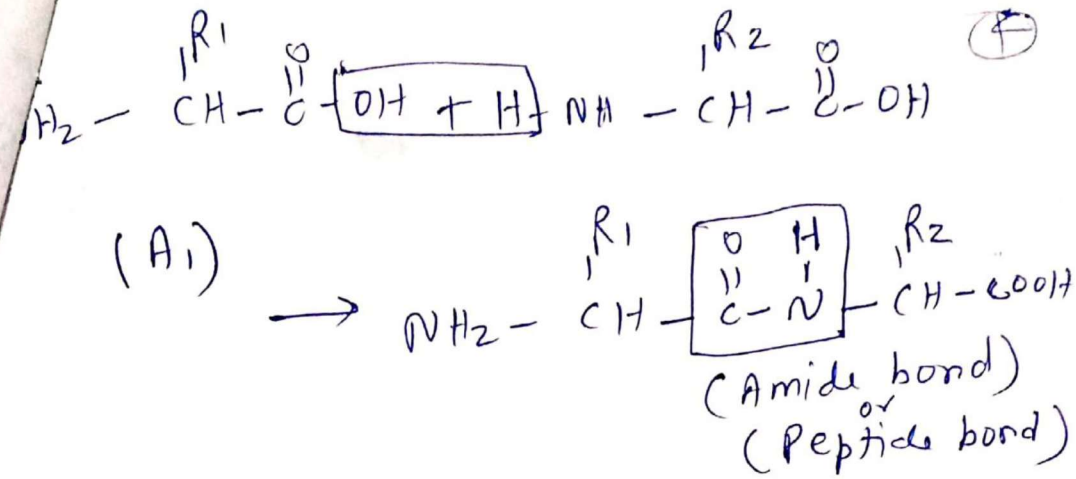
The structure of amino acid can be represented by general formula



(α- Amino acid).

Since $-NH_2$ group is attached to α C-atom; that's why it is called α-amino acid.

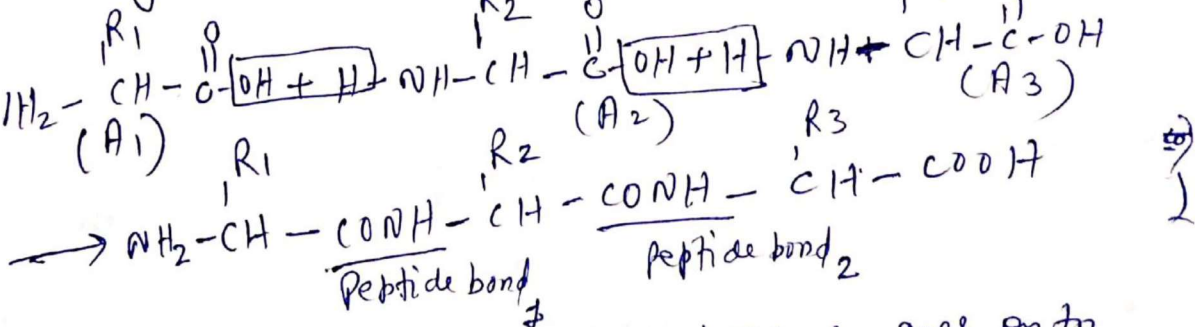
When one Amino acid joins with another amino acid the —OH group from the carboxyl group of one amino acid and the H-atom from amino group of another amino acid reacts together to form an amide (-CONH) bond, with the removal of one H_2O molecule. This amide bond is



In a structure of protein, many amino acids react with one another to form many peptide bonds with the removal of H_2O molecules, to form a long chain. This long chain is called polypeptide chain due to presence of many peptide bonds.

Polypeptides → Poly (many) + Peptides

The reaction is as follows (from 3 amino acids A_1, A_2 and A_3.



The Three dimensional structure of Protein (collagen)

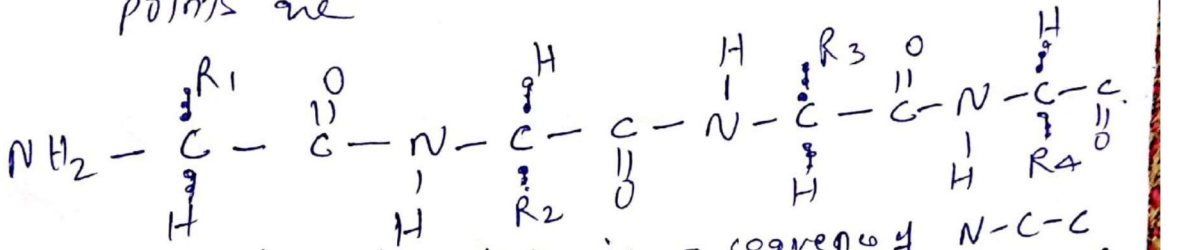
we see that in the above polypeptide chain, so many the group repeat that is

$NH\,CHR_1\,CO\;\; NH\,CHR_2\,CO\;\; NH\,CHR_3\,CO$

when $R_1, R_2, R_3 \cdots R_n \approx R$

this can be represented as $NH\,CHR\,CO$ and it is called Amino acid residue.

