2. PROTEINS AND NUCLEIC ACIDS

SYNOPSIS

I. PROTEINS AND AMINO ACIDS :

1. The name proteins meaning prominent or 'first' (Greek : proteios = first) is well chosen by Brezelius (1538) because proteins play a very important role in the structure and metabolism of the biological cell.
2. *These are vital chemical substances essential for the growth and maintenance of life.*
3. Proteins are the most complex of all macromolecules found in living cells of both plants and animals.
4. They are very vital of living organisms as they perform a wide variety of biological functions.
5. In addition, they are structural components of many tissues.
6. Animal cell wall is made up of proteins.
7. Some of the important proteins and their functions are given below in table.

Some Important Proteins and their Functions

Type	Examples	Functions
Enzymes	Trypsin, Pepsin	Catalyse biochemical reactions
Transport	Haemoglobin	Transport of oxygen from lungs to various tissues through blood stream
Storage	Myoglobin	Stores oxygen in mucles unitl it is needed for energy production
Motion	Myosin, Acin	Involved in muscle movement
Structural	Collagen, Keratin	Structural and protective function, occur in hairs, nails, teeth etc.,
Informational transmission	Insulin, Glucagon	Function as hormones

Chemical Composition of Proteins

Chemically the elements carbon, hydrogen, oxygen and nitrogen are present in all the proteins. Some of these may contain elements like sulphur, phosphorus, iodine or traces of metals like iron, zinc and manganese etc., Upon hydrolysis, proteins decomposes as :

$$\text{Protein} \xrightarrow{\text{Hydrolysis}} \text{Peptide} \xrightarrow{\text{Hydrolysis}} \alpha - \text{Amino acids}$$

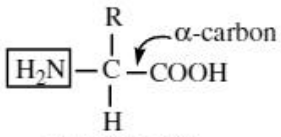
Let us briefly discus the different constituent units of proteins :

α - Amino acids

As the name suggests, amino acids contain primary amino* ($-NH_2$) and carboxyl (–COOH) groups and depending upon their relative positions in the carbon atom chains, the amino acids are classified as $\alpha, \beta, \gamma, \delta$ and so on. However, upon hydrolysis, proteins given only α -amino acids. There are twenty α -amino acids present in different proteins. The amino acids which can be synthesised by the body are known as non-essential amino acids while those which the body fails to synthesise are called essential amino acids shown by the sign 'e' or as*. These are suplemented by diet. Just like other organic families. α -amino acids can be assigned IUPAC names but these are generally named according to common system. In fact, each amino acid has been given an abservation which normally consists of first three letters of the common name. For example, glycine has been abbreviated as *Gly* and alanine as *Ala* and so on.

Classification of α-Amino acids

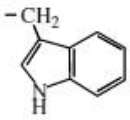
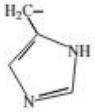
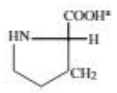
α-Amino acids are classified as acidic, basic or neutral depending upon the relative number of amino aid carboxyl groups present. Neutral amino acids have equal number of these groups, in the acidic, the carboxyl groups are in excess while in basic α-amino acids, amino groups have greater proportions.



α-Amino acid

These twenty α- amino acids both essential and non-essential along with their 'three letter symbol' and 'one letter code'are given in Table.

Nature of α- amino acids

Name of the amino acids	Characteristic feature of side chain, R	Three letter symbol	One letter code
1. Glycine	H	Gly	G
2. Alanine	$-CH_3$	Ala	A
3. Valine*	$(H_3C)_2CH-$	Val	V
4. Leucine*	$(H_3C)_2CH-CH_2-$	Leu	L
5. Ioleucine*	$H_3C-CH_2-\underset{\displaystyle CH_3}{\underset{\vert}{CH}}-$	Ile	I
6. Arginine*	$HN=\underset{\displaystyle NH_2}{\underset{\vert}{C}}-NH-(CH_2)_3-$	Arg	R
7. Lysine	$H_2N-(CH_2)_4-$	Lys	K
8. Glutamic acid	$HOOC-CH_2-CH_2-$	Glu	E
9. Aspartic acid	$HOOC-CH_2-$	Asp	D
10. Glutamine	$H_2N-\overset{\displaystyle O}{\overset{\Vert}{C}}-CH_2-CH_2-$	Gln	Q
11. Asparagine	$H_2N-\overset{\displaystyle O}{\overset{\Vert}{C}}-CH_2$	Asn	N
12. Threonine*	$H_3C-CHOH-$	Thr	T
13. Serine	$HO-CH_2-$	Ser	S
14. Cysteine	$HS-CH_2-$	Cys	C
15. Methionine*	$H_3C-S-CH_2-CH_2-$	Met	M
16. Phenylalanine•	$C_6H_5-CH_2-$	Phe	F
17. Tyrosine	$(p)HO-C_6H_4-CH_2-$	Tyr	T
18. Tryptophan•		Trp	W
19. Histidine•		His	H
20. Proline		Pro	P

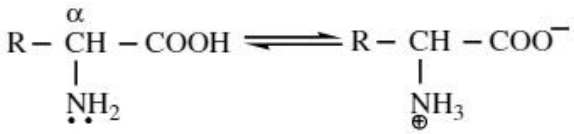
Proline is an exception. Here a secondary amino group (>NH) is attached to α-carbon. Thus proline is imino carboxylic acid

Essential amino acid, a = entire structure

Physical Properties of α - Amino acids :

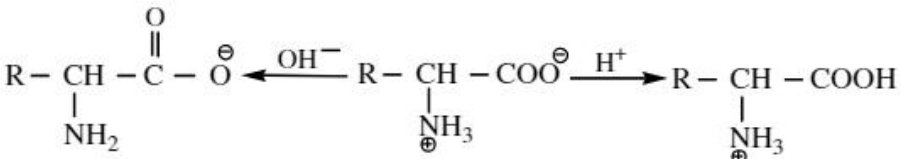
The important characteristics of α - amino acids are listed:

1. α -Amino acids are usually colourless crystalline solids with high melting points.
2. These are generally water soluble due to intermolecular hydrogen bonding with H_2O molecules.
3. α -Amino acids behave as dipolar ion or a **Zwitter ion** due to the transfer of a proton (H^+) from carboxyl group to the amino (NH_2) group in the same molecule.



Dipolar ion

In this form α -amino acids behave as amphoteric i.e, they can combine with acids (COO^- ion accepts H^+) and bases (NH_3^+ losses H^+)

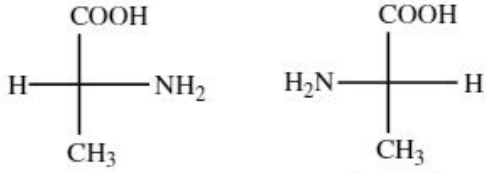


(Anion) Zwitter ion (Cation)

Isoelectric Point in α -amino acids

In acidic medium, the cation formed migrates towards cathode while in the basic medium, anion migrates towards anode on passing electric current. At a certain pH of the medium called isoelectric point of an α - amino acid, the dipolar ion behaves as neutral and does not migrate to any electrode on passing current. The isoelectric points of different α -amino acids are in the pH range of 5.5 to 6.3. At this point, a particular α -amino acid has the least solubility in water and this property can be employed to separate different α -amino acids present in the mixture obtained upon the hydrolysis of proteins.

4. With the exception of the first member glycine (NH_2CH_2COOH), all other α -amino acids are optically active due to the presence of chiral carbon. They have been assigned notations D or L depending upon the configuration about the chiral carbon atom. In the Fischer projection formula, the carboxyl group (–COOH) is shown at the top. In the D-form, the amino (NH_2) group towards the right while in the L-form, it is present on the left. For example D and L form of alanine $(CH_3\underset{\underset{NH_2}{|}}{C}HCOOH)$ are expressed as



D-Alanine L-Alanine

Most of the naturally occurring amino acids gave L configuration

Chemical Properties of α-Amino acids :

Chemically α-amino acids show the important characteristics of both the primary amines and of carboxylic acids. We have discussed them in details in unit 14 and unit 14 respectively.

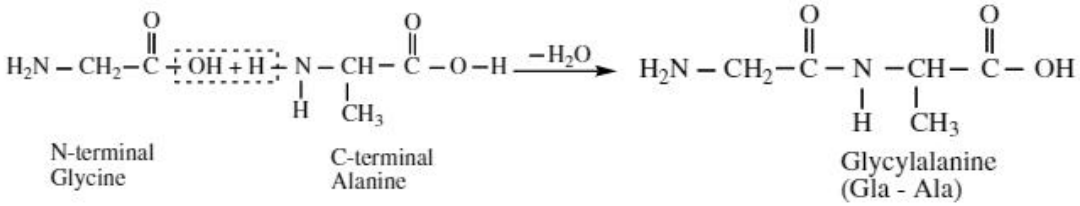
Peptides

Peprides are the compounds formed when two or more molecules of α-amino acids combine with the loss of molecules of H_2O and they link with the help of bonds called peptide bonds (–CO–NH). Actually, there is a loss of OH part from carboxyl group and H atom from amino group and a molecule of H_2O is thus eliminated.

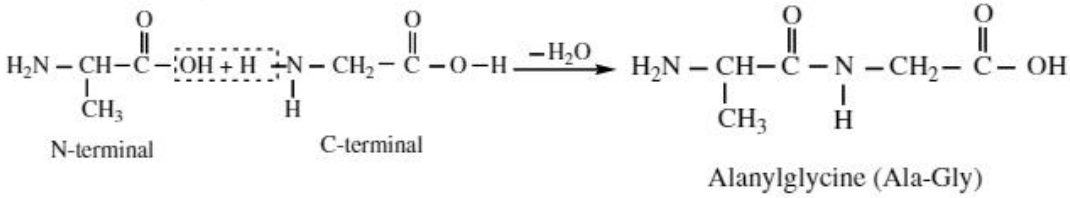
Remember : In the formation of a peptide

* There is a free amino group at one end of the molecule known as N-terminal end and a free carboxyl group at the other end called C-terminal end
* By convention, a peptide is named starting from N-terminal amino acid to be followed by other amino acids and ending with C-terminal amino acid.
* While writing the structure of a peptide or polypeptide, the N-terminal end is written on the left while C-terminal end on the right.

For example, glycine and alanine can combine in two different ways



The alternate way of combination is



Similarly, six different tripeptide from three α-amino acids glycine, alanine and phenylalanine are possible. These are :

(i) Gly-Ala-Phe

(ii) Gly-Phe-Ala

(iii) Ala-Gly-Phe

(iv) Ala-Phe-Gly

(v) Phe-Gly-Ala

(vi) Phe-Ala-Gly

Depending upon the number of amino acids present, the peptides have been classified as :

(i) Oligopeptides : contain 2 to 9 amino acids

(ii) Polypeptides : contain 10 to 100 amino acids

(iii) Proteins : contain more than 100 amino acids

Polypeptides

As stated above, the peptides containing upto 100 amino acids are known as polypeptides. The same of any polypeptide starts from N-terminal residue. These are of amphoteric nature because of the presence of N-terminal amino group and C-terminal carboxyl group at the either ends. They give the characteristics reactions of primary amines and carboxylic acids. Polypeptides have also isoelectric point like amino acids where they are neutral in nature. As this point, they are least soluble and have of a tendency to aggregate.

Classification of Proteins

Proteins have been classified on the basis of their composition and also upon the products of hydolysis.

Classification based upon composition. On the basis of the composition, proteins have been classified into two main types :

(i) **Fibrous proteins :** In this type, the proteins consist of linear molecules which are placed side by side to form fibres. The different polypeptide chains are held by intermolecular hydrogen bonding resulting in strong intermolecular forces of attraction. They have long thread like structure. These proteins are quite stable under moderate changes of temperature as well as pH value i.e., their structures do not change. These are usually insoluble in water. Fibrous proteins constitute the structural materials of the animal tissues. A few important fibrous proteins are listed. Keratin (in skin), collagen (in tendons), myosin (in muscles), fibroin (in silk) etc.,

(ii) **Globular proteins :** In these proteins, the molecules of polypeptides are folded into compact units forming spheroidal shapes. The peptide chains in them are stabilised by intramolecular hydrogen bonds. These are generally soluble in aqueous solutions of acids, bases and salts. The function of globular proteins is to maintain and regulate the life cycle. A few important globular proteins are listed.

Haemoglobin (transport agent), gamma globulins (antibodies), insulin(hormones), maltose (enzyme) etc.

Classification according to hydrolysis products : Based upon the different products from as a result of hydrolysis, proteins have been classified into the following types :

(i) Simple proteins these are the proteins which when hydrolysed from only α-amino acids e.g., albumins, globulins, glutelins etc.,

(ii) Conjugated proteins in this case, a protein part is linked to non-protein part called prosthetic group. The prosthetic part is mostly concerned with the special biological function of protein. The conjugated proteins have different types depending upon the nature of the prosthetic group. These are

(a) Nucleoproteins : The prosthetic group is of nucleic acid. e.g., nuclein

(b) Glycoproteins : The prosthetic group is some carbohydrate. e.g., mycin

(c) Chromoproteins : The prosthetic group is some pigment having some metal such as Fe, Cu, Mn etc., in the structure. e.g., haemoglobin, chlorophyll etc.

(iii) Derived proteins : These are the proteins fromed by the partial hydrolysis of simple conjugated proteins such as proteoses, peptones, peptides, etc.,

Structure of Proteins :

The complete structures of proteins are quite complex. Therefore, their structures are usually caused at different levels as explained below.

Primary structure of Proteins

It refers to the order or sequence in which the various amino acids are linked to one and another a protein. In tells us the covalent structure including the disulphide bridges of a protein. The difference in chemical and biological proterties of various proteins and peptides arises due to difference their primary structure. Even a change of just one amino acid can drastically alter the properties of protein molecule. For example, haemoglobin, the molecule in the blood that carries oxygen consists of 574 amino acid units. Changing just one specific amino acid in the sequence results in a successive haemoglobin found in patients suffering from sickle cell anaemia. In these patients, the successive haemoglobin in red blood cells precipitates causing the cells to sickle (*i.e.*, the cell acquires shape similar to a sickle) and sometimes the cell bursts.

Normal haemoglobin : –Val–His–Leu–Thr–Pro–Glu–Glu–Lys–

Sickle cell haemoglobin : –Val–His–Leu–Thr–Pro–Val–Glu–Lys–

The sickle cell haemoglobin contains *valine*(Val) in place of glutamic acid (Glu) present in formal haemoglobin.

The primary structure of a protein is found by its successive hydrolysis with acid, alkali or enzyme. The successive hydrolysis give different products having different molecular masses. In 1953, the British chemist, *Frederick Sanger* determined the first ever primary structure of protein *'insulin'*. He was a Nobel Prize in 1962 for his work on the determination of primary structure of insulin.

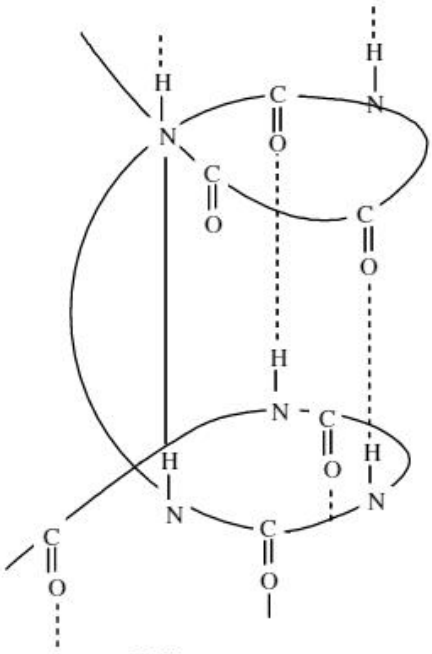
Insulin is a polypeptide hormone produced in the *pancreas*. It is essential for the metabolism of carbohydrates and sugars in the body. It contains 51 amino acids arranged in two chains which are cross-linked to each other at two places by disulphide bonds. Insulin has an important role in the sugar level in the blood deficiency of insulin leads to *'diabetes'*.

Secondary structure of proteins

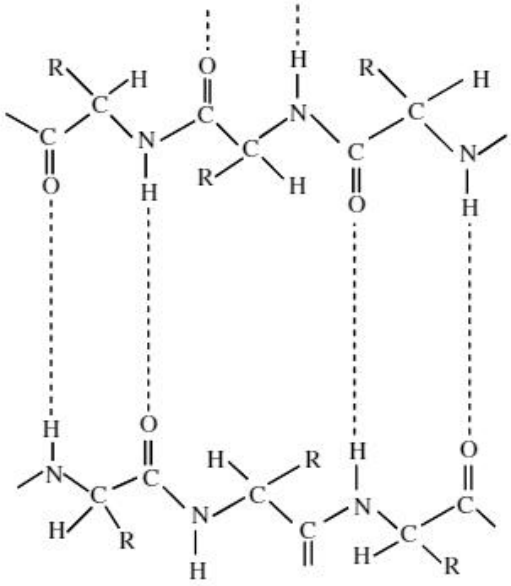
The long, flexible peptide chains of proteins are folded into the relatively rigid regular conformation called the secondary structure. It refers to the conformation which the polypeptide chains assume as a result of hydrogen bonding between the > C = O and > N–H groups of different peptide bonds.

The type of secondary structure a protein will acquire, in general depends upon the size of the R-group. If the size of the R-groups are quite large, the protein will acquire α-helix structure. If on the other hand, the size of the R-groups are relatively smaller, the protein will acquire a β-flat sheet structure.

(a) **α-Helix structure :** If the size of the R-groups are quite large, the hydrogen bonding occurs between > C = O group of one amino acid unit and the > N–H group of the fourth amino acid unit within the same chain. As such the polypeptide chain coils up into a spiral structure called right handed α-helix structure. This type of structure is adopted by most of the fibrous structural proteins such as those present in wool, hair and muscles. These proteins are elastic i.e., they can be stretched. During this process, the weak hydrogen bonds causing the α-helix are broken. This tends to increase the length of the helix like a spring. On releasing the tension, the hydrogen bonds are reformed, giving back the original helical shape.