→ In a long polypeptide chain, the main points are



In the main chain, there is a sequence of N-C-C.

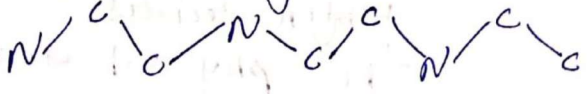
In a peptide bond, the O-atom of $>C=O$ group and H-atom of $>NH$ group are present on the alternate side of main chain. They are not on the some side of main chain.

The O-atom of one amino acid residue ($NH\,CHR_1\,CO$) and the O-atom of (adjacent) another amino acid residue ($NH\,CHR_2\,CO$) are present on the alternate side of the main chain, They are also not on the some side of main chain

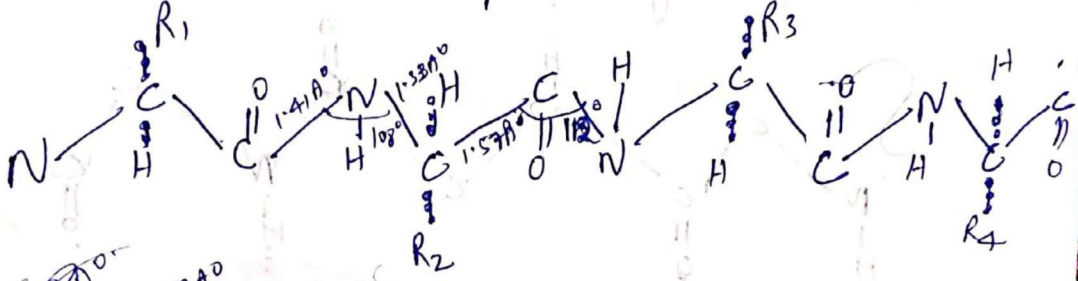
Side chain (R_1) of one

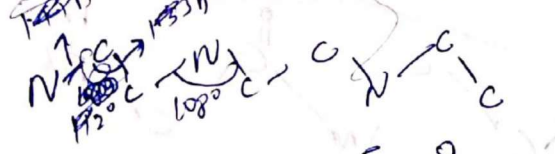
ide chain (R_2) of another (adjacent) amino acid residue ($NHCHR_2CO$) are present on the alternate side of main N–C–C chain.

- The main N–C–C–N–C–C–N–C–C chain is also not straight. They are in zig-zag position.



The final structure of a single polypeptide chain can be represented as.





represents X-axis sequence.

- peptide bind $\left[-\overset{\overset{O}{\|}}{C}-\underset{\underset{H}{|}}{N}-\right]$ represents Y-axis

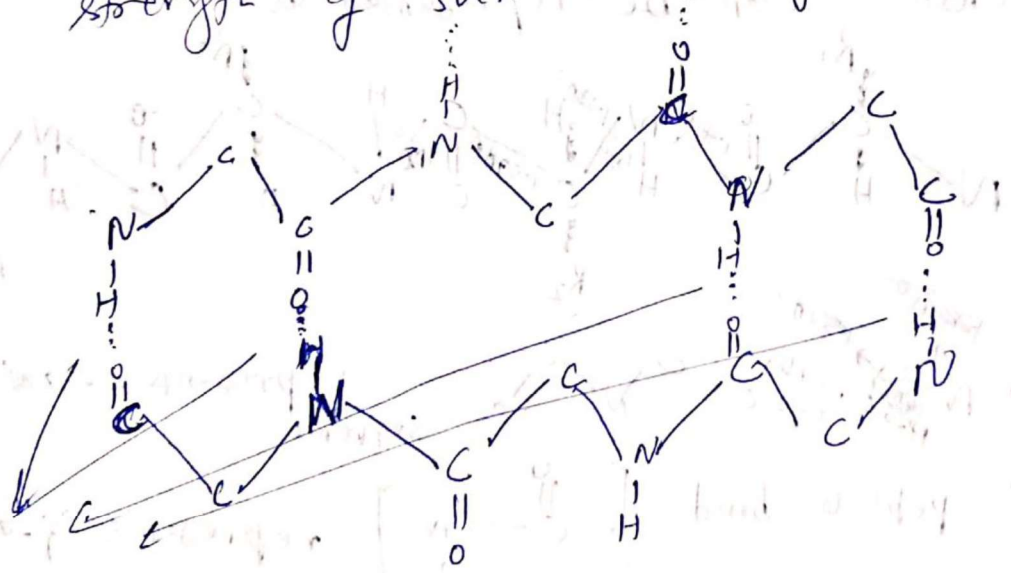
- $\overset{\overset{H}{|}}{\overset{\overset{R_n}{|}}{C}}$ represents Z-axis

So, we see that polypeptide chain has actually a 3-D structure. The H-atom and O-atom of the peptide (amide) bond form a 2-D plane with the main –N–C–C– chain. and the side chain (R) and the H-atoms attached to α-C-atom form another 2D plane at right angle to the former.

The polypeptide chains of protein molecules are oriented parallel to the fibre axis and also parallel to one another.

The individual planes again held tightly together by cross linkages acting cross with the main $-NH-C-CH$ which decides.

The physical and chemical properties of protein are decided by the nature and strength of such cross linkages.



Cross linkages.

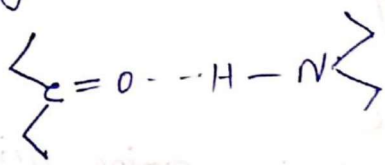
The following are cross linkages present in collagen:-

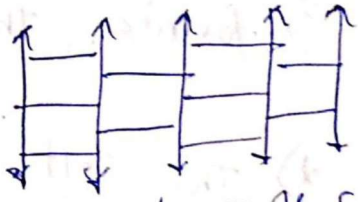
1) The direct carbimino backbone link
2) The salt link
3) Amide link
4) Others.

1) The direct carbimino link

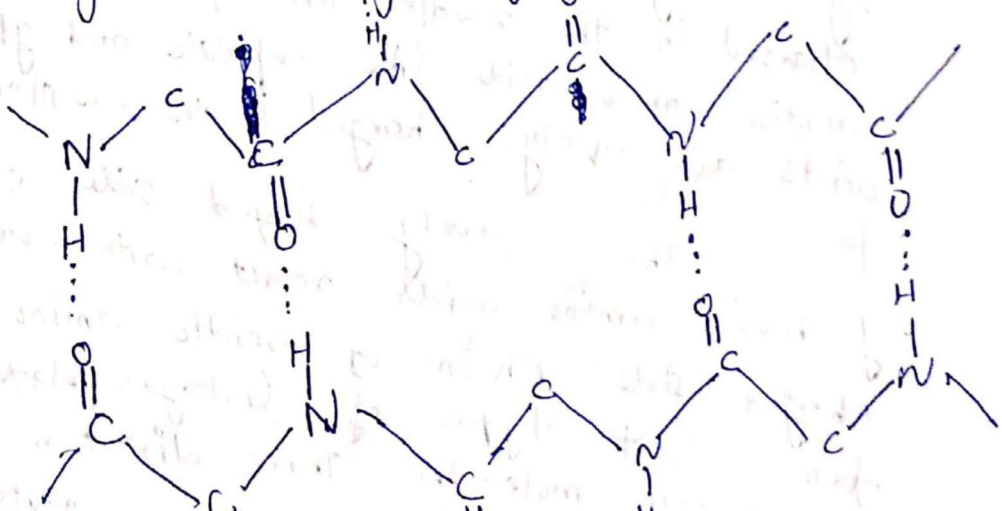
This is the main cross linkage.

This is a H-bond type of linkage formed between O-atom of >C=O carbonyl group and H-atom of >N-H imino group of polypeptide chains. The polypeptide chains of protein are grouped together by such H-bonds at several points.





This is much more clear from the following structure.



On an average,
The H-bond energy is 8 Kcal/mole
Even though the strength of indivi
H-bond is very small, but the c
Strength of several such H-bonds in
Polymers is very great and these b
are actually responsible for the stabilit
of hide protein to action, heat, chemical
enzyme and bacteria.