α-Helix structure



β-Flat sheet structure

(b) **β-Flat sheet or β-Pleated sheet structure :** If R-groups are relatively small, the peptide chains lie side by side in a zig-zig manner with alternate R-groups on the same side situated at fixed distances apart. The two such neighbouring chains are held together by intermolecular hydrogen bonds. A number of such chains can be inter-bonded and this results in the formation of a flat sheet structure. These chains may contract or bend a little in order to accommodate moderate sized R-groups. As a result, the sheet bends into nparallel folds to form pleated sheet structure known as β-pleated sheet structure. These sheets are then stacked one above the other like the pages of a book to form a three dimensional structure. The protein fibrion in slik fibre has a β-pleated sheet structure. The characteristic mechanical properties of silk can easily be explained on the bais of its β-sheet structure. For example, silk is non-elastic since stretching leads to pulling the peptide covalent bonds. On the other hand, it can be bent easily like a stack of pages because during this process, the sheets slide over each other.

Tertiary structure of proteins

The tertiary structure of a protein refers to its complete three dimensional structure. It arises due to folding and superimposition of various secondary structural elements to give the entire molecule a spherical shape.

At normal pH and temperature, each protein will take a shpe that is energetically most stable. Once amino acids join up to form the primary structure the subsequent structures follow automatically. This is governed by the attractive and repulsive forces between different parts of the polypeptide chains. Thus we can that the primary structure of a protein dictates its tertiary structure.

In the tertiary structure of a protein the coils and folds of the polypeptide molecule are so arranged as to hide the non-polar amino acid side chains inside chains nearer to form active sites of enzyme proteins. The tertiary structure is maintained by weak bonds such as hydrogen, ionic, covalent (disulphide bridges) and hydrophobic interactions formed between one part of the polypeptide chain and another.

The biological activity of a protein molecule depends largely on its specific tertiary structure. Thisstructure is easily disrupted by a change in pH or temperature and this results in the stopping of the functions of a protein. Proteins with a tertiary structures are named as globular proteins as they have more or less a spherical shape. Such proteins are soluble in water. Some common examples of globular proteins are myoglobin in muscles, haemoglobin in blood, albumin in egg white etc. Perutz and Kendrew shared the 1962 Nobel prize in chemistry for determining the tertiary structure of haemoglobin and myoglobin through X-ray diffraction studies.

Quaternary Structure of Proteins

Some of the proteins are composed of two or more polypeptide chains referred to as sub-units. The spatial arrangement of these sub-units is known as quaternary structure

Denaturation of Proteins

A protein present in biological system with a unique three dimensional structure and biological activity is known as native protein. When the native protein is subjected to either some physical change (e.g., change in temperature) or chemical change by taking part in certain chemical reactions which bring about a change in pH, this leads to denaturation of the native protein. The denaturation is due to the breaking of the hydrogen bonds as result of which the globules unfold and helix get uncoiled. The protein loses its biological activity on account of denaturation. Chemically denaturation does not change the primary structure of a protein and only brings about change in secondary or tertiary structures. The change in appearance of an egg white during cooking is due to denaturation. Another example of denaturation is the coagulation of milk when it is heated with an acidic substance like lemon juice. It is due to the denaturation of milk protein lactalbumin. The denaturation of proteins of egg white or milk is irreversible in nature.

Tests for Proteins

The presence of α -amino acids and other reactive groups proteins can be detected by the following specific tests :

1. **Biuret Test :** In this test, few drops of copper sulphate solution are added to an alkaline solution of protein when a bluish violet colour develops. This test is basically for peptide linkage and is also given by some bigger hydrolytic products of proteins.
2. **MIllon's Test :** Millon's reagent is prepared by dissolving and equal amout of mercuric of mercurous nitrate in distilled water. Proteins give a white precipite with Millon's reagent which changes to red upon heating.
3. **Ninhydrin Test :** Proteins and α -amino acids give a blue or violet colour with ninhydrin which is striketo hybdrindene.
4. **Molisch's Test :** An alocholic solution of α -naphthol and protein is prepared. Concentrated sulphuric acid is added dropwise to this solution taken in a test tube. A violet colour develops at the function of the liquids. This test is given by proteins which contain a carbohydrate group.

II. ENZYMES

We have learnt in the study of carbohydrates that these are body fuels i.e., they provide necessary energy to the body and keeps it working. Actually, human body is just like a furnace in which chemical reactions take place and are responsible for the digesion of food, absorption of appropriate molecules and production of energy. The entire process involves a series of reactions that are catalysed by biocatalysts known as enzymes. Thus, enzymes may be defined as *biological or bio-catalysts which catalyse the reactions in living beings.*

All enzymes are basically globular proteins. Enzymes are very specific for a particular reaction as well as for a particular substrate. These are generally named after the compounds or the class of substances

with which they are linked or work. For example, the enzyme maltase is so named since it catalyses the hydrolysis of maltose into glucose.

$$\underset{\text{Maltose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{\text{Maltase}} \underset{\text{Glucose}}{2C_6H_{12}O_6}$$

In some cases, the enzymes are also named after the reaction in which these are used. For example the enzymes which catalyse the oxidation of one substrate with simultaneous reduction of the other are called oxidoreductase enzymes. In general, if the name of a substance ends with suffix - 'ase' it means that it belongs to the family of enzymes.

Chemical Nature of Enzymes

Without exception, all enzymes are protein molecules. Some enzymes are simple protein i.e., their molecules consist of only amino acids while the others are conjugated proteins and their molecules consist of amino acids and non-proteinous part which is known as prosthetic group. The prosthetic graoup is necessary for protein to act as enzyme and is termed co-enzyme. The protein part of a conjugated protein is called apoenzyme and the molecule as a whole is called holoenzyme.

$$\underset{\text{(Conjugated protein)}}{\text{Holoenzyme}} \rightleftharpoons \underset{\text{(Protein)}}{\text{Apoenzyme}} + \underset{\text{(Prosthetic group)}}{\text{Co}-\text{enzyme}}$$

Thus, co-enzyme may be defined as *a substance necessary for the activity of certain enzyme*

But now-a-days, most of biochemists use the term cofactor in general and specify co-enzyme only for those cofactors which are organic molecules in nature.

Specific Nature of Eznymes

We have studied that every biological reaction requires a specific kind of enzyme. The number of such reactions is very large and therefore, the enzymes that are needed for this purpose are also quite large (nearly 3000). It may be noted that without enzymes, the biological process would be very slow and sluggish. For example, it will require about 50 years to digest a single meal in the absence of enzymes. The enzyme which catalyse the biological reactions are termed as bio-catalysts. Some common enzymes and the reactions which are catalysed by them are given in the following table.

Some examples of enzymes

Enzyme	Reaction catalysed
Urease	Urea $\rightarrow$ $CO_2 + NH_3$
Invertase	Sucrose $\rightarrow$ Glucose + Fructose
Maltase	Maltose $\rightarrow$ Glucose + Glucose
Lactase	Lactose $\rightarrow$ Glucose + Galactose
Amylase	Starch $\rightarrow$ α -Glucose
Carbonic anhydrase	$H_2CO_3 \rightarrow CO_2 + H_2O$
Pepsin	Proteins $\rightarrow$ Amino acids
Trypsin	Proteins $\rightarrow$ Amino acids
Nucleases	DNA, RNA $\rightarrow$ Nucleotides

The important characteristics of enzymes are briefly discussed

1. **Chemical nature :** Enzymes are genearlly complex macromolecules (proteins) with high molecular masses.
2. **Specificity :** Every biological reaction requires a different kind of enzyme. This is due to their highly specific name i.e., each enzyme catalyses only one chemical reaction. Since there is a large number of biological reactions therefore, a large number of enzymes are required in a living system. To date more than 3000 enzymes have been identified and they constitute the largest and most highly specialised class of proteins.
3. **Temperature and pH sensitivity :** The enzymes function best at an optimum termperature (25°C – 40°C). Their activity decreases with decreases as well as as increase in temperature and stops at 0°C and above 80°C. Similarly, enzymes show maximum efficiency at an optimum pH (6–7.7). Their activity may slow down or stop outside this pH range
4. **Efficiency :** Another remarkable property of enzymes is their efficiency. Efficiency of a catalyst is measured in terms of turn over number . The turn over number of an enzyme refers to the number of molecules of a substance acted upon by one molecules of enzyme per minute. Enzymes are very efficient catalysts. They speed up the rate of bio-reactions by a factor upto 10^{20}

   To get some idea of tremendous efficiency adn specificity of enzymes, let us consider the enzyme carbonic anhydrase, present in red blood cells. This enzyme catalyses the reversible reaction i.e., the breakdon of carbonic acid to water and carbon dioxide.

$$H_2CO_3 \underset{}{\overset{\text{Carbonic anhydrase}}{\rightleftharpoons}} H_2O + CO_2$$

   Under ideal conditions a single molecule of carbonic anhydrase is capable of catalysing the breakdown of about 36 million molecules of carbonic acid per minute. The enzyme carbonic anhydrase an important role in maintaining the carbon dioxide levels in the body fluds and tissues.

Enzyme Inhibitors

These are the chemical substances which tend to reduce the activity of a particular enzyme instead of increasing it. These are mostly the inorganic ions or the complex organic molecules. Such enzymes are called enzyme inhibitors. A few examples of the enzyme inhibitors are : salts of heavy metals, cyanide ion, DNP (dinitrophenol) DEP(diisopropyl fluorophosphate). Even high energy radiations inhibit the enzyme activity

Mechanism of Enzyme Action

We have stated that the enzymes are specific in behaviour and catalyse only specific substrates. In their role may be compared to lock and key arrangement. Just as a key can open only a particular lock, in the sameway an enzyme can analyse a particular reaction only. The detalis of the mechanism have been discussed in unit 5 on surface chemistry

Applications of Enzymes in industry

Enzymes are widely used for the manufacture of various useful products. For example

(i) enzymes like *invertase, zymase* and *maltase* are used in the manufacture of alcoholic drinks like wine and beer.

(ii) enzyme *renin* is used for the manufacture of cheese.

(iii) enzyme *maltase* is used for the manufacture of malt, which is used in making health drinks like 'Maltova'.

(iv) enzyme *pepsin* is used to soften tough meats.

(v) enzyme *invertase* is used for manufacture of invert sugar.

(vi) enzyme α *-amylase* can be used to manufacture sweet from corn starch.

Diseases caused by Enzyme Deficiency

Certain diseases are caused by the deficiency of enzymes. For example, the congenital disease phenyl ketone urea is due to the decficiency of the enzyme phenylalanine hydroxylase. The disease results in the accumulation of amino acid phenylalanine or its compounds in the body leading to brain damage and mental retardation in children. The disease can be prevented by a diet with low phenylalanine content. Albinism is another disease caused due to deficiency of enzyme tryosinase. An albino person or animal (white tiger, white peacock, white mouse etc.,) has a white skin, white hair and pink eyes. It is due to the lack of colouring matter-melanin. Enzyms are also used to treat diseases related to heart. Many heart attacks are caused by blood clot formation in a coronary artery. The enzyme streptokinase dissoves the blood clot.

III. NUCLEIC ACIDS :

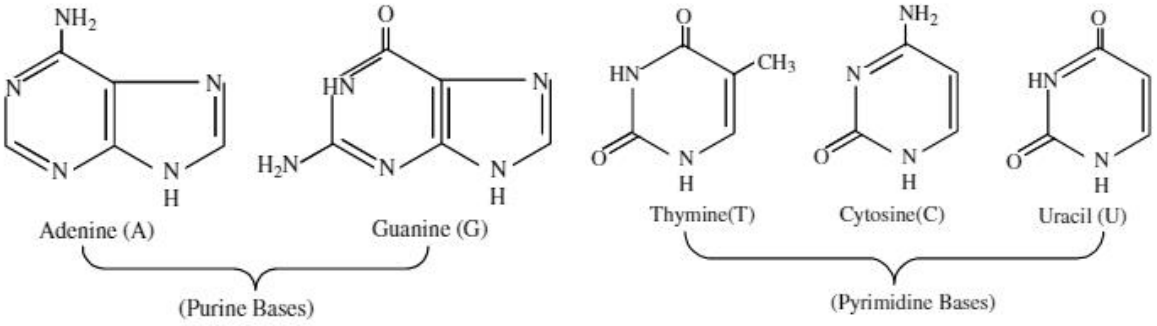
Nucleic acids are the biological important polymers which are present in all living cells. These are required for the storage and expression of genetic information. Nucleic acids play a vital role in the transmission of hereditary characteristics and also in the biosynthesis of proteins including enzymes. Thus, they control the metabolic activity of the living organisms

Nucelic acids, for the first time were isolated by a Swiss physicial Friedrich Miescher from the nucleus of the pus cell. They were named as nuclein. The name nucleic acid was given later on by Altman in 1589.

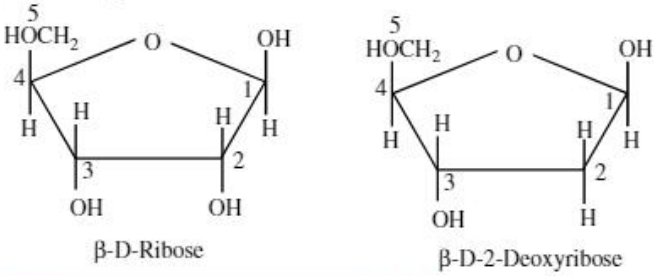
Chemical composition of Nucleic Acids

Nucleic acids are colourless, complex and amorphous compounds and are made of three units. These are nitrogenous bases, a pentonse sugar and phosphoric acid.

Nitrogenous bases : Two types of nitrogenous bases are present in nucleic acid i.e., purines and pyrimidines. A purine is made up of six membered ring condensed with a five membered rind while the pyrimidine is a single six membered heterocylic rind with two nitrogen atoms present in it. The bases derived from purine are Adenine(A) and Guanine (G) while those having the pyrimidine ring are Thymine (T), Cytosine(C) and Uracil (U).



Sugars : Two types of sugars have been isolated by carrying out the hydrolysis of nucleic acids. These are β-D ribose and β-D-2 deoxyribose. Both of them contain a five membered heterocyclic ring and are generally called pentose sugars.



In addition to bases and sugars, phosphoric acid as phosphate is another constituent of nucleic acid

Based on the constituents present, there are two types of nucleic acids. These are

Deoxyribonucleic acid (DNA) : The base constituents are Adenine (S), Guanine (G), Thymine(T) and Cytosine (C). Deoxyribose is the sugar component present

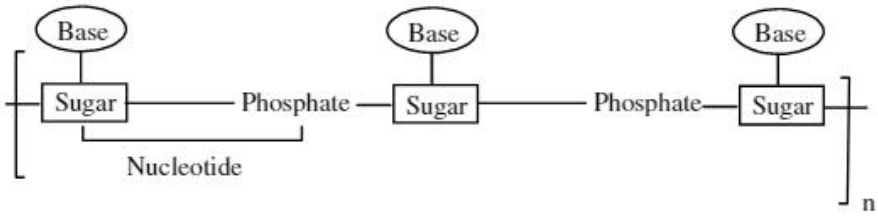
Ribonucleic acid (RNA) : It differs from DNA with respect to one pyrimidine base and sugar constituent. Thymine (T) has been replaced by uracil (U). Similarly, the sugar constituents in RNA is ribose and not deoxyribose.

In fact, the two nucleic acids have been assigned different names only on the basis of the sugar constituents. Both these nucelic acids have different biological functions of perform

From the above discussion we may conclude that

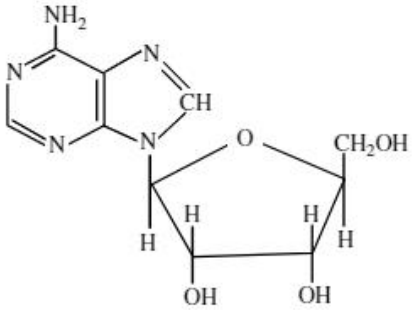
* Bases. Adinine, Guanine and Cytosine are present in both DNA and RNA
* Base. Thymine is present only in DNA while Uracil is present only in RNA
* Pentose sugar deoxy ribose is present in DNA while ribose is in RNA

Arrangement of constituents in Nucleic Acids. These are in fact three building blocks in nucleic acid. A combination of base and sugar is know as nucleoside. Similarly, base, sugar and phosphates from nucleotides while nucleic acids are polynucleotides which means that these are the polymers of nucleotides.



Nucleosides have been named taking into account the constituents present

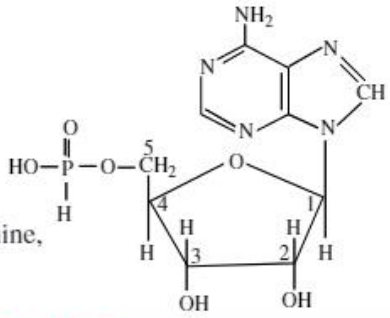
Adenosine	:	Adenine + Ribose
Guanosine	:	Guaninine + Ribose
Cytodine	:	Cytosine + Ribose
Deoxythymidine	:	Thymine + Deoxyribose



The structure of adenosine representing the points of linkage HOH_2C between adenine and ribose has been shown.

Similarly, when nucleosides are attached to phosphate or phosphoric acid at C_5 position, different types of nucleotides are formed. For example,

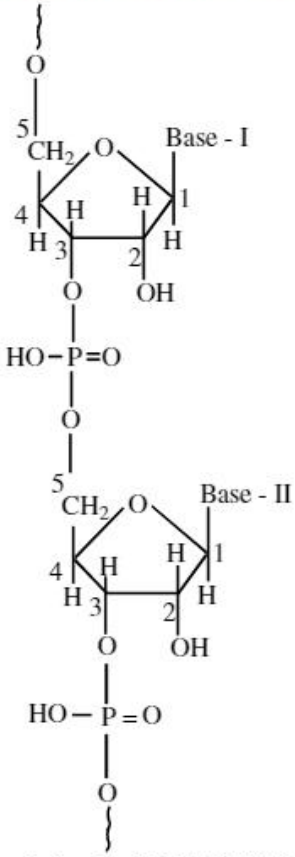
Adenylic acid	:	Adenosine + phosphoric acid
Guanylic acid	:	Guanosine + phosphoric acid
Cytidylic acid	:	Cytidine + phosphoric acid
Uridylic acid	:	Uridine + phosphoric acid



The structure of adenylic acid which is a combination of adinine, ribose and phosphoric acid has been shown.

Primary Structure of DNA

DNA is a macromolecule consisting of two polydeoxyribonucleotide chains. Each poly deoyribonucleotides is formed by linkage of many deoxyribonucleotides through phosphodiester bonds. These bonds are present between two adjacent nucleotide components. The primary structure of DNA has been shown. The base constituent may be different (e.g. adinine, cytosine)

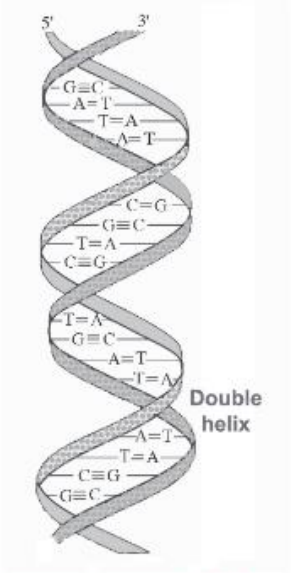


Secondary structure of DNA

J.D. Watson and F.H.C. Crick in 1953 proposed a double helicle model of DNA. According to this, DNA molecule consists of two deoxyribonucleide chains that are spirally coiled around each other on a common axis. The coiling is generally right haded and shows major and minor grooves alternately. The diameter of DNA molecule is uniform. The two chains are held together by the formation of hydrogen bonds. However the hydrogen bonding is according to a specific rule i.e., adenine binds itself to thymine and guanine to cytosine

This base pairing rule (A=T) and (C=G) suggests that the two polynucleotide chains are complementary to each other. If we know the sequence of nitrogen bases in one chain we can automatically know the sequence in the other chain.

For example, if the sequence of the nitrogen bases in one poly peptide chains is ATCCACGGG, then the sequence in the other chain will be TAGGTGCCC. Actually the two chains are parallel but in opposite directions or in antiparallel direction. Thus, if the formation phosphodienter bonds in one chain is 5'–3' then in the other chain the arrangement will be 3' - 5'. These Helical structure of DNA as given by Waton and Crick has been shown in the Fig.



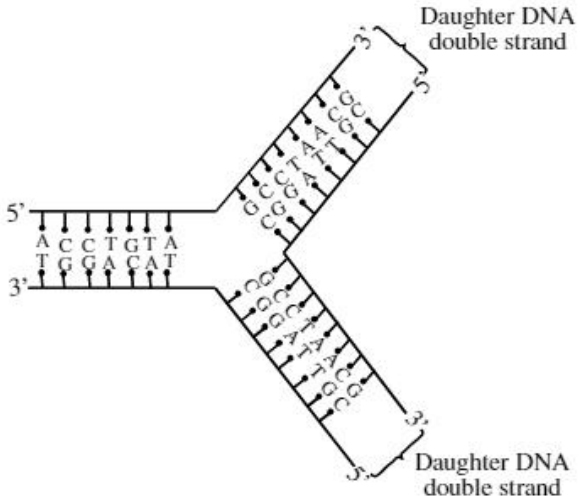
Biological Functions of Nucleic Acids

Two important biological functions of nuclei acids are: Replicaiton and protein synthesis. These are briefly discussed.

Replication, Replication may be defined as:

The process by which a single DNA molecule product two identical copies of itself.

Replication is an enzyme catalysed process. The process of replication starts with the partial unwinding of the two strands of the DNA double helix through breaking of the hydrogen bonds between pairs of base. Each strand then act as the template (or pattern) for the synthesis of two new strands of DNA in the cell environment. The specificity of base pairing ensures that each new strand is complementary to its old template strand. As a result, two identical copies of DNA from the original DNA are produced. Each of these two copies are then passed on to the two new cells resulting from cell division. In this way hereditary characters are transmitted from one cell to another.



Synthesis of proteins: Another important function of DNA is the synthesis of proteins. The DNA molecule in the cell nucleus hold the code for the synthesis of all the proteins present in a cell. This genetic information is coded in DNA in the form of specific sequence of bases. The synthesis of a specific protein involves the following two steps

a) Transcription b) Translation

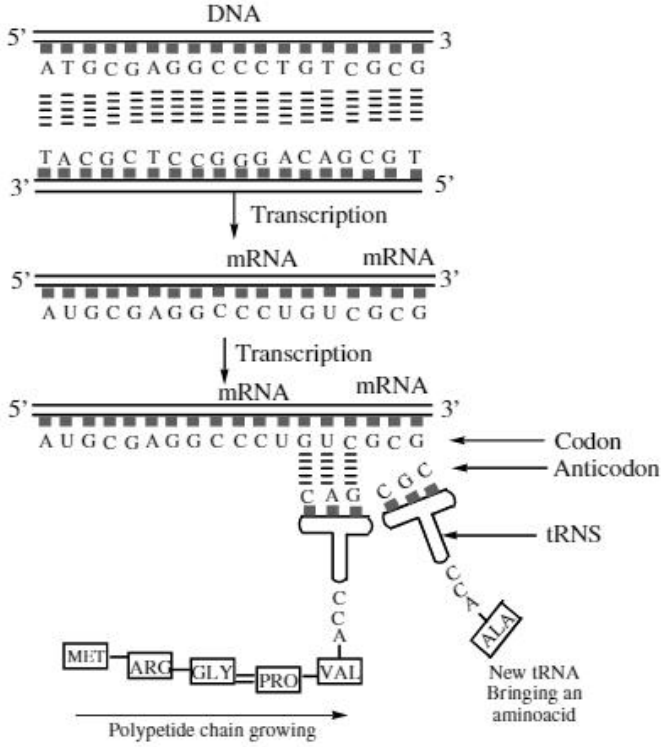
a) **Transcription :** The process which leads to the synthesis of RNA is called transcription. The process starts with the partial unwinding of the two strands of the DNA double helix through breaking of the hydrogen bonds between pairs of bases. The genetic information for the synthesis of proteins exists in the base sequence of one of the two chains of DNA molecule. This chain is often called sense chain. The base sequence on this chain act as a template (or pattern) for the synthesis of RNA. The process of transcription very similar to the process of replication with the difference that in this case ribonucleotides rather than deoxyribonucleotides assemble along the uncoilded chain in accordance with the base pairing principle. As RNA has the base uracil in place of thymine, therefore, in RNA strand, the base uracil appears opposite to the base adenine in the DNA templete. The base pairing for other bases remains the same as in replication i.e., in RNA cytosine appears opposite to guanine, adenine appears opposite to thymine and guanine appears opposite to cytosine of DNA. For example, if the base sequence in DNA strands is ATCGGTAC - the base sequence in RNA strand will be - UAGCCAIG -.

After the RNA strand is synthesised, the DNA - RNA double helix separates. The RNA thus synthesised migrate to the cytoplasm. While the DNA itself returns to its double helix structure. In this manner three type of RNAs are synthesised:

(i) messenger RNA or mRNA (ii) Transfer RNA or tRNA (iii) Ribosomal RNA or rRNA

Each of these three types of RNAs does different functions during the synthesis of a protein molecule.

(b) Translation : The synthesis of proteins occurs in the cytoplasm of the cell. After transcription mRNA moves from the synthesis of proteins occurs in the cytoplasm of the cell. After transcription serves as the templete for the synthesis of protein. The rRNA is a component of ribosomes. The specific nucleotide sequence in the mRNA determines the order in which the different amino acid residues have to be joined. The sequence of bases in mRNA are read in s serial order in groups of three at a time. Each triplet of nucleotides (having a specific sequence of bases) is known as codon. Each codon acts as a code for a particular amino acid. Since there are four different bases (adenine, cytosine, guanine and uracil) present in mRNA and particular base can be repeated (i.e., triplet like AAG or AAA are possible) therefore, $4^3 = 64$ different triplets are possible.



Out of these 61 triplets code for specific amino acids while the remaining three are known to code for chain termination. These are called stop codons or nonsense codons. Since there are only 20 different amino acids in proteins, therefore, more than one codon code for the same amino acid. For example two triplets UUU and UUC code for the same amino acid-phenylalanine. The amino acids are brought to the mRNA by another type of RNA called transfer RNA or RNA. Each amino acid has at least one corresponding tRNA.

At one end of the tRNA molecule is a trinucleotide base sequence that is complementary to some trinucleotide base sequence on mRNA. The other end of RNA molecule has a specific base sequence of three nucleotides - CCA with an –OH group on the sugar exposed on the terminal adinine nucleotide. This –OH group combines with the specific amino acid and carries it to the mRNA. After transfer of

amino acid the tRNA is free to go back and repeat the process when the synthesis of a specific protein is completed, a stop codon signals the end. The protein synthesised is released from the ribosome. Several enzymes co-ordinate this complex process.

SECOND BASE

	U	C	A	G	
U	UUU, UUC: Phenylalanine; UUA, UUG: Leucine	UCU, UCC, UCA, UCG: Serine	UAU, UAC: Tyrosine; UAA*; UAG*	UGU, UGC: Cysteine; UGA*; UGG: Tryptophan	U C A G
C	CUU, CUC, CUA, CUG: Leucine	CCU, CCC, CCA, CCG: Porline	CAU, CAC: Histidine; CAA, CAG: Glutamine	CGU, CGC, CGA, CGG: Arginine	U A G
A	AUU, AUC, AUA: Isoeucine; AUG**: Methionine	ACU, ACC, ACA, ACG: Thereonine	AAU, AAC: Asparagine; AAA, AAG: Lysine	AGU, AGC: Serine; AGA, AGG: Arginine	U C A G
G	GUU, GUC, GUA, GUG**: Valine	GCU, GCC, GCA, GCG: Alanine	GAU, GAC: Aspartic Acid; GAA, GAG: Glutamic Acid	GGU, GGC, GGA, GGG: Glycine	U C A G

*Codons for termination of peptide chain. Codons for initiation of peptide chain.

Thus the sequence of amino acids in the protein so synthesised is predetermined from the nucleotide base sequence of mRNA which in turn is correspondingly derived from the base sequence of DNA. The DNA sequence that codes for a specific protein or a polypeptide is called a gene. Thus, very protein in a cell has a corresponding gene. The relation between the nucleotide triplets and the amino acid is called the genetic code.

Protein synthesis a very fast process. About 20 amino acids added in one second. For example, the protein fibroin is the major structural component of silk. A single fibroin gene makes 10^4 copies of its mRNA and each mRNA produces 10^5 molecules of fibroin protein. Thus, a single fibroin gene makes a total of 10^9 molecules of protein per cell in period of 4 days.

DNA Fingerprinting

We all know that every individual has unique fingerprints and fingerprints of no two persons match. These occur as a circles in the tips of fingers and are being used for the identification since very long. However, they can be altered in case some surgery is done. It is quite interesting to note that every individual has its own sequence of bases in DNA and the information regarding this is called DNA fingerprinting. It is the same for all the cells in the body and cannot be changed or altered by any known means

DNA fingeprinting has assumed great significance over the years. The parentage or paternity of individuals can be established with its help in case there are counterclaims. Similarly, in accidental death particularly due to fire, it si sometimes not possible to recognise the body. The identify can be established by performing the DNA tests on the parents. It is being used in the forensic laboractories to establish the identities of individuals

Distinction Between RNA and DNA

We have discussed on detail the biological functions of both DNA and RNA. Let us try to compare them in a tabular form as follows.

Distinction between RNA and DNA

Ribonuclelc acid (RNA)	Deoxyribonucleic acid (DNA)
1. The pentose sugar present in RNA is D-ribose	The pentose sugar present in DNA is D-2 deoxyrinose.
2. RNA contains cytosine and uracll as pyrimidine bases and guanine and adenine as purine bases and guanine and adenine as purine bases.	DNA contains cytosine and theymine as pyrimidine.
3. It is a single chain of polynucleotides.	It is double chain of polynucleotides.
4. It is formed by DNA and cannot repliate itself.	It an replicate itself.
5. Its moleucle is relatively short with low molecular mass.	Its molecule is relatively long with high molecular mass.
6. It regulates protein synthesis.	It controls structure, metabolism, differentiation and transfer the characters from one generation to the other.
7. It is an essential genetic material of plant viruses	It is an essential genetic material of lukaryotic cells

Mutation:

Mutation may be defined as :A chemical change in DNA molecule that could lead to the synthesis of proteins with an altered sequence of amino acids.

The changes in DNA molecule can happen spontaneously or may be caused by radiation, chemical agents or viruses. The majority of changes in DNA are repaired by special enzymes in the cell. However, failures in repair can cause a mutation, The altered proteins produced through a mutation may have no biological activity leading to the death of cell. Mutation also leads to an increased likelihood of the development of cancerous cells. Carcinogenic compounds exert influence in this way. Thus mutation leads to the formation of defective genes which causes abnormalities or diseases.

Example-1 : If one strand of a DNA has the sequence - ATCGTCCA - what is the sequence of the complementary strand?

Solution : In a DNA molecule, adenine (A) always pairs with thymine (T) and guanine (G) always pairs with cytosine (C)

Base sequence in one strand of DNA: –ATCGTCCA–

Base sequence in the complementary strand: –TAGCAGGT–

Therefore, the sequence of bases on the complementary strands is –TAGCAGGT–

Example-2 : What will be the sequence of bases on mRNA molecule synthesised on the following strand of DNA?

Solution: We known that cytosine (C) always pairs up with guanine (G). Since RNA does not have thymine but instead has uracil, therefore, thymine (T) in DNA pairs up with adenine (A) in RNA but adenine (A) in DNA must pair up with uracil (U) in RNA

Base sequence in DNA strand:-TATCTACCTGGA-

Base sequence in mRNA strand : -AUAGAUGGACCU-

IV. VITAMINS

Vitamins represent a group of organic compounds which are required in very small amounts for the healthy growth and functioning of animals including human beings. In general, they cannot be made by organisms and so have to be supplied in the diet. They are chemically different from the main nutrients i.e., carbohydrates, proteins and fats. Absence or deficiency of a vitamin can cause a specific disease. Hence vitamins may be defined as

A group of biomolecules other than carbohydrates, proteins and fats, which are required in small amounts for the normal metabolic processes and for the life, growth and health of human beings and animals. However, these are not synthesised by the body.

Types of vitamins:

Vitamins are complex organic molecules. Previously vitamin was named as "vitamine" coined from two words vital and amine because the earilier identified compounds had amino groups. However, the later studies revealed that most of them did not contain any amino group. Therefore, the name vitamine was discarded and replaced with the present name i.e., "Vitamin". Structurally vitamins have very little in common. Therefore for simplicity, these are usually designated by alphabet letters such as A,B,C,D,E and K. About twenty five vitamins are known till date. These have been broadly classified into following two categories.

i) **Water insoluble vitamins :** These include vitamins A,D, E and K. These vitamins are fat soluble substances.

ii) **Water soluble vitamins:** These include vitamin B-Complex, (B_1, B_2, B_5 or nicotinic acid B_6, B_{12}, pantothenic acid, biotin or vitamin H and folic (acid) and vitamin C.

A useful information for the commonly used vitamins is given for the benefit of the students.

Some Important Vitamins (Characteristics, Sources and Deficiency Diseases)

Vitamin	Characteristics	Source	Deficiency diseases
1. Vitamin A or Retinal:	Soluble in oils and fats but insoluble in water, stable to heat. Promotes growth and improves vision. It also increases resistance to disease	Milk, butter, egg, fish and fish oil (cod liver oil). It can also be synthesised in the body from carotenoids present in carrots, tomatoes, ripe mangoes etc. Carotenoids are the precursors of vitamin A	Night blindness, stunted growth, xerosis (drying of skin), xerophthalmia (cornea becomes opaque)
2. Vitamin B complex: a) Vitamin B_1 or Thiamine	Soluble in water but insoluble in oils and fats. Destroyed by heat above 310K	Pulses, nuts, whole cereals (rise, wheat etc.,) rice bran, yeast, egg yolk, milk, green vegetables and fruits.	Beriberi (paralysis of legs and general weakness) and loss of appetite
(b) Vitamin B_2 or Riboflavin	Soluble in water but insoluble in oils and fats. Sensitive to light but stable to heat. Essential for growth and general health	Milk, yeast, green vegetables, meat liver, kidney etc.	Retards growth, causes general inflammation of tongue, dermatitis and cheilosis (craking of lips and corners of the mouth)
(c) Vitamin B_6 (It is a mixture of three substances-pyridoxine, pyridoxal and pyridoxamine)	Soluble in water but insoluble in oils and fats	Rice bran, yeast, meat, fish, eggs, whole cereals (wheat, maize, rice etc)	Causes pellagra (shrivelled skin) and anaemia(bloodlessness) in man. Effects central nervous system. Causes general weakness, insomnia and irritability.

Vitamin	Characteristics	Source	Deficiency diseases
d) Vitamin B_{12} or cyanocobalamin contains cobalt	Water soluble, stable to heat	Milk egg and all animal tissues	Pernicious anaemia, inflammation of tongue and mouth
3. Vitamin C or ascorbic acid	Soluble in water but insoluble in oils and fats. Destroyed by cooking or prolonged exposure to air. It increases resistance of the body towards diseases. Maintains healthy skin and helps in the heating of cuts and abrasions	Citrus fruits (oranges lemon, grape fruit, lime etc), amla, cabbage, guava etc.	Causes scurvy (bleeding of gums), pyorrhea (loosening of teeth and bleeding of gums)
4. Vitamin D or ergocalciferol	Soluble in oil and fats but insoluble in water. Stable to heat and resistant to oxidation. It controls absorpion of calciuk and phospphorus form intestine. Vitamin D is structurally related to steroids.	Eggs, fish liver oils, butterliver, meat etc. Vitamin D is produced by plants from ergosterol when exposed to light	Rickets (bending of bones) in children and deformation of bones and teeth. Osteomalacia in adults.
Vitamin E (It is a mixture of four vitamins called α,β,γ and δ-tocopherols	Soluble in oils and fats but insoluble in water. Stable to heat, light and oxidation.	Eggs, milk, fish, wheat, germ oil, nuts, cotton seed oil, peanut oil etc.	Needed for beautiful glowing skin. Antioxidant, prevents destruction of RBC. In animals, its deficiency causes sterility in males, death of embryos and muscle degeneration
Vitamin K or phylloquinone (It is a mixture of two vitamins called K_1 and K_2)	Soluble oils and fats but insoluble in water. Can withstand cooking, sensitive to light and alkali	Vitamin K_1 can be obtained from green leafy vegetables like cabbage, spinach, carrot tops and alfa alfa. Vitamin K_2 occurs mainly in intestinal bacteria.	Its deficiency leads to faulty blood clotting and haemorrhage. Vitamine K restores normal blood clotting.