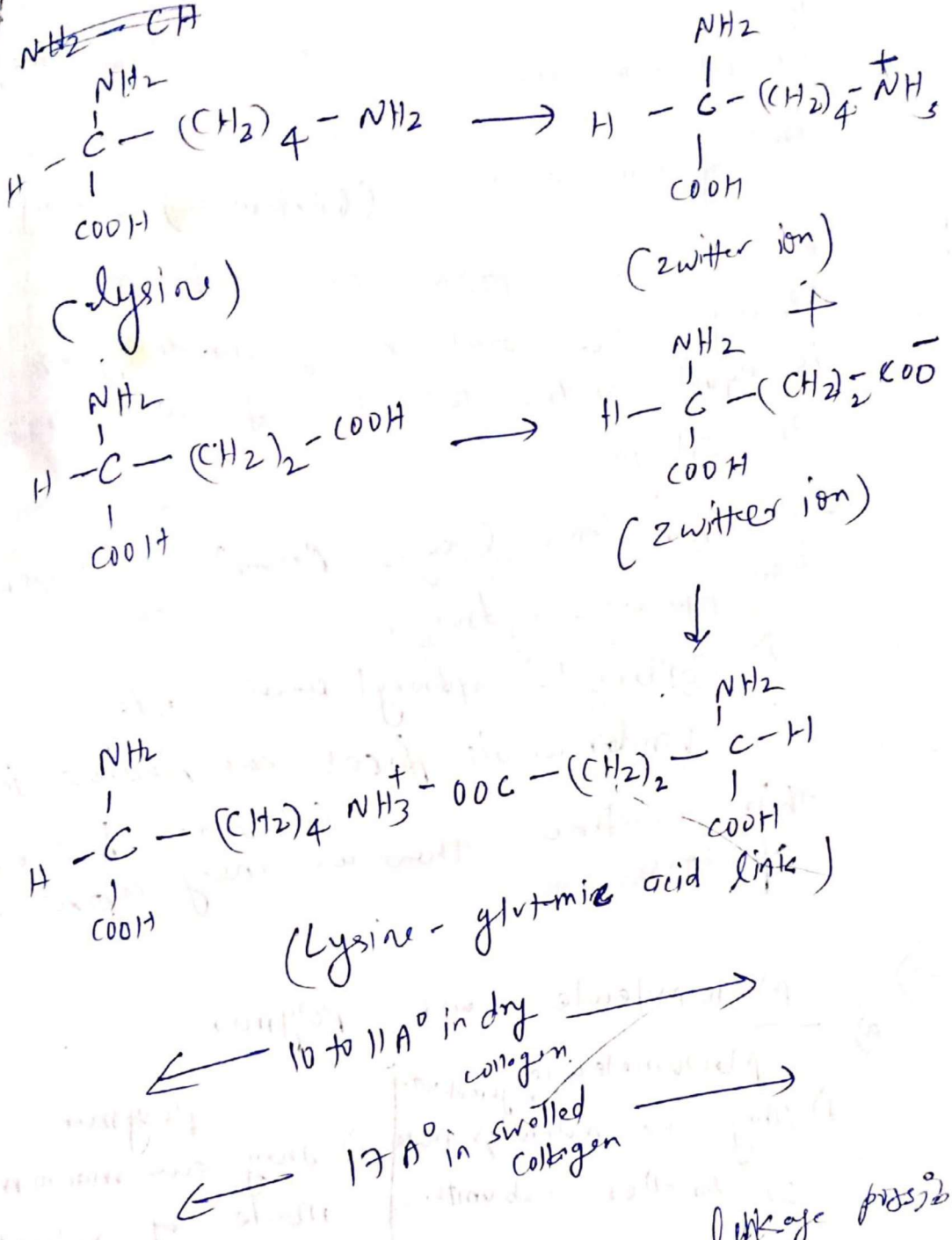
The H-bonds of collagen are broken down and the latter is converted into glue when digested with

1) water at > 60°c
2) meta cresol ≥ 15°c
3) formic, thioglycolic and lactic acid) 0°c

d) The salt linkage

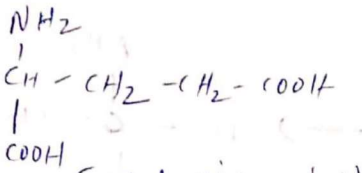
In collagen, the basic amino acids like lysine, arginine and histidine are +vely charged in the zwitter ion form. Similarly the acidic amino acids like aspartic and glutamic acids are -vely charged in the zwitter ion form.