V. HARMONES

In a multicellular organism, like human beings, communication between various cells is essential to regulate their development and coordinate various cellular activities. The communication among cells is established by certain bio-molecules called hormones which act as messengers. These are secreted by specialised cells called glands and are recognised by special structures called receptors located on the cell surface of the target cells. Upon receiving a chemical signal, the receptors trigger a cell to respond by bringing about specific changes in its properties. Thus hormones may be defined as:

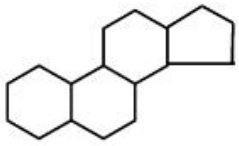
A group of biomolecules which are produced in the ductless (endocrine) glands and are carried to different parts of the body by the blood stream where they control various metabolic processes or show physiological activity which may be inhibitory or stimulatory. They are required only in very small amounts and are not stored in the body.

In mammals, the secretion of the hormones is controlled by anterior lobe of the pituitary gland located at the base of the brain. These hormones are then carried to the other gland such as adrenal cortex, thyroid and sex glands, to stimulate the production of other hormones. Hormones are very potent and so are produced in small quantities only

Classification of hormones

Based on their chemical structure hormones, fall into three classes: steroid hormones, polypeptide hormone and amine hormones.

1. **Steroid Hormones:** Steroids are a group of naturally compounds which are widely distributed in plants and animals. Their structure is based on a four ring network consisting of three cyclohexane rings and one cyclopentane ring. Apart from hormones, the steroid nucleus is found in some vitamins, drugs, and bile acids. Steroid alcohols are known as sterols. Cholestrol is the most common sterol present abundantly in animals. It is a part of all cell membranes and is the starting point for the synthesis of all other steriods. Steroid hormones are of two types.



Steroid nucleus

(a) **Sex Hormones:** One of the most important groups of steroid hormones are the sex hormones. In males, steroid hormones originate in testes and adrenal cortex. Testosterone, dihydroestosterone and endrogens are the principal male sex hormones. During puberty, these stimulate the development of primary as well and secondary male sex characteristics such as voice, growth of hairs, texture of skin etc., Which differentiate males from females. Estrogens are female sex hormones. These are produced primarily in ovaries and are responsible for development of female sex characteristic during puberty. A third group of sex hormones are gestogens. These are corpus leuteum hormones. Common examples of gestogens are progesterone, pregnandiol etc.

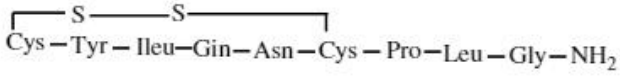
In addition, male and female sex hormones have significant effects on anabolic system. Male sex hormones are used by athletes and sportsmen to increase the mass and strength of muscles. The use of anabolic steriods is now banned in competitive sports. Some synthetic female sex hormones such as mestranol are used as oral contraceptives (e.g., Mala - D). When these are taken orally they suppress ovulation.

(b) **Adrenal Cortex Hormones:** Hormones produced by cortex of the adrenal glands are known adrenal cortex hormones of corticoids, Their production is controlled by the hormones of the anterior lobe of the pituitary glands. Some important examples of corticoids are cortisone, corticosterone, and aldosterone. These hormones regulate metabolic process, control mineral and water balance. The deficiency of the se hormones leads to the loss of fluids and their excess results in an increase in blood pressure.

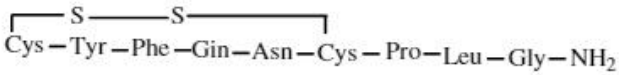
2. **Peptide Hormones:** Peptide hormones are made up of α – amino acid units. Common example of peptide hormones are insulin, oxytocin, vasopressin, angiotensin II glucagon, secretion etc. A few important peptide hormones are briefly discussed.

(i) ***Insulin:*** It is a polypeptide hormone secreted by pancreas. Its function is to lower blood glucose level by increasing the rate of conversion of glucose into glycogen. Its deficiency in human beings causes diabetes.

(ii) ***Oxytocin:*** It is secreted by the posterior lobe of pituitary gland. It causes the contraction of the uterus during child birth. It is a nano - peptide (peptide made from nine amino acid residues) with the following amino acid sequence.



(iii) ***Vasopressin:*** It is also secreted by the posterior lobe of pituitary gland. It controls the reabsorption of water in the kidneys. It is a nanopeptide (peptide made from nine amino acid residues) with the following amino acid sequence

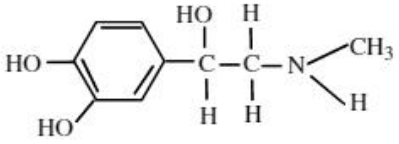


(iv) ***Angiotensin:*** It is present in blood plasma of persons with high blood pressure (hypertension). It is a potent vasocontrictor i.e., it leads to the construction of blood vessles. It is an octapeptide i.e., it contains eight amino acid residues

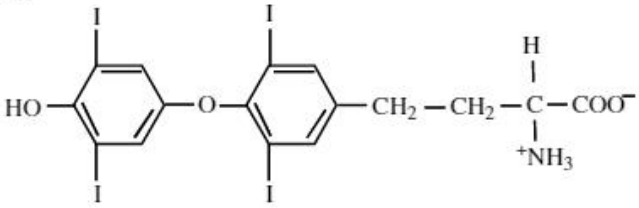
3. **Amine Hormones:** Amine hormones are water soluble compounds. These are structurally derived from amino acids. Examples of amine hormones are adrenaline (epinephrine) and thyroid hormones such as thyroxin.

(i) ***Adranaline:*** It is secreted by adrenal medulla. It is needed to prepare animals including humans for emergency in several ways. It increases the heart beat rate, the heart output and the blood pressure. It prepares the ardiovascular system for emergency action. It stimulates the breakdown of liver glycogen into blood glucose which is the fuel for anaerobic muscular work. These properties make adrenaline one of the most valuable drugs used in medicine.

(ii) Thyroid hormones such as thyroxin, are secreted by thryoid gland. It controls the metabollism of carbohydrates, proteins and lipids.



Adernaline



Thyroxine

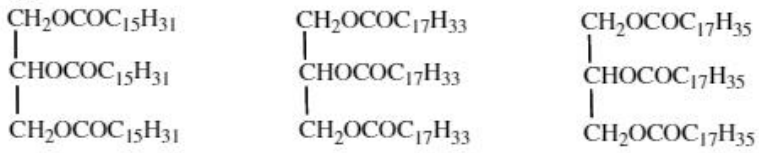
The deficiency of hormones caused series of metabolic disturbances in the body such as diabetes, goitre etc. An imbalance of sex hormones may result in malfunctioning of the sex organs.

VI. LIPIDS

The term 'lipids' embraces a variety of naturally occurring compounds which in general are sparingly soluble in water and more soluble in organic solvents. In addition to this, all lipids yield monocarboxylic acids (saturated and unsaturated) upon hydrolysis. Lipids include oils, fats, waxes and phospholipids.

Oils and Fats : These are often known as simple lipids. These are chemically the triesters of glycersol with a variety of acids and are also called glycerides or triglycerides.

A few common glycerides are :



Tripalmitin Triolein Tristearin

Oils are liquids ordinary temperature and contain large proportions of unsaturated acids (e.g. triolein). Fats are solids at room temperature and contain large proportions of saturated acids (Tripalmitin and Tristearin). It has been pointed out earlier that fats and oils are the major source of energy for the human body. These hydrolysed in the intestines in the presence of the enzyme 'lipase' to form glycogen and fatty acids. These are absorbed in the blood stream. When they reach cells, combustion takes place to form carbon dioxide and water and energy is liberated.

$$\text{Oils and Fats + Water} \xrightarrow{\text{Lipase}} \text{Glycerol + Fatty acids}$$

$$\text{Glycerol or Fatty acids + oxygen} \rightarrow \text{Carbon dioxide + Water + Energy}$$

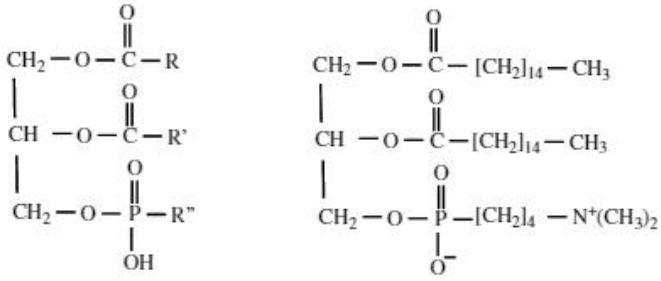
The energy which is released is stored in the form of adenosine triphosphate (ATP). Whenever energy is needed, ATP hydrolyses to give adenosine diphosphate (ADP), phosphate ion and energy.

$$\text{ATP + Water} \rightarrow \text{ADP + Phosphate + Energy}$$

This energy is utilised for various activities of the body as well to maintain the body temperature. One gram of an oil or a fat provides about 30 kJ of heat during combustion. This is almost double the mount of heat provided by carbohydrates. Hence the oils and fats are good source of energy. They are into needed to absorb vitamins A and D in the intestinal tract and to transport them in the body. Moreover they act as thermal insulators and protect our body from temperature fluctuation of the climate. Facts are reserve food materials in the body and remain stored under the skin. They can hydrogenase to provide energy during starvation or illness.

Phospholipids

These are the triglycerides in which –OH groups of glycerol esterified by fatty acids and the third –OH group is esterified with phosphoric acid and a suitable alcohol.



A phospholipid Lecithin

Lecithin is the phospholipid present in the white of an egg. The cell membranes are mainly made of phospholipids and globular proteins. The relative proportions of these two constituents vary among different cells. In a cell membrane the phospholipids are arranged in a double layer or bilayer their polar heads facing outside and non-polar tails into the interior of the membrane. This mangement allows the polar hydrophillic phosphate ester head groups to ineract with aqueous arrounding both inside and outside of the cell. On the other hand, this arrangement permits the non-hydrophobic tails to be away from the aqueous surroundings. The protein components of the membrane are either embedded in the bilayer called intrinsic proteins or are attached to either side of membrane called extrinsic proteins depending upon their functions.

LECTURE SHEET

EXERCISE-I

(Proteins and nucleic acids, Enzymes, Vitamins, Harmones, Lipids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The functional group which found in amino acid is
   1) –COOH group 2) $-NH_2$ group 3) $-CH_3$ group 4) both 1 & 2
2. The building unit of all proteins are
   1) monosaccharides 2) lipids 3) amino acids 4) primary amines
3. The structural feature which distinguishes proline from α- amino acids is
   1) It is optically inactive 2) It contains aromatic group
   3) It is a dicarboxylic acid 4) It is a secondary amine
4. Which of following amino acids contains a thiol group in the side chain
   1) methionine 2) cysteine 3) valine 4) serine
5. The number of amino acids found in proteins that a human body can synthesize is
   1) 20 2) 10 3) 5 4) 14
6. Among the following the basic amino acid is
   1) Glycine 2) Argenine 3) Proline 4) Cysteine
7. For an aminoacid 'X', the isoelectric point is 6.1. Then 'X' is
   1) Acidic amino acid 2) Basic amino acid
   3) Neutral amino acid 4) Acidic or basic amino acid
8. β-pleated structure of proteins is
   1) Primary structure 2) Secondary structure
   3) Tertiary structure 4) Quaternary structure
9. The back bone for different segments in a protein is in the following form
   1) α-helix 2) α-pleated 3) coil 4) 1 or 3
10. Secondary structure of protein refers to
    1) Mainly denatured proteins and structure of prosthetic groups
    2) Three-dimensional structure, especially the bond between amino acid residues that are distinct from each other in the polypeptide chain
    3) Linear sequence of amino acid residues in the polypeptide chain
    4) Regular folding patterns of continuous portions of the polypeptide chain
11. Tertiary structure of a protein will lead the polypeptide chains to get the following shapes
    1) linear, octahedral 2) angular, tetrahedral
    3) fibrous, globular 4) fibrous, planar
12. The restriction of the biological nature and activity of proteins by heat or chemical agent is called
    1) dehydration 2) denaturation 3) deamination 4) denitrogenation

13. Which of the following is an example of "irreversible denaturation" of a protein ?
1) boiling egg 2) change of amino acid 3) enzymatic action 4) its synthesis

14. Which one of the following is not a protein?
1) Wool 2) Nail 3) Hair 4) DNA

15. For a neutral amino acid (X), isoelectric point is 5.8. Now its solubility at this point in water is
1) maximum 2) minimum 3) zero 4) unpredictable

16. Which of the following molecule is capable of forming zwitter ion ?
1) CH_3–CHOH–NH_2 2) NH_2CH_2COOH 3) CH_3–COOH 4) CCl_3–NO_2

17. Regarding secondary structure of a protein, correct statement(s) is/are
A) peptide bonds possess regional planarity
B) C=O and –NH– of different peptide chains are held by Van der Waal attarctions
C) closely packed arrangement so as to minimise repulsion between "R" groups
1) only C 2) only B 3) A and B only 4) A and C only

18. The secondary structure of a protein refers to
1) hydrophobic interactions 2) sequence of α-amino acids
3) fixed configuration of the polypeptide backbone 4) α-helical backbone.

19. In a protein, the different types of attractions that exist are
A) H bonding B) hydrophobic C) ionic D) covalent
1) B, C and D only 2) A, C and D only 3) A, B and C only 4) A, B, C and D

20. The non-protein portion of a protein is called
1) Functional 2) Characteristic group 3) Prosthetic group 4) Enolic group

21. The function of enzymes in the living system is to
1) transport oxygen 2) provide immunity
3) catalyse biochemical reactions 4) provide energy

22. Enzymes belong to which class of compounds ?
1) Polysaccharides 2) Polypeptides
3) Polynitro heterocyclic 4) Hydrocarbons

23. Enzymes are made up of
1) Edible proteins 2) Proteins with specific structure
3) Nitrogen containing carbohydrates 4) Carbohydrates

24. Nuclic acids are called acids mainly because of the presence of
1) –COOH group 2) –OH group of sugar unit
3) –OH group of the heterocyclic base 4) –OH group of phosphate unit

25. Which of the following is not a pyrimidine base
1) Uracil 2) Thymine 3) Cytosine 4) Guanine

26. The following does not belong to either purines or pyrimidines
1) Tryptophan 2) Cytosine 3) Uracil 4) Adenine

27. The purine base present in RNA is
1) Guanine 2) Thymine 3) Cytosine 4) Uracil

28. The bases that are common in both RNA and DNA are
1) adenine, guanine, cytosine 2) adenine, guanine, thymine
3) adenine, uracil, cytosine 4) guanine, uracil, thymine

29. Adenosine monophosphae (AMP) is a
1) nucleotide 2) nucleoside 3) insecticide 4) antibacterial

30. An example for N-glycoside is
1) Adenine 2) Guanine 3) Cytosine 4) Cytidine

31. Adenosine is an example of a
1) Nucleotide 2) Nucleoside 3) Purine base 4) Pyridine base

32. Nucleoside on hydrolysis gives
1) Pentose sugar and purine base
2) Pentose sugar, phosphoric acid, purine or pyrimidine base
3) Pentose sugar and a heterocyclic base 4) Heterocyclic base and phosphoric acid

33. In nucleic acids, the sequence is represented as
1) Phosphate - base - sugar 2) Sugar - base - phosphate
3) Base - sugar - phosphate 4) Base - phosphate - sugar

34. Adenine pairs with thymine through
1) two hydrogen bonds 2) one hydrogen bond
3) three hydrogen bonds 4) four hydrogen bonds

35. Hydrolysis of adenosine triphosphate involves rupture of
1) Base-sugar bond 2) Sugar-phosphate bond
3) P–O–P bond 4) P–N–P bond

36. The backbone of a nucleotide strand contains the following sequence of arrangement
1) Base–Sugar 2) Sugar–Phosphate 3) Base–Phosphate 4) $Base_1$–$Base_2$

37. AT/GC value for human beings is
1) 1.52 2) 1.25 3) 0.93 4) 1

38. The couplings between base units of DNA is through :
1) Hydrogen bonding 2) Electrostatic bonding
3) Covalent bonding 4) Vander Waals forces

39. Synthesis of identical copies of DNA is called
1) transcription 2) replication 3) translation 4) reverse transcription

40. The prosthetic group attached to the enzymes of vitamin B_{12} at the time of reaction is
1) cellulose 2) 5 - deoxy adenosyl
3) β-methly aspartic acid 4) glutamic acid

41. Water soluble vitamins are
1) A,D 2) E,K 3) D,E 4) C,B

42. Which one of the following is a source of vitamin "A" ?
1) Milk 2) Fish liver oil 3) Yeast 4) Egg

43. Sterol, the basic unit of vitamin D, consists of 4 rings they are
1) Three 6-carbon rings one five carbon ring 2) Three 5-carbon rings one six carbon ring
3) Four 6-carbon rings only 4) Four 5-carbon rings only

44. Deficiency of Vitamin E leads to
1) Neurosis of heart muscles 2) Degeneration of lacrymal gland
3) Beri-Beri 4) Dermatitis

45. Anti haemorrhagic vitamin is
1) A 2) B 3) D 4) K

46. Defficiency of the following vitamin leads to pellagra
1) A 2) B_2 3) B_5 4) C

47. Convulsion is due to deficiency of vitamin
1) B_1 2) B_2 3) B_5 4) B_6

48. The cheaf source of vitamin "H" is
1) Yeast 2) Citrous fruit 3) Rice polish 4) Cereals

49. Vitamin E is also called
1) Cyanocobalamin 2) Tocopherol 3) Lactoflavin 4) Ascorbic acid

50. The best source of vitamin C is
1) Codeliver oil 2) Egg yolk 3) Citrous fruits 4) Fish liver oil

51. Nervousness anaemia is caused by the deficiency of vitamin
1) B_1 2) B_2 3) B_6 4) B_{12}

52. Which one of the following statements is true regarding vitamin ?
1) Vitamins are needed in large amounts to maintain good health
2) Vitamins are secreted by ductless glands
3) Vitamins A,D,E,K are fat soluble and vitamins B complex and C are water soluble
4) All vitamins are synthesised in human body

53. Which of the following substance acts as stimulator ?
1) Vitamin 2) Enzyme 3) Hormone 4) Carbohydrate

54. Harmone containing only ketonic functional group is
1) Estradiol 2) Progresterone 3) Testosterone 4) Insulin

55. In insulin molecule S–S linkage is in between
1) Cysteine–Glycine 2) Cystein – Cystein 3) Cysteine–Valanine 4) Proline – Cystein

56. Which of the following maintains constant sugar level in blood ?
1) Gibberlins 2) Insulin 3) Glucogen 4) Estrone

57. For artificial ripening of fruit which of the following is used ?
1) Testosterone 2) Insulin 3) Ethylene 4) Estrogen

58. The hormone which controls the uterine cycle in women is
1) Estrone 2) Androsterone 3) Progesterone 4) Testosterone

59. Insulin is a
1) Non steroidal, peptide hormone 2) Steroidal, peptide hormone
3) Non steroidal, amino acid hormone 4) Steroidal, amino acid derivative hormone

60. An example for amino acid hormone is ?
1) Insulin 2) Testosterone 3) Thyroxine 4) Progesterone

61. In insulin molecule there are two chains 'A' and 'B', 'A' contain 'X'-amino acids and 'B' contain 'Y' amino acids. The value of X and Y are
1) 21, 31 2) 21, 30 3) 28, 36 4) 32, 34

62. In plants, lipids occur in
1) fruits 2) nuts 3) seeds 4) all the above

63. Which one of the following acts as an emulsifier in lipid metabolism?
1) Amino acid 2) Fatty acid 3) Bile acid 4) Gluconic acid

64. The fat α – oleo-β – palmito-α^1 – stearin is an example of
1) tri glyceride 2) simple lipid 3) mixed fat 4) all the above

65. $\begin{matrix} CH_2 - O - CO - C_{15}H_{31} \\ | \\ CH - O - CO - C_{17}H_{33} \\ | \\ CH_2 - O - CO - C_{17}H_{35} \end{matrix}$
This neutral lipid is called as
1) α - palmito, β -oleo, α^1 - stearin 2) α - oleo, β - palmito, α^1 - stearin
3) α - stearo, β -oleo, α^1 - palmitin 4) α - palmito, β - oleo, γ - stearin

66. Which of the following lipids can insulate nerve impulse?
1) Simple lipids 2) Phospholipids 3) Glycolipids 4) Terpenes

67. Lanoline wool is
1) Palmitic ester of cholesterol only 2) Stearic ester of cholesterol only
3) Oleic ester of cholesterol only 4) palmitic or stearic or oleic ester of cholesterol

68. A carbohydrate, galactose is present in
1) Terpenes 2) Glycerophosphatides 3) Glycolipids 4) Phosphoinositides

69. Molecular formula of cholesterol is
1) $C_{27}H_{45}OH$ 2) $C_{28}H_{43}OH$ 3) $C_{27}H_{43}OH$ 4) $C_{28}H_{45}OH$

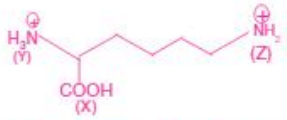
70. Tristearin and Triolein are ____ lipids
1) saturated, unsaturated 2) unsaturated, unsaturated
3) saturated, saturated 4) unsaturated, saturated

71. A diglyceride on hydrolysis gave glycerol and a fatty acid. If the formula of fatty acid is $C_{15}H_{31}COOH$, the diglyceride is
A) simple lipid B) 1,2-stearin C) 1,2-palmitin D) 1,3-palmitin
1) A, B and D 2) B, C and D 3) A, B and C 4) A, C and D

LEVEL-II (ADVANCED)

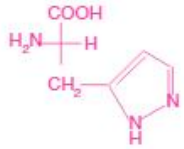
Straight Objective Type Questions

1. Consider in the compound given :



The correct order of acidic nature of the positions X, Y, Z is

a) Z > X > Y b) X > Y > Z c) X > Z > Y d) Y > X > Z

2. 

Histidine has pK_{a1}=1.8, pK_{a2} = 9.2 and pK_{a3} = 6.0. The isoelectric point, PI of histidine is likely to be

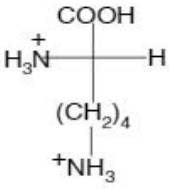
a) in between 1.8 and 6.0

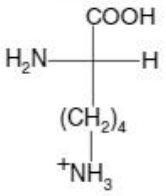
b) in between 6.0 and 9.2

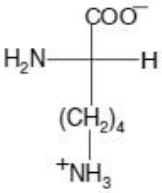
c) below 1.8

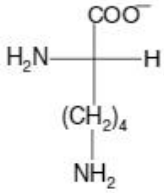
d) above 9.2

3. Which of the following is the major solute species in a solution of lysine at pH=10.5(pI=9.6)?

a) 

b) 

c) 

d) 

4. In an electric field, if an amino acid migrates towards cathode, the pH of the solution is said to be

a) less than pI b) more than pI

c) equal than pI d) 7 (seven)

5. During the process of digestion, the proteins present in food materials are hydrolysed to amino acids. The two enzymes are involved in the process.

Proteins $\xrightarrow{\text{Enzyme - A}}$ polypeptides $\xrightarrow{\text{Enzyme - B}}$ amino acids are respectively.

a) pepsin and trypsin

b) invertase and zymase

c) amylase and maltase

d) diastase and lipase

6. Proteins give

a) a violet colour with alkaline $CuSO_4$ solution

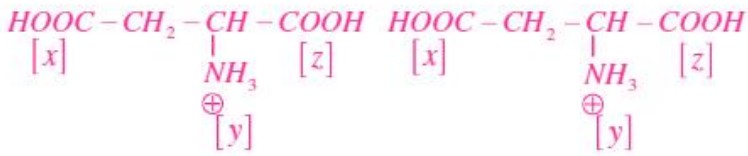
b) a purple colour on boiling with dilute ninhydrin solution

c) yellow colour on boiling with HNO_3

d) All the above

7. The primary structure of protein is based upon the
   a) hydrogen bonding
   b) vander Waal's attraction
   c) ionic bonding
   d) covalent bonding

8. The Pka values for 3-Ionisable groups x, y, z of glutamic acid are 4.3, 9.7 & 2.2 respectively.



   The isoelectric point for the Aminoacid is
   a) 7.0 b) 3.25 c) 4.95 d) 5.95

9. The enzyme Ptyalin used for the digestion of food is present.
   a) Blood b) Saliva
   c) Intestines d) Adrenal gland

10. Which of the following set contain only essential Amino acids?
   a) Alanine, Tyrosine, Cysteine
   b) Leucine, Lysine, tryptophan
   c) Alanine, glutamine, Lysine
   d) Leucine, Proline, glycine

11. Which of the following has Imidazole ring
   a) Alanine b) Tyrosine c) Leucine d) Histidine

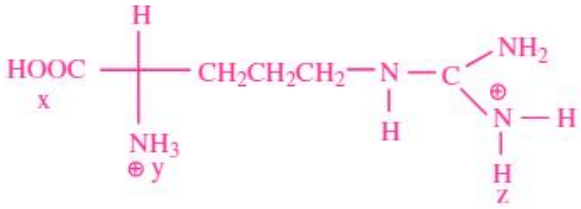
12. The 10% energy transfer law of food chain was given by
   a) Linderman b) Tansley c) Stanely d) Weismann

13. Which of the following test is used to test for peptide linkage
   a) Biuret test b) Ninhydrin test
   c) Molischsis test d) Borsch's test

14. Which of the following protein destroy the antigen, when it enter in Body cell.
   a) Insulin b) Antibody
   c) Chromo protein d) Phaspno proteine

15. Which of the following statement is/are true?
   a) All amino acids found in proteins have L-configuration
   b) All amino acids contain one chiral center
   c) Some amino acids contain one, while some contain more (or) even no chiral centers
   d) All aminoacids found in proteins have primary amino group.

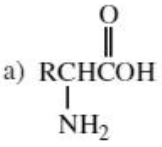
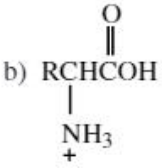
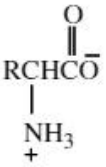
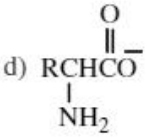
More than One correct answer Type Questions

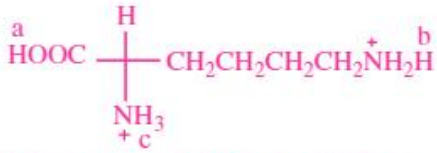
16. 

Correct order of basic strength is

a) x > y > z b) x > z > y c) z > y > x d) y > z > x

17. When α -amino acid is dissolved in water and the pH of the solution adjusted to 12, which of the following species is predominant ?

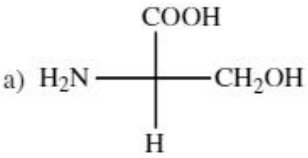
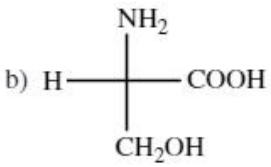
a)  b)  c)  d) 

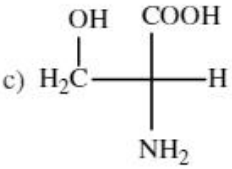
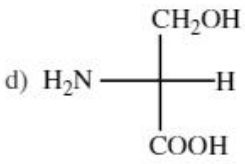
18. 

Correct order of acidic strength is

a) a > b > c b) c > b > a c) a > c > b d) b > a > c

19. Which of the following/s does not belong to L-serine

a)  b) 

c)  d) 

20. Excess of $Na^{(+)}$ ions in human body causes.

a) Heigh B.P. b) Fat c) Low B.P. d) Diabetes

21. Which of the following aminoacid does not contain S-atom

a) Serine b) Lysine c) Tyrosine d) Cysteine

22. Among the following fatty acid/s are

a) Oleic acid b) Stearic acid c) Palmitic acid d) Nucleic acid

Linked Comprehension Type Questions

Passage - I: **(Amino acids)**

	pK_{a_1} (–COOH)	pK_{a_2} ($-NH_2$)	pK_{a_3} (Acid or base of –R)
$HOOC-CH_2-\underset{\underset{NH_2}{\mid}}{CH}-COOH$			
	2.1	9.8	3.9
Aspartic acid			
$HOOC-\underset{\underset{NH_2}{\mid}}{CH}-(CH_2)_4-NH_2$	pK_{a_1} (–COOH)	pK_{a_2} ($-NH_2$)	pK_{a_3} (Acid or base of –R)
Lysine	2.2	9.0	10.5
$HOOC-\underset{\underset{NH_2}{\mid}}{CH}-CH-OH$			
Threonine	2.6	10.4	
$HOOC-\underset{\underset{NH_2}{\mid}}{CH}-CH_2CH_2CONH_2$			
Glutamine	2.2	9.1	

23. The aqueous solution of lysine is neutral at

a) pH = 7 b) pH = 9.8 c) 2.2 d) 5.6

24. At pH = 3 which of the following of aspartic acid is predominant ?

a) $^{-}OOC-CH_2-\underset{\underset{NH_3^+}{\mid}}{CH}-COO^-$

b) $^{-}OOC-CH_2-\underset{\underset{NH_3^+}{\mid}}{CH}-COO^-$

c) $HOOC-CH_2-\underset{\underset{NH_3^+}{\mid}}{CH}-COO^-$

d) $HOOC-CH_2-\underset{\underset{NH_2}{\mid}}{CH}-COO^-$

25. Consider the following structures for glutamine:

I) $HOOC-\underset{\underset{NH_2}{\mid}}{CH}-CH_2CONH_2$

II) $^{-}OOC-\underset{\underset{NH_2}{\mid}}{CH}-CH_2CONH_2$

III) $^{-}OOC-\underset{\underset{+NH_3}{\mid}}{CH}-CH_2CONH_2$

a) I and II are conjugate acid-base pairs

b) The maximum conc. of II is found at pH = 9.1

c) The maximum con. of III is found at pH = 2.2

d) I and II are conjugate acid and conjugate base of III, respectively

26. The Zwitter ionic form of lysine is

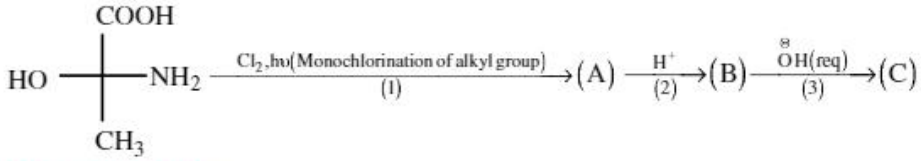
a) $^{-}OOC-\underset{\underset{NH_2}{|}}{CH}-(CH_2)_4-\overset{+}{N}H_3$

b) $^{-}OOC-\underset{\underset{+NH_3}{|}}{CH}-(CH_2)_4-NH_2$

c) $HOOC-\underset{\underset{+NH_3}{|}}{CH}-(CH_2)_4-\overset{+}{N}H_3$

d) $^{-}OOC-\underset{\underset{+NH_3}{|}}{CH}-(CH_2)_4-\overset{+}{N}H_3$

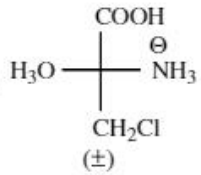
Passage-II :



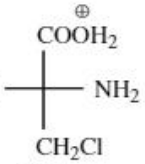
27. The product (A) is

a) An achiral compound
b) Chiral compound(racemic mixture)
c) A chiral compound (optically pure)
d) A mixture of diastereomers

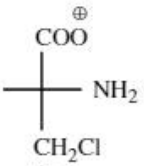
28. Compound (B) is

a) 

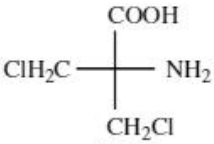
(±)

b) 

(±)

c) 

(±)

d) 

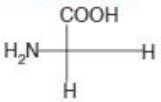
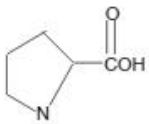
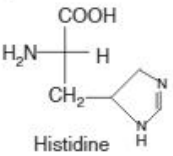
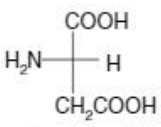
(±)

29. The product (C) is

a) An anion
b) A zwitter ion(species with positive and negative end)
c) A cation
d) A dianion

Matrix Matching Type Questions

30. Match the following.

Column-I	Column-II
A)  Glycine	p) Optically active amino acid
B)  proline	q) Suitable for van slyke estimation
C)  Histidine	r) Neutral amino acid
D)  Aspartic acid	s) Basic amino acid

31. Match the following.

Column-I	Column-II
A) $CH_3-\underset{\underset{NH_2}{|}}{CH}-CH_2-\overset{\overset{O}{\|}}{C}-OH$	p Exists as Zwittter ion in solid form
B) $CH_3-CH_2-\underset{\underset{NH_2}{|}}{CH}-COOH$	q) On heating gives diastereomeric product
C) $H_2N-CH_2.CH_2CH_2-\overset{\overset{O}{\|}}{C}OH$	r) On heating gives a cyclic product
D) H_2N-CH_2-COOH	s) Treatment of ninhydrin gives blue colour

Integer Type Questions

32. What is the total number of acidic amino acids found in human proteins ?

33. Net charge available on a basic amino acid at pH = 1 would be

34. How many tripeptides are possible when Glycine, Alanine and Phenylalanine are allowed to form peptide bonds ?

35. A tripeptide is composed equally of L–valine, L–tyrosine and L–alanine (one molecule of each). How many isomeric tripeptides of this kind may exist _____

36. In an amino acid the Carboxylic group ionises at $p^{Ka_1} = 2.40$ and Ammonium ion at $p^{Ka_2} = 9.60$ then the isoelectric point is?

37. Iso electric point of Alanine is $p^H = 6$. At which p^H, maximum concentration of zwitter ion of alanine will be present ?