These +vely charged side chains of basic amino acids react with -vely charged side chains of acidic amino acids form salt type of linkages (electrostatic) in protein molecules. Their direction and are not fixed. Ex:- Lysine - glutamic

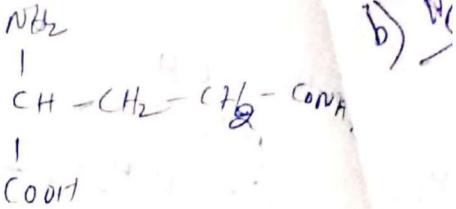


3) Amide link

The other possible cross linkage possible is amide cross linkage. A/c to most of the protein chemists, very small amount of acidic amino acids are found in collagen. most of them remains as asparagine



(glutamic acid)



(Glutamine) (Amide)

finding from an experiment the total no. of amide groups is equal to the total no. of Serine residues in collagen.

4) Other cross linkages present in collagen

a) Hydroxy - hydroxyl

b) Carboxyl - hydroxyl ester etc

c) vander waals forces are possible in collagen. but about their existence there are many controversial opinions.

5) Macromolecule and polymer.

a)

Macromolecule of high mol. wt.	Polymer
1) They are molecules made of smaller subunits.	1) They are macromolecules made of repeating subunits
2) All macromolecules are not polymers.	2) All polymers are macromolecule.
3) Ex:- Triglyceride is (Fat) a macromolecule not polymer	3) protein is both a polymer and a macromolecule. since protein is made by repeating units of amino acids
3 fatty acids ($C_{15}H_{31}COOH$) + CH_2OH, $CH.OH$, CH_2OH → triglycerides.	4) Ex:- cellulose, polyethene
4) Ex:- Lipids, some dyes	

(3)

b) Hydrolysis of protein :-

$$\text{Protein} + HCl \xrightarrow[\Delta]{6 \text{ to } 12 \text{ hrs}} \text{Amino acids}$$

(5x / 6x)

$$\text{Protein} + H_2SO_4 \xrightarrow[\Delta]{12 \text{ to } 24 \text{ hrs}} \text{Amino Acids.}$$

(5x / 6x)

When a protein is heated with 5 or 6 times its weight with strong HCl (6 to 12 hrs) / strong H_2SO_4 (for 12 to 24 hrs), it is hydrolysed / decomposed producing finally Amino acids. This is a direct Proof that protein is composed of aminoacids. Nearly 25 different amino acids (basic, acidic, aromatic, aliphatic etc.) have been isolated from protein.

c) Amino acids present in Collagen :-

Collagen consists of amino acids wound together to form triple-helices of elongated fibrils. It is mostly found in fibrous tissues such as tendons, ligament and skin. Almost 21 amino acids approx. are found in collagen. which ranges from acidic (aspartic, glutamic), basic (lysine, arginine & histidine), aliphatic (Alanine, leucine, valine), aromatic (phenyl alanine, tyrosine)

Tryptophan is aminoacid is absent in collagen by which collagen can be identified.

d) Reaction of Protein with acids & bases.

We know that protein is a polym (ocbeptation) made by the union of several α-amino ($NH_2-CHR-COOH$). since an amino ac molecule has both acidic ($-COOH$) and basic ($-NH_2$) groups and so it can react with both acid and base.

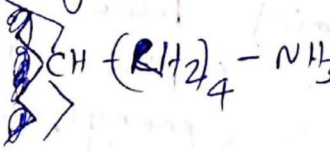
The acidic and basic groups in the side chains of some amin acids also increase the acidic and basic character of the respective amino acids.

Salt formation :-

Ex:- Amino acids react with each other in a typical acid-base neutralisation reaction to form a salt. The reaction is simply the transfer of $-H$ (H^+) from the acid to the amine and the attraction of the +ve and -ve charges. Ex: glycine and $\overset{+}{N}H_3-CHR-COO^-$ alanine may interact in the zwitter ion form to make salt

b) Salt formation of Side chains

Lysine - glutamic acid link



Qe Sequence of amino acids present in collagen. (10)

Protein $\xrightarrow[\text{Strong HCl/H}_2\text{SO}_4]{\text{hydrolysis}}$ Aminoacids $\xrightarrow[\text{suitable solvent}]{\text{Paper chromatographic technique}}$ seperated and identified by their respective Rf values

Quantitatively determined. $\leftarrow$ Spectrophotometer (mass spectroscopy)

The no. of gram molecules of glycine, proline and hydroxy proline in gelatine are nearly 1/3, 1/6 and 1/9 of the total gram molecule of the amino acid residues respectively. The scientist therefor suggested in the polypeptide chain of collagen, glycine could be every 3rd residue, proline every 6th and hydroxy proline every 9th.

So, the following are the two possible amino acid sequences in polypeptide chain of collagen.

a) — G P X G P X G P X G X X — and

b) — G X P G X X G X P G X X —

where G represents glycine, P proline and X any other amino acid residue.

—— O ——