KEY SHEET (LECTURE SHEET)

EXERCISE-I

LEVEL-I

1) **4**	2) **3**	3) **4**	4) **2**	5) **2**	6) **2**	7) **3**	8) **2**
9) **4**	10) **4**	11) **3**	12) **2**	13) **1**	14) **4**	15) **2**	16) **2**
17) **4**	18) **4**	19) **3**	20) **3**	21) **3**	22) **2**	23) **2**	24) **4**
25) **4**	26) **1**	27) **1**	28) **1**	29) **1**	30) **4**	31) **2**	32) **3**
33) **3**	34) **1**	35) **3**	36) **2**	37) **1**	38) **1**	39) **2**	40) **2**
41) **4**	42) **2**	43) **1**	44) **1**	45) **4**	46) **3**	47) **4**	48) **1**
49) **2**	50) **3**	51) **4**	52) **3**	53) **3**	54) **2**	55) **2**	56) **2**
57) **3**	58) **3**	59) **1**	60) **3**	61) **2**	62) **4**	63) **2**	64) **4**
65) **1**	66) **2**	67) **4**	68) **3**	69) **1**	70) **1**	71) **4**	

LEVEL-II

1) **b**	2) **b**	3) **d**	4) **a**	5) **a**	6) **d**	7) **d**	8) **b**
9) **b**	10) **b**	11) **d**	12) **a**	13) **a**	14) **b**	15) **c**	16) **c**
17) **d**	18) **c**	19) **acd**	20) **ab**	21) **bc**	22) **abc**	23) **b**	24) **c**
25) **a**	26) **a**	27) **b**	28) **a**	29) **b**	30) **A-qr; B-pr; C-pqs; D-pq**		
31) **A-q; B-pqrs; C-r; D-pr**			32) **7**	33) **1**	34) **1**	35) **6**	36) **6**
37) **6**							

PRACTICE SHEET

EXERCISE-I

(Proteins and nucleic acids, Enzymes, Vitamins, Harmones, Lipids)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The peptide linkage is

1) $-\overset{|}{C}H-COO-NH-$ 2) $-\overset{|}{C}H-CO-NH-$

3) $-\overset{|}{C}H-CH_2-CO-NH_2$ 4) $-\overset{|}{C}H-NH-NH-CO-$

2. Which of the following amino acids possesses a non-polar side chain

1) isoleucine 2) serine 3) cysteine 4) glutamic acid

3. The amino acid which contain a hydroxy group in the side chain

1) cysteine 2) glutamine 3) serine 4) leucine

4. Imino acid among these compounds is

1) Serine 2) Proline 3) Tyrosine 4) Lysine

5. Which of the following statement is not correct ?

1) proteins are polyamides formed from amino acids

2) except glycine, all other amino acids show optical activity

3) natural proteins are made up of L-isomers of amino acids

4) in α amino acids, $-NH_2$ and –COOH groups are attached to different carbon atoms

6. Which of the following statement is not correct ?

1) amino acid can exist as inner salt

2) each polypeptide has one C - terminal and other N - terminal

3) Enzymes are naturally occurring simple proteins

4) The union of two amino acids produces two peptide linkages

7. Which of the following is a globular protein?

1) Collagen 2) Myoglobin and Haemoglobin

3) Myosin 4) Enzymes

8. IUPAC name of Glycine is
   1) 2-amino propanoic acid 2) 2-amino butanoic acid
   3) 2-amino ethanoic acid 4) 2-amino pent-1, 5-dioic acid

9. Among Valine, Leucine, Isoleucine,Lysine and phenyl alanine, odd member is
   1) Leucine since others are acidic 2) Valine since others are basic
   3) Isoleucine since others are optically active 4) Lycine since others are neutral

10. D-Alanine differs from L-Alanine with respect to
   1) configuration 2) chemical formula
   3) number of $-NH_2$ groups 4) number of –COOH groups

11. In L-Phenyl alanine the amino group lies at
   1) right side to chiral centre 2) left side to chiral centre
   3) para position to –COOH in benzene ring 4) ortho position to –COOH in benzene ring

12. Nature of aqueous solutions of two different amino acids X and Y are acidic and basic. Now X and Y are
   1) Alanine and Valine 2) Aspartic acid and Aspargine
   3) Glutamine and Glutamic acid 4) Aspartic acid and Lysine

13. The pH at which an amino acid carries no net charge is called it's
   1) isoelectric point 2) inversion point 3) neutralisation poin 4) triple point

14. Which of the following does not exit as a zwitter ion ?
   1) Glycine 2) Alanine 3) Sulphanilic acid 4) Picric acid

15. Which of the following belongs to oligo peptides ?
   1) Toxin 2) effective hormone 3) DNA 4) t-RNA

16. Number of peptide linkages in the artificial sweetner "aspartame" is
   1) 2 2) 21 3) 1 4) 11

17. Proteins contain the following chemical linkages in addition to –CO–NH– linkages
   1) NH----- O = C 2) –HS = SH– 3) C = N----H–O– 4) –O–O–

18. Proteins cannot be denatured by the addition of
   1) water 2) acids 3) detergents 4) heat

19. Denaturation of protein leads to loss of its biological activity by
   1) Formation of amino acids
   2) Loss of primary structure
   3) Loss of both primary & quaternary structures
   4) Loss of both secondary and tertiary structures

20. Urea $\xrightarrow{x} CO_2 + NH_3$. The enzyme '$x$' is
   1) Invertase 2) Lactase 3) Urease 4) α -amylase

21. Cellulose converted to Glucose by the action of
   1) Maltase 2) Emulsin 3) Pepsin 4) Trypsin

22. Enzymes are associated with same non-protein component called
   1) Co-factor 2) Promoter 3) Catalytic poison 4) All

23. Trypsin converts proteins to
1) α -L-amino acid 2) Pepsin 3) Lactase 4) Invertase

24. Which of the following constitutes the genetic material of the cell ?
1) Nucleic acids 2) Proteins 3) Lipids 4) Carbohydrates

25. Which one of the following is not present in DNA?
1) adenine 2) ribose 3) cytosine 4) guanine

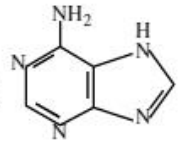
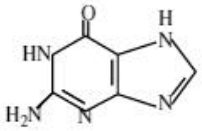
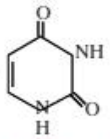
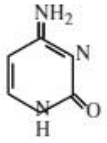
26. A nitrogenous base which is present in the structure of RNA but not in DNA is
1) Uracil 2) Thymine 3) Cytosine 4) Guanine

27. The pentose sugar in DNA and RNA has
1) Open chain structure 2) Pyranose structure 3) Furanose structure 4) None of the above

28. In nucleic acids, the nucleotides are linked to one another through
1) Hydrogen bond 2) Peptide bond 3) Glycosidic linkage 4) Phosphate groups

29. In both DNA and RNA, heterocyclic base and phosphate ester linkages are at
1) C'_5 and C'_2 respectively of the sugar molecule
2) C'_2 and C'_5 respectively of the sugar molecule
3) C'_1 and C'_5 respectively of the sugar molecule
4) C'_5 and C'_1 respectively of the sugar molecule

30. How many base pairs are present in each full turn of the DNA double helix ?
1) 4 2) 6 3) 8 4) 10

31. The base present in Cytidine :
1) 
2) 
3) 
4) 

32. The ratio of number of A+G to the number of C + T in DNA of E. Coli species is
1) 1 : 1 2) 0.93 3) 1.52 4) 1.8

33. The main role of DNA in a living system is
1) It is the structural material of cell walls 2) It is an enzyme
3) It carries the hereditary characteristics of the organism
4) It participates in cellular respiration

34. Which of the following statements about RNA is incorrect ?
1) It has a single strand 2) It does not undergo replication
3) It contain any pyrimidine base 4) It controls the synthesis of proteins

35. If the sequence of bases in DNA is TGAACCCTT, the sequence of bases in m-RNA is
1) ACUUGGGAA 2) TCUUGGGTT 3) ACUUCCCAA 4) TUCUGTUTU

36. The synthesis of m RNA will be in the direction of
1) $3^1 \rightarrow 5^1$ 2) $5^1 \rightarrow 3^1$ 3) by both 4) none

37. The genetic information of a human cell contained in _____ of chromosomes
1) 46 pairs 2) 23 pairs 3) 46 4) 23

38. Which of the following processes is "semi conservative" ?
1) translation 2) transcription 3) replication 4) reverse transciption

39. During the replication of DNA, one of the two strands is synthesized in pieces and are joined latter in the presence of enzyme called
1) RNA ligase 2) DNA ligase 3) r-RNA 4) m-RNA

40. Which of the following statements about DNA is not correct ?
1) It has a double helix structure 2) It undergoes replication
3) The two strands in a DNA molecule are exactly similar
4) It contains the pentose sugar, 2-deoxyribose

41. The RNAs which take part in the synthesis of proteins is/are
1) m-RNA 2) r- RNA 3) t-RNA 4) All the three above

42. Each codon consists of _____ nitrogen bases
1) four 2) twenty 3) three 4) sixty four

43. Transcription is a process when
1) messenger RNA is formed from DNA 2) ribosome RNA is formed from DNA
3) protein is synthesised at the ribosomes 4) none of the above

44. The chief source of vitamin D is
1) Fish 2) Spinach 3) Cow dung 4) Citrous fruit

45. Antiricketic Vitamin is
1) Vitamin A 2) Vitamin B_{12} 3) Vitamin C 4) Vitamin D

46. Calcium absorption in intestine is the function of
1) Vitamin A 2) Vitamin B 3) Vitamin C 4) Vitamin D

47. Anti sterility factor which is necessary for fertility of men and birth process of the female is
1) Vitamin E 2) Vitamin A 3) Vitamin C 4) Vitamin D

48. In all green leaves and vegetables which of the following vitamin is available ?
1) Vitamin A 2) Vitamin D 3) Vitamin K 4) Vitamin B_{12}

49. Which of the following vitamin is known as Nicotinic acid ?
1) B_1 2) B_2 3) B_3 4) B_5

50. Which of the following vitamin involves in the synthesis of RNA ?
1) A 2) B 3) C 4) B_{12}

51. Vitamin B_{12} is rich in
1) Sewage sludge 2) Liver of pig 3) Egg 4) all

52. Formation of RBC is because of
1) Mucoprotein 2) Vitamin B_{12} 3) Vitamin C 4) Both 1 & 2

53. Ascorbic acid resembles the structure of
1) Vitamin A 2) Glucose 3) Cellulose 4) Vitamin D

54. Dark red tongue, fissuring at corners of mouth and lips are the symptoms of the deficiency of which vitamin
1) C 2) A 3) B_2 4) D

55. Vitamin B_6 is known as
1) Pyridoxine 2) Thiamine 3) Tocopherol 4) Riboflavin

56. Vitamin D is called
1) Ascorbic acid 2) Calciferol or ergocalciferol
3) Thiamine 4) Riboflavin

57. Which of the following vitamins is not soluble in water ?
1) C 2) B_1 3) B_2 4) D

58. The deficiency of vitamin K causes
1) Haemorrhage 2) Lengthening time of blood clotting
3) Inflammation of tunge 4) Both (1) and (2)

59. Milk contains vitamins
1) A, D and E 2) A, B_{12} and D 3) C, D and K 4) B_1, B_2 and A

60. The metal present in vitamin B_{12} is
1) Iron 2) Manganese 3) Cobalt 4) Magnesium

61. The condition of vitamin deficiency is known as
1) Vitaminosis 2) Avitamonosis 3) Both 1 and 2 4) Anemea

62. Which one of the following statements is incorrect regarding vitamins ?
1) Vitamin A is essential for growth and vision
2) Vitamin D is essential for development of bones
3) A red coloured carotene in the body breaks into vitamin C
4) Vitamin K is essential for blood coagulation

63. The organic compound which is required in minute quantities in order to maintain good health of the living organism is :
1) Vitamin 2) Protein 3) Lipid 4) Carbohydrate

64. Receptors of hormones are generally
1) Carbohydrates 2) Vitamins 3) Lipids 4) Protiens

65. Substances produced by endocrine glands are
1) Vitamines 2) Harmones 3) Herb 4) Drug

66. Which of the following is a derivative of amino acid ?
1) Thyroxin 2) Estradiol 3) Estrogene 4) Progesterone

67. Total number of carbon atoms present in steroid nucleus
1) 24 2) 17 3) 10 4) 20

68. Which of following hormone is produced by testis ?
1) Progesterone 2) Estradiol 3) Testosterone 4) Estrone

69. Synthetic testosterone promotes
1) Menstrual cycle 2) Muscle growth 3) Respiration 4) Birth control agents

70. Phosphorylation of glucose is increased by
1) Auxins 2) Insulin 3) Ethylene 4) Trausmatic acid

71. Which of the following is not an example of phytohormones ?
1) Cytokinins 2) Ethylene 3) Auxins 4) Insulin

72. Estradiol is responsible for the development of
1) Primary male characters 2) Secondary female characters
3) Primary female characters 4) Secondary male characters

73. Which of the following maintains constant sugar level in blood ?
1) Gibberlins 2) Insulin 3) Glucogen 4) Estrone

74. **Column-I** (Name of hormone) **Column-II** (Functional group in hormons)
1) Testosterone a) Double bond
2) Estradiol b) Ketone
3) Progesterone c) Alcohols
4) Ethylene d) Alcohol and ketone
The correct match is
1) 1-c; 2-b; 3-d; 4-a 2) 1-d; 2-c; 3-b; 4-a
3) 1-d; 2-c; 3-a; 4-b 4) 1-a; 2-b; 3-c; 4-d

75. Which of the following hormones contains iodine ?
1) Insulin 2) Thyroxine 3) Adrenaline 4) Testosterone

76. Which of the following is a male sex hormone ?
1) Progesterone 2) Estrone 3) Epinephrine 4) Testosterone

77. The sex hormone which controls the development and maintenance of pregnancy is
1) Cortisone 2) Thyroxine 3) Progesterone 4) Estrone

78. The hormones used by athletes to increase the mass and strength of muscles is/are
1) Estrogens 2) Gestogens
3) Androgens 4) Both estrogens and androgens

79. Number of six membered rings present in a steroid nucleus is
1) 1 2) 2 3) 3 4) 4

80. The organic compound that transfer biological information from one group of cells to distant tissues or organs are called as
1) Vitamins 2) Proteins 3) Hormones 4) Carbohydrates

81. Terpenes are the polymers of
1) Pentanoic acid 2) 1,3-Pentadiene 3) Isoprene 4) Pentanal

82. Lipids are
1) Nucleic acids occurring in plants 2) Proteins occurring in animals
3) Carbohydrates occurring in plants 4) Fats of natural origin

83. Which of the following is not belonging to lipids ?
1) carbohydrates 2) oils 3) fats 4) waxes

84. Esters of glycerol with long chain fatty acids are called
1) homo lipids 2) simple lipids 3) triglycerides 4) all the above

85. Lipids are stored in
A) Liver B) Muscles C) Adipose tissues D) Bone marrow
The correct combination is
1) Only C 2) Only D 3) C and D only 4) All

86. Hydrolysis of fats and oils in the body produces
1) Ester 2) Adipase 3) Carbon dioxide 4) Carboxylic acid

87. The most efficient source of energy in the human body is
1) Fats 2) Sugars 3) Proteins 4) Nucleic acids

88. Mixed fat with symmetrical nature is ___
1) α,β-Dipalmitin 2) α,α^1-Dipalmitin
3) α,α^1–Dipalmito, β-stearin 4) α,β-Dipalmito, α^1-stearin

89. Unsymmetrical simple lipid is ____
1) 1–Palmitin 2) 2–Palmitin
3) 1, 3–Dipalmitin 4) 1, 3–Dipalmito, 2–stearin

90. Waxes are esters of higher fatty acids with long chain
1) Monohydric alcohols 2) Dihydric alcohols
3) Trihydric alcohols 4) All the three above

91. The triglycerides of which of the following unsaturated fatty acids are not present in oils and fats ?
1) Oleic acid 2) Linoleic acid 3) Linolenic acid 4) Formic acid

92. Ester of myricyl alcohol with palmitic acid is present in
1) Animal fur 2) Bee's wax 3) Sperm whale oil 4) Wool

93. Linoline fat is an ester of cholesterol with
1) long chain alcohol 2) phosphoric acid
3) long chain fatty acid 4) glycerol

94. Which of the following is an unsaturated acid
1) Linoleic acid 2) Stearic acid 3) Caproic acid 4) Archidic acid

95. Lecithin and cephalin are
1) Neutral fats 2) Glyc olipids 3) Waxes 4) Phospholipids

96. Which one of the following is not a lipid ?
1) Lecithin 2) Spingomyelins 3) Insulin 4) Cephalin

97. Which of the following is not a wax ?
1) Myricyl palmitate 2) Tripalmitin 3) Myricyl cerotate 4) Cetyl palmitate

98. Formula of linolenic acid is $C_{17}H_{29}$.COOH. The double bonds occupy the position at
1) C–9, C–15 2) C–12, C–15 3) C–9, C–12, C–15 4) C–9 only

99. Glycolipids are
1) Hetero lipids 2) Neutral fats 3) Derived lipids 4) Waxes

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. One of the the essential alpha amino acids is
   a) Lysine b) glycine c) serine d) proline

2. Which amino acid is achiral?
   a) Alanine b) Valine c) Proline d) Glycine

3. All common amino acids except one react with cold nitrous acid (HNO_2) and evolve nitrogen gas, that amino acid is
   a) cysteine b) proline c) histidine d) None of these

4. Which of the following is used in a colour test of amino acid ?
   a) Ninhydrin b) Cyanogen bromide c) Trypsin d) Chymotrypsin

5. Isoelectric point is
   a) the pH at which all molecular species are ionised and that carry the same charge
   b) the pH at which all molecular species are neutral and uncharged
   c) the pH at which half the molecular species are ionised (charged) and other half unionised
   d) the pH at which negataively and positively charged molecular species are present in equal concentration

6. The helical structure or a secondary structure of proteins is stabilised by
   a) peptide bonds b) dipeptide bonds c) H-bond d) ether bonds

7. The destruction of the biological nature and activity of proteins by heat or chemical agent is called
   a) dehydrataion b) denaturation c) denitrogenation d) deamination

8. Which of the following amino acids contains sulphur in its structure
   a) Proline b) Cysteine c) Leucine d) Histidine

9. Which statement about the zwitter ionic form of an amino acid is correct?
   a) The zwitter ion acts only as a base
   b) The zwitter ion carries an overall charge which can be positive or negative
   c) The zwitter ion is neutral overall
   d) The zwitter ion acts only as an acid

10. Which of the following statements is true for phenylalanine in an aqueous solution at pH=pI?
    a) The nonpolar, neutral species $C_6H_5CH_2CH(NH_2)CO_2H$ is the most abundant solute
    b) The concentrations of [+] and [–] charged moelcular ions are equal.
    c) Racemization is rapid
    d) This condition is impossible, since pH can never equal pI

11. Which of the following statement is not true ?
    a) Pheromenones are secreted outside the body by the insects
    b) Aspirin is analgesic and antipyretic
    c) Sucrose is a dipeptide commonly known as aspartame
    d) The DNA assists in the synthesis of RNA molecules

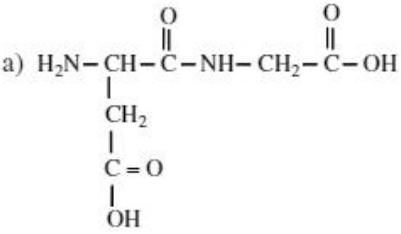
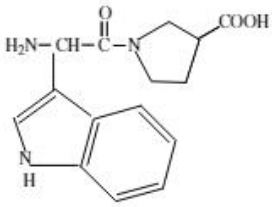
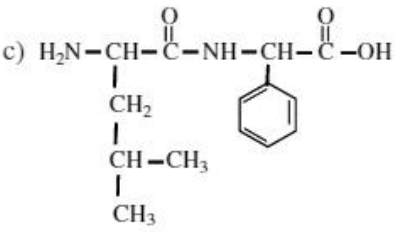
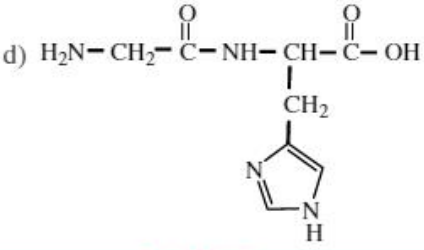
12. Which of the following is correct with respect to the amino acid composition of proteins?
    a) Larger proteins have a more uniform distribution of amino acids than smaller proteins
    b) The average molecular weight of an amino acid in a protein increases with the size of the protein
    c) Proteins with different functions usually differ significantly in their amino acid composition
    d) Proteins with the same molecular weight have the same amino acid composition

13. Which of the following refers to particularly stable arrangements of amino acid residues in a protein that give rise to reoccuring patterns?
    a) Primary structure
    b) Secondary structure
    c) Tertiary structure
    d) Quaternary structure

14. By adding SDS (sodium dodecyl sulphate) during the electrophoresis of proteins, it is possible to
    a) determine a protein's isoelectric point
    b) determine an enzyme's specific activity
    c) determine the amino acid composition of the protein
    d) preserve a protein's native structure and biological activity

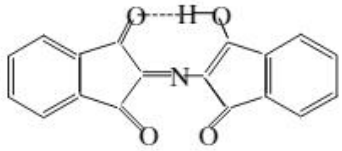
15. Which protein is main constituent of milk ?
    a) Casein
    b) Insulin
    c) Myosine
    d) Keratin

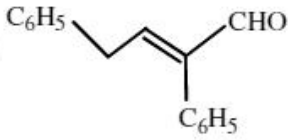
16. Which of the following statement about the conformation (secondary and tertiary structure) of proteins is false?
    a) The four atoms of an amide linkage (-CO-NH-) lie in a plane as a result of resonance between the nitrogen and the carbonyl group
    b) Electrostatic attraction occurs between basic and acidic side chains
    c) The favoured conformation of a protein is always that which has the greatest number of hydrogen bonds
    d) The presence of the amino acid proline has the effect of turning a corner in a protein

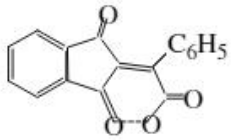
17. Which of the following structures is not a dipeptide ?
    a) 
    b) 
    c) 
    d) 

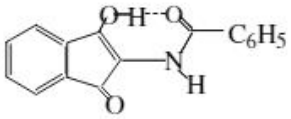
18. Which of the following statement about the arrangement of a protein in three dimensions is false?
    a) As a result of hydrogen bonding a portion of a protain may exist as a right– handed α-helix with 3.6 amino acid residues per turn, and a repeat unit of 5.4 A°
    b) As a result of hydrogen bonding a portion of a protein may exist as a pleated sheet, in which the repeat unit is 7.0 A°
    c) In a pleated sheet, the polyamide chains may be parallel or antiparallel
    d) A portion of a protein may exist as a flat sheet with a repeat unit of 7.2 A°

19. Ninhydrin reagent reacts with acids to give a purple colour. In the reaction of ninhydrin with phenylalanine, which of the following is responsible for this colour?

a) 

b) 

c) 

d) 

20. Which of the following statements most correctly defines the isoelectric point?
    a) The pH at which all molecular species are ionized and that carry the same charge
    b) The pH at which all molecular species are neutral and uncharged
    c) The pH at which half the molecular species are ionized (charged) and the other half unionized
    d) The pH at which negatively and positively charged molecular species are present in equal concentration

21. Anti bodies are ____
    a) Carbohydrates
    b) Cellulose compounds
    c) Globular proteins
    d) Immuno globulins

22. Proteins $\xrightarrow[H_2O]{x}$ Aminoacids 'x' is an enzyme found in insterline is
    a) Trypsine
    b) Pepsine
    c) Lactobacclli
    d) Amylose

23. Composition of DNA is ____
    a) Pentose, phosphoric acid, A, G, U, T
    b) Aldo pentose, Phosphoric acid, A, G, U, T
    c) Aldo pentose, Phosphoric acid A, G, C, T
    d) Keto pentose, phosphoric acid, A, G, C, T

24. Insulin is an example of
    a) Drug, Hormone & Polypeptide
    b) Hormone & Lipid
    c) Enzyme & Vitamin
    d) Protein & Vitamin

25. In DNA strand at 136th position is the base thymine, then the base present at opposite strand is ____ at same position.
    a) Thymine
    b) Adenine
    c) Uracil
    d) Guinine

26. Which of the following has an aromatic ring?
    a) Alanine
    b) Lycine
    c) Tyrosine
    d) Glycine

27. At p^H=4 Glycine exist as

a) $\overset{\oplus}{N}H_3-CH_2-COOH$ b) $\overset{\oplus}{N}H_3-CH_2-COO^{(-)}$ c) NH_2-CH_2-COOH d) $NH_2-CH_2-COO^{(-)}$

28. Which of the following element is present in insulin?

a) Sodium b) Zinc c) Lithium d) Iron

29. Iodine value is related to _____ in our system is

a) Alcohols b) Amino acids c) Fats d) Waxes

30. Acrolin test is negative for

a) Oils b) Fats c) Proteins d) Lipids

More than One correct answer Type Questions

31. An activated amino acid A($H_2NCHRCOX$) reacts with an amino acid B($H_2NCHR'CO_2H$). Which statement is correct about this reaction?

a) The amino acids are coupled by a peptide link of form – CONH–
b) Activation prevents reaction between two moelcules of A
c) The reaction involves elimination of HX
d) A dipeptide is formed

32. Peptides are compounds of amino acids joined by amide bonds. Which of the following statements is correct ?

a) Amide groups are more resistant to hydrolysis than are similar ester groups
b) p–p resonance stabilizes the amide bond
c) Stable conformation of peptides are restricted to those having planar amide groups.
d) Amide groups do not participate in hydrogen bonding interactions

33. A protein can be denaturated by ____

a) Change of pH b) Addition of detergents
c) Adding Urea d) Strong heating

34. Which of the following combination are correct in case of proteins?

a) α–helix of protein ——— secondary structure
b) Sequence of Amino acids ——— Primary structure
c) Denaturation ——— Breaking of peptide bonds
d) β-plated sheet ——— quaternarystructure

35. Which of the following amino acids have very high isoelectric pH value, higher than 9?

a) Proline b) Lysine
c) Tyrosine d) Arginine

36. Which of the following is(are) characteristics of an -amino acid at their isoelectric point?

a) It possesses no net charge
b) Both acid and amine groups remain in their neutral state
c) It does not move towards either electrode under influence of applied electric field
d) It has no net effect on the moistened litmus paper

37. Which of the following statements regarding a peptide linkage in a protein molecule is/are correct?
a) It is an amide linkage
b) It has partial double bond character
c) It is hydrophilic in nature
d) It connects protein molecules through H-bonds

38. What is/are true regarding 20 standard amino acid molecules?
a) They are all chiral and have L-configuration
b) They have very high melting points compared to other organic compounds of comparable molar masses
c) They have very low solubility in diethyl ether
d) They have very high electrical conductivity in aqueous solution

39. The waxes are long chain compounds of fatty acids and they does not belong's to
a) Esters b) Alcohols c) Ethers d) Acetic acid

40. Which of the following/s is/are not deficiency disease of vitamin-E
a) Antifertility b) Abortion c) Coagulation d) Beri-Beri

41. Kwashiorkar is caused by the deficiency of
a) Vitamines
b) Harmones
c) Essential aminoacids
d) Gly, Ala, ...

42. The number of Amino acids in the two protomers of insulin are
a) 21 b) 30 c) 29 d) 27

43. Walls of blood vessels, ligaments are called ____
a) Keratins
b) Collagens
c) Globular proteins
d) Fibrous proteins

44. Which of the following is true statement
a) Geometry of peptide linkages lies in a plane
b) Geometry of peptide linkages is unstable
c) The Geometry of peptide which are lies in plane are stable by resonance
d) The atoms of peptide link are not in plane

Linked Comprehension Type Questions

Passage - I:

Transcription is the synthesis of m.RNA from a DNA in cell nucleus. It resembles the DNA replication. DNA contains the sequence of bases called pramotor sites. These pramotor sites are bound to the enzyme which initiates the m.RNA synthesis

45. The process involve in the RNA farmation on DNA template is
a) Transcription b) Translation c) Replication d) Transfermation

46. Enzyme required for transcription
a) Restriction enzyme b) DNA polymerase c) RNA polymerase d) RNA ase

47. Sigma factor is the component of
a) DNA ligase b) DNA polymerase c) RNA polymerase d) ENDO Nuclease

Passage-II:

The synthesis of identical copies of DNA is called replication (or) Duplication of DNA. DNA is duplicated so that the DNA in the New cell is identical to original DNA.

Replication of DNA is enzyme catalysed process. In this 2-strands of DNA strats unconding at perticuler region.

48. Which of the following Biomolecules self repair mechanism

a) DNA, RNA & Protein b) DNA & RNA c) Only DNA d) Only RNA

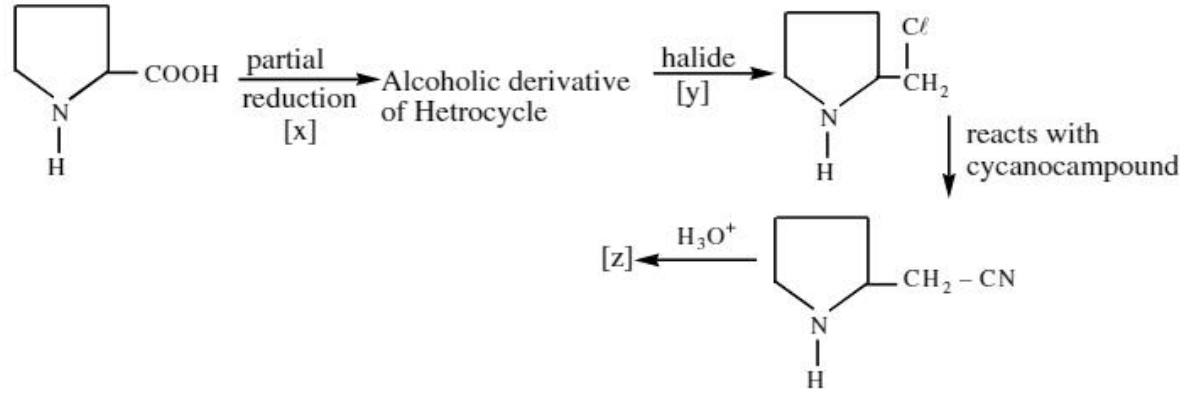
49. Which of the following mechanism of DNA polymerase help in prevent error during replication of DNA

a) Recheking b) Proof cheking c) Proof reading d) All

50. The desortion of DNA helix due to pyrimidine dimer farmation is called

a) Nick b) Kink c) Single strand break d) None

Passage-III :



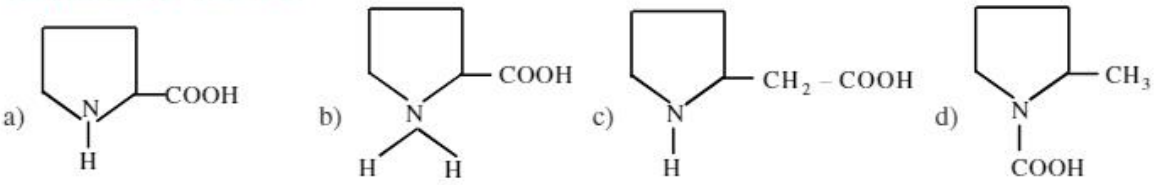
51. The reducing agent 'x' is

a) Zn-Hg b) $LiAlH_4$ c) Ni/300^0C d) Zn-Cu

52. The halide 'y' will be

a) PCl_5 b) NaCl c) $CHCl_3$ d) CH_3CH_2Cl

53. The product 'z' will be is



Passage-V :

Proteins can also be classified based on their shapes and solubility in water.

(i) Fibrous proteins are long and stringy, and are in soluble in water. Their primary role in structural materials of animal tissues.

Eg: Collagens, Elastins, Keratins, and Fibrins.

(ii) Globular proteins are compact and spherical and are soluble in water example enzymes, hormones, antibodies, transport proteins respiratory proteins.

54. Which of the following belongs to collagen

a) Hair b) Tendons c) Egg d) Milk

55. Elastins are the structural component of ____

a) Lungs b) Heart c) Blood d) Liver

56. Fibrin proteins are essential for

a) Heart Beating b) Respiratory c) Bones growth d) Blood clotting

Matrix Matching Type Questions

57. Match vitamins and their difficiency diseases.

Column-I	Column-II
A) vitamin–B_{12}	p) sterility
B) vitamine-B_6	q) haeomorrhagic condition
C) vitamine-E	r) Pernicious anaemia
D) vitamine-K	s) skin diseage

58. Match the proteins and their functions.

Column-I	Column-II
A) Transport proteins	p) Clotting of blood
B) Respiratory proteins	q) Outer layer of skin
C) Keratines	r) Movement of ions
D) Fibrins	s) Release of oxygen which kill imicrobes

Integer Type Questions

59. The number of polypeptide chains in insulin is ?

60. The number of possible dipeptides formed with two amino acids A and B are

61. Number of peptide chains in oligo proteins.

62. _____ structures associated with shape of protiens.

63. Aspartime has _____ number of peptide bond/s

64. Number of sugar molecules in protiene _____.

65. Number of H bonds present between adenine and thymine in formation of Nucleic acid

66. A hexapeptide has composition Ala-Gly-Phe-Val_3. Both N-teriminal & C-terminal units are val. The number of val-val peptide bonds present, half of total 1^0-structures hexapeptide passible which satisfy these conditions are _____.

67. Least solubility of Lysine in H_2O at the p^H = _____.

68. Number of disulphide linkages present in Insulin are ____.

69. A Nano peptide contains _____ Peptide linkages.

70. A hepta peptide of m.wt 529 μ, is made up of glycine [m.wt = 7.5μ], Alamine [m.wt = 89μ] and valine [m.wt = 117μ]. On hydrolysis gives corresponding amino acids. If the product mixture contains 35.32% of glycine. The sum of alanine and valine molecules in a molecule of hepta peptide is ___

71. Calculate average isoelectric point of (Lysine + Asparticacid). The Pka_1, Pka_2, Pka_3, of dication of lysine are 2.18, 8.95, 10.53 respectively. The Pka_1, Pka_2, Pka_3, of cation of aspartic acid 1.20, 3.32, 9.60 respectively ____.

72. The two polypeptide chains of insulin are cross linked at ____ places.

73. Number of elements present in living cell are ____

KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I

1) **2**	2) **1**	3) **3**	4) **2**	5) **4**	6) **4**	7) **2**	8) **3**
9) **4**	10) **1**	11) **2**	12) **4**	13) **1**	14) **4**	15) **2**	16) **1**
17) **2**	18) **1**	19) **4**	20) **3**	21) **2**	22) **1**	23) **1**	24) **1**
25) **2**	26) **1**	27) **3**	28) **4**	29) **3**	30) **4**	31) **4**	32) **1**
33) **3**	34) **3**	35) **1**	36) **2**	37) **2**	38) **3**	39) **2**	40) **3**
41) **4**	42) **3**	43) **1**	44) **1**	45) **4**	46) **4**	47) **1**	48) **3**
49) **4**	50) **4**	51) **3**	52) **2**	53) **2**	54) **3**	55) **1**	56) **2**
57) **4**	58) **4**	59) **4**	60) **3**	61) **2**	62) **3**	63) **1**	64) **4**
65) **2**	66) **1**	67) **2**	68) **3**	69) **2**	70) **2**	71) **4**	72) **2**
73) **2**	74) **2**	75) **2**	76) **4**	77) **3**	78) **3**	79) **3**	80) **3**
81) **3**	82) **4**	83) **1**	84) **4**	85) **3**	86) **4**	87) **1**	88) **2**
89) **4**	90) **1**	91) **4**	92) **2**	93) **3**	94) **1**	95) **4**	96) **3**
97) **2**	98) **3**	99) **1**					

LEVEL-II

1) **a**	2) **d**	3) **b**	4) **a**	5) **d**	6) **c**	7) **b**	8) **b**
9) **c**	10) **b**	11) **d**	12) **c**	13) **a**	14) **d**	15) **a**	16) **d**
17) **b**	18) **d**	19) **a**	20) **d**	21) **d**	22) **a**	23) **c**	24) **a**
25) **b**	26) **c**	27) **a**	28) **b**	29) **c**	30) **c**	31) **acd**	32) **abc**
33) **abcd**	34) **ab**	35) **b**	36) **ac**	37) **abcd**	38) **bcd**	39) **bcd**	40) **cd**
41) **cd**	42) **ab**	43) **bd**	44) **ac**	45) **a**	46) **c**	47) **c**	48) **c**
49) **c**	50) **b**	51) **b**	52) **a**	53) **c**	54) **b**	55) **a**	56) **d**
57) **A-r; B-s; C-p; D-q**			58) **A-r; B-s; C-q; D-p**			59) **2**	60) **4**
61) **2**	62) **4°**	63) **1**	64) **2**	65) **2**	66) **6**	67) **67**	68) **3**
69) **8**	70) **4**	71) **6**	72) **3**	73) **6**			

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A tripeptide contains _____ peptide links
   1) 3 2) 2 3) 6 4) 4

2. The primary structure of a protein tells about
   1) 3D arrangement of all atoms 2) shape of poly peptide chain
   3) specific sequence of amino acids 4) 3D arrangement of oligo peptide chains

3. The bond that determines the secondary structure of a protein is
   1) Co-ordinate bond 2) Covalent bond
   3) Hydrogen bond 4) Ionic bond

4. If the amino group of Glycine and carboxylic acid group of Alanine undergo elimination of water molecule, the name of the compound thus formed is
   1) Alanylglycine(dipeptide) 2) Glycyl alanide(tri peptide)
   3) Glycyl alanine(dipeptide) 4) Alanineglycine(dipeptide)

5. Which one of the following is not a protein?
   1) Wool 2) Nail 3) Hair 4) DNA

6. Regarding enzymes, incorrect statement is
   1) an enzyme is generally a protein 2) an enzyme may be a conjugated protein
   3) enzyme gets deactivated during reactions 4) enzyme gets activated during reactions

7. Purine without ketonic group is
   1) adenine 2) adenosine 3) cytidine 4) thymidine

8. 6 - amino purine is
   1) Adenosine 2) Adenine 3) Cytosine 4) Thymine

9. The pyrimidine bases present in RNA are
   1) Cytosine and Thymine 2) Thymine and Uracil
   3) Cytosine and Uracil 4) Uracil and Guanine

10. Which of the following vitamin acts as important component of NADP (&) DPN ?
    1) A 2) D 3) B_5 4) B_{12}

11. Steroid hormones are produced by the
    a) Adrenal cortex b) Pancreas c) Thyroid d) Testis e) Pitutiary
    1) a and d 2) a, b, and c 3) c, d 4) d, e

12. The amino acid cysteine often forms a disulphide bond with another nearby cysteine. The reaction is best classified as
    1) an addition 2) a substitution 3) an oxidation 4) a reduction

13. Peptides are composed of amino acids joined by amide bonds. Which of the following statement is not correct?
1) Amide groups are more resistant to hydrolysis than are similar ester groups
2) resonance stabilizes the amide bond
3) stable conformations of peptides are restricted to those having planar amide groups
4) Amide groups do not participate in hydrogen bonding interactions

LEVEL-II

LECTURE SHEET (ADVANCED)

Straight Objective Type Questions

1. Essential amino acid among the following is
a) Glycine b) Tryptophan c) Alanine d) Proline

2. The helical structure of proteins is stabilized by
a) H-bonding b) Vander Waals' forces
c) ionic bond d) peptide bond

3. Mark the wrong statement about denaturation of proteins
a) The primary structure of the protein does not change
b) Globular proteins are converted into fibrous proteins
c) Fibrous proteins are converted into globular
d) The biological activity of the protein is cancelled

4. Addition of an electrolyte such as sodium dodecyl sulphate causes
a) renaturation of proteins since it stabilises hydrophobic interactions
b) denaturation of proteins since it disturbs hydrophobic interactions
c) renaturation of proteins since it maintains necessary isoelectric point
d) denaturation of proteins since it causes cleavage of O = C – N – H bonds

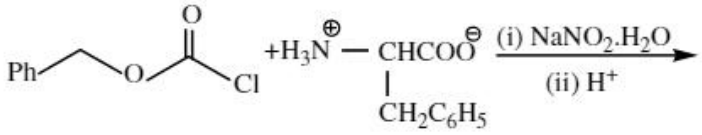
5. The non-protein portion of a protein is called
a) Functional b) Characteristic group
c) Prosthetic group d) Enolic group

6. In a nucleotide the phosphate linkage is generally attached to
a) C - 1 of sugar b) C - 2 of sugar
c) C - 5 of sugar d) N - of base

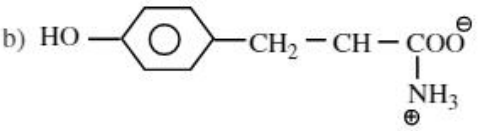
7. Deficiency of Vitamin "C" leads to
a) gum swelling
b) blead easily and teeth become loose
c) delay in wound healing
d) all

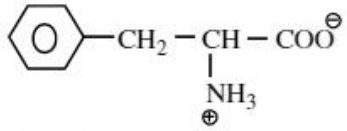
More than One correct answer Type Questions

8. What is the product of the following reaction ?



a) $C_6H_5CH_2OCONH.\underset{\underset{CH_2C_6H_5}{|}}{CHCOOH}$

b) 

c) 

d) None of the above

9. Which statement about proteins is correct?

a) Collagen is an example of fibrous protein

b) Myoglobin is an example of a globular protein and contains a prosthetic group

c) Proteins are naturally occurring polypeptides

d) Hydrogen bonding between C=O and H–Ngroups

10. Which of the following is an important secondary structural feature in large peptides and proteins?

a) The α–helix

b) The β–turn

c) Chair conformation

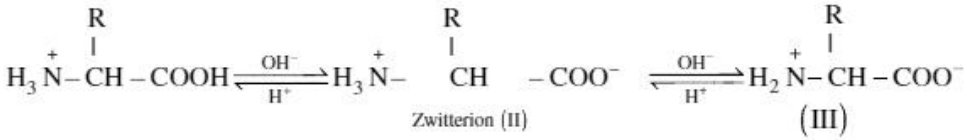
d) The β–pleated sheet

Linked Comprehension Type Questions

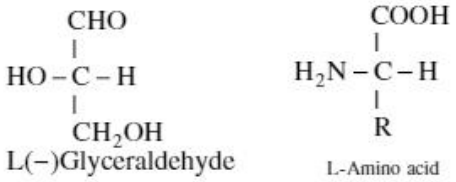
Passage:

α–amino acids are high melting crystalline solids because of the zwitterion structure. They are moderately soluble in water. In acidic medium, α–amino acids exist as cations (I) and thus migrate towardas cathode under the influence of an electric field. On the other hand, in alkaline medium, α–amino acids exist as anions (III) and thus migrate towards anode under the influence of an electric field. However, at some intermediate value of p^H, the concentration of the cationic form (I) and anionic form (III) will become equal and consequently the α–amino acid will exist primarily as the neutral dipolar ion (II). At this p^H, there would be no net migration of the amino acid in an electric field. This p^H at which there is no net migration of the amino acid under the

influence of an applied electric field is called isoelectric point (pI). Each amino acid has a characteristic isoelectric point. The pH of an amino acid that does not have an ionisable side chain such as alanine is average of pK_a values of the carboxyl group and the protonated amino group.



Further, the α – carbon of all the amino acids (except glycine) is chiral (asymmetric) and hence amino acids can exist in two stereoisomeric forms i.e., D and L. However, all the naturally occurring amino acids belong to the L-series.



11. Which of structural formula of lysine $(NH_2-\underset{\displaystyle COOH}{\underset{|}{CH}}-CH_2-CH_2-CH_2-CH_2NH_2)$ at pH 13 ?

a) $H_3\overset{\oplus}{N}CH_2CH_2CH_2CH_2\underset{\displaystyle \oplus NH_3}{\underset{|}{CH}}CO_2H$

b) $H_3\overset{\oplus}{N}CH_2CH_2CH_2\underset{\displaystyle NH_2}{\underset{|}{CH}}CO_2^{\ominus}$

c) $H_2NCH_2CH_2CH_2CH_2\underset{\displaystyle NH_2}{\underset{|}{CH}}CO_2^{\ominus}$

d) $H_2NCH_2CH_2CH_2CH_2\underset{\displaystyle NH_2}{\underset{|}{CH}}COOH$

12. In alanine, carboxyl group ionises at $pK_{a1} = 2.34$ and ammonium ion at $pK_{a2} = 9.69$. The isoelectric point of the amino acid is at p^H

a) 6.02 b) 2.34 c) 9.60 d) 6.97

13. N-terminus of the peptide structure is on the

a) left hand side b) right hand side c) both sides d) random way

Matrix Matching Type Questions

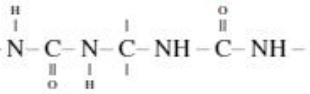
14.

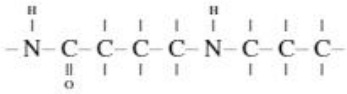
Column-I (Vitamins)	Column-I (Disease)
A) A	p) Folate defficiency Anaemina
B) C	q) Bleeding gums
C) D	r) Osteomalacia
D) B_{12}	s) Xeropthalmia

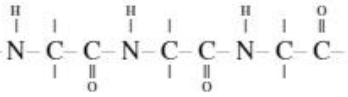
PRACTICE SHEET (ADVANCED)

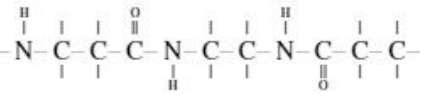
Straight Objective Type Questions

1. Which of the following structure represents the peptide chain?

a) 

b) 

c) 

d) 

2. Peptides are composed of amino acids joined by amide bonds. Which of the following statements is not correct?
   a) Amide groups are more resistant to hydrolysis than are similar ester groups
   b) p-π resonance stabilises the amide bond
   c) Stable conformations of peptide are restricted to those having planar amide groups
   d) Amide groups doesnot participate in hydrogen bonding

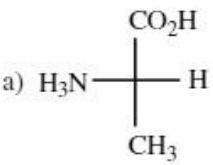
3. Glutamic acid, $H_2N-CH(CH_2CH_2COOH).COOH$ has pK_{a1}, (α-COOH) = 2.2, $pK_{a2}(\alpha-\overset{+}{N}H_3)$ = 9.8 and pK_{a3}(R group COOH) = 4.3. The isoelectric point of glutamic acid is
   a) 5.9 b) 7 c) 10.2 d) 3.25

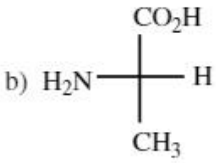
4. $R-\underset{\underset{NH_2}{|}}{CH}-COOH \xrightarrow{HNO_2} A.$

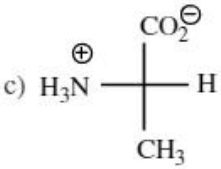
   The product is
   a) RCH_2COOH b) RCH_2NH_2 c) RCH(OH) COOH d) R CH(OH) CH_2OH

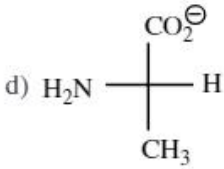
5. You have a mixture of three amino acids: E(pI=3.2), Y(pI=5.7) & K(pI=9.7) Under electro-phoresis at pH=7.7, in which direction will each component of the mixture move?
   a) E to anode; Y & K to cathode
   b) E to anode; Y stationery; K to cathode
   c) E to cathode; Y stationery; K to anode
   d) E & Y to anode; K to cathode

6. Which of the following is the major solute species in a solution of alanine at pH=6?

a) 

b) 

c) 

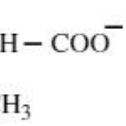
d) 

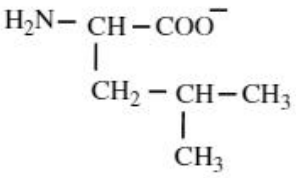
7. The most important contribution to the stability of a protein's conformation appears to be the
   a) entropy increase from the decrease in ordered water molecules forming a solvent shell around it
   b) maximum entropy increase from ionic interactions between the ionized amino acids in a protein
   c) sum of free energies of formation of many weak interactions among the hundreds of amino acids in a protein
   d) sum of free energies of formation of many weak interactions between its polar amino acids and surrounding water

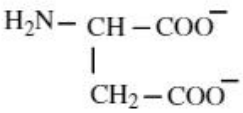
More than One correct answer Type Questions

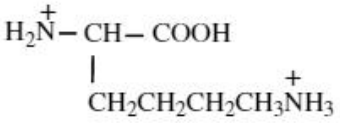
8. Which of the following amino acids have very low isoelectric pH value (lower than 5)?
   a) Histidine b) Aspartic acid c) Glutamic acid d) Arginine

9. In which of the following case, the forms of amino acid and pH is (are) correctly matched?

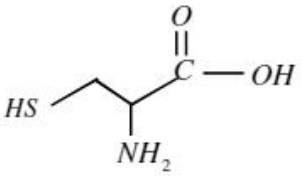
   a) Alanine : pH = 3, 

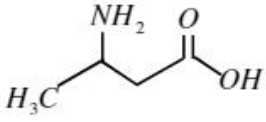
   b) Leucine: pH= 10, 

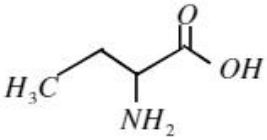
   c) Aspartic acid: pH=9, 

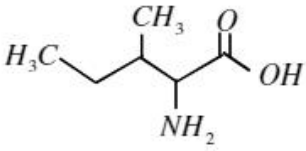
   d) Lysine: pH =3, 

10. Which of the following aminoacids can be obtained when sample of protein is hydrolysed

   a) 

   b) 

   c) 

   d) 

Linked Comprehension Type Questions

Passage-I :

An analysis of the hydrolysis products of salmine, a polypeptide from salmon gave following result of weights of amino acids in gram per 109.66g of salmine

Ie : Isoleucine : 1.31 Alanine : 0.89 Serine : 7.35 Argemine : 86.40

valine : 3.51 Glycine : 3.0 Proline : 6.90

molecular weight of salmine is : 10,966
molecular weight of Serine : 105
molecular weight of alanine is : 89
molecular weight of Argenine : 174
molecular weight of Isoleucine : 131
molecular weight of Protine : 115
molecular weight of Valine : 117
molecular weight of Glycine : 75

11. Singly present amino acids in the salmine are
   a) Serine & valine b) Isoleucine & proline
   c) Alamine & Glycine d) Alamine & Isoleucine

12. Composition of salmine is

a) Ala. Arg_{50} . Gly_4 . lle . Pro_6 . Sex_7 . Val_3 b) Ala .Arg_{50} .Gly_{14} . lle_3 .Pro_6 .Ser .Val

c) Ala. Arg_{50}. Gly_3. lle_4. Pro_6. Ser_7. Val d) Ala. Arg_{50}. Gly_6. lle. Pro_4. Ser_7. Val_3

13. Salmine is also known as

a) Protamine sulphate b) Protamine c) Peparine d) Heparine

Passage-II:

The deficiency of enzyme in living system can cause many diseases. For eg: pheonyl alanine hydroxylase cause a congential disease which is called [PKU]. Which damage brain & mental retardation. Extent of this disease can controlled by diet. So we can say enzymes acts as powerfull drugs, with their self prepared.

14. The Abrivation of PKU is

a) Phenyl keto urea b) Phenyl alanine keto urea

c) Protonil keto urea d) None

15. An enzymic preparation is called

a) Enzymaisation b) Enzyme catalysed reaction

c) Streptokinase d) Both a & b

16. Enzyme catalytic reaction occur in aqueous solution at temperature of

a) 298^K b) 300^K c) 273^K d) 310^K

Matrix Matching Type Questions

17. Match Food and % of protein they contain

Column-I	Column-II
A) Milk	p) 33%
B) Cheese	q) 12.5%
C) Potatoes	r) 2%
D) Meat	s) 5%

Integer Type Questions

18. p^I of $H_3\overset{\oplus}{N}-CH_2-COOK$ is 5

$H_3\overset{\oplus}{N}CH_2COOH \rightleftharpoons H_2NCH_2COO^- + H^+ \; K_a = 10^{-4}$

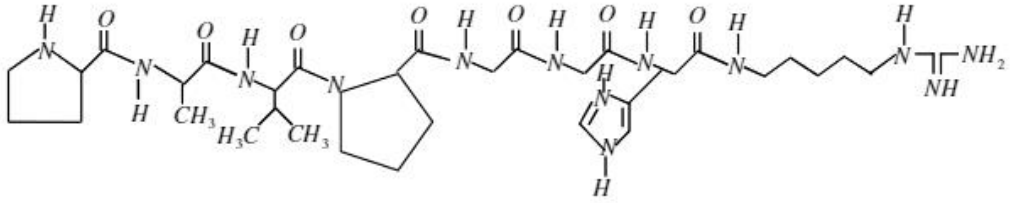
$H_2\overset{\oplus}{N}CH_2COO^- \rightleftharpoons H_2NCH_2COO^- + H^+ K_a = 10^{-x}$ What is x?

19. RNA polymerase [OCHOA 1953] has _____ polypeptide chains.

20. Oxytocin-sold under the trade name pitocin, is a naturally occurring hormone is a nonapeptide which is used to stimulate uterine contraction. It contain number of amide functional groups. How many are 2^0-amides in oxytocin.

21. The glucolycis of 1 molecule of glucose produces _____ molecules of ATP.

22. Number of moles of water required to hydrolyse 1mole of following oligo peptide is ____ moles.



23. P^H in stomock is approximately _____

KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

1) **2** 2) **3** 3) **3** 4) **1** 5) **4** 6) **4** 7) **1** 8) **2** 9) **3** 10) **3**

11) **1** 12) **3** 13) **4**

LEVEL-II

LECTURE SHEET (ADVANCED)

1) **b** 2) **a** 3) **d** 4) **b** 5) **c** 6) **c** 7) **c** 8) **a** 9) **abd** 10) **abd**

11) **c** 12) **a** 13) **a** 14) **A-s; B-q; C-r; D-p**

PRACTICE SHEET (ADVANCED)

1) **c** 2) **d** 3) **d** 4) **c** 5) **d** 6) **c** 7) **c** 8) **bc** 9) **bcd** 10) **ab**

11) **d** 12) **a** 13) **a** 14) **a** 15) **c** 16) **d** 17) **A-s; B-p; C-q; D-q** 18) **6**

19) **5** 20) **7** 21) **2** 22) **8** 23) **2**

Numerical Exercise

1. What is number of chiral carbon atoms in alanine?
2. α – helix is also known as $x.y_{13}$ helix where x and y are numbers. What is its value?
3. How many pyrimidine bases occur in both RNA and DNA?
4. Systematic name of Guanine is x-amino – y – oxopurine where x and y are numbers. What is value of x + y
5. What is ratio of $\frac{A+T}{G+C}$ in human beings?
6. What ratio of $\frac{A+T}{G+C}$ in the bacteria Escherichia coli?

KEY SHEET (Numerical Exercise)

1) **1** 2) **3.6** 3) **1** 4) **8** 5) **1.52** 6) **0.93**