CHAPTER 9

Biomolecules

EXAM DRILL

ANSWERS

1. (d) : Glycosidic bond is formed between the two carbon atoms of two adjacent monosaccharides by dehydration. Non reducing sugars do not reduce cuprous ions to cupric ions.

2. (c) : Tyrosine is the naturally occuring amino acid produced to stimulate thyroxine, which is the hormone produced by the thyroid gland.

3. (d) : The given structure corresponds with the structure of ribose sugar. As it lacks a phosphoric acid hence it can be a nucleoside not a nucleotide.

4. (d) : Living organisms requires 6 elements in relatively large amounts. C, H, O, N, P, S. These elements contribute to the structural organization of living organisms.

5. (a) : Catabolism releases energy. Primary Metabolites are found throught the plant kingdom. Secondary metabolites accumulate in small quantities only in specific parts of the plant.

6. The differences between nucleoside and nucleotides are as follows :

S. No.	Nucleoside	Nucleotide
(i)	Nucleoside is formed by union of a nitrogen base with a pentose sugar.	Nucleotide is formed by the union of a nitrogen base, a pentose sugar and phosphate group.
(ii)	It is a component of nucleotide.	Nucleotide is formed through phosphorylation of nucleoside.
(iii)	It is slightly basic in nature.	A nucleotide is acidic in nature.

OR

Secondary structure of proteins is the development of new steric relationships of amino acids present in the linear sequence inside the polypeptides. There are mainly two types of secondary structures - α helix and β pleated. Secondary structure is maintained by hydrogen bonds between amide hydrogens and carboxyl oxygen of the peptide backbone.

7. The salient features of Watson and Crick DNA model are as follows –

(i) The two strands of DNA double helix are held together by hydrogen bonds between nitrogen bases on opposite strands.

(ii) The two DNA chains are antiparallel *i.e.* they run parallel but in opposite directions.

(iii) The DNA duplex to have two types of alternate grooves, major and minor.

(iv) One turn of 360° of the spiral includes 10 nucleotides on each strand of DNA.

8. (a) Wet weight refers to the gross weight of a product with moisture content, or weight of fully hydrated tissue while dry weight refers to the mass of an object after drying.

(b) The chemical analysis is the determination of physical and chemical properties of a substance.

9. Monosaccharides are simple carbohydrate monomers which cannot be hydrolysed further into smaller components. They have a general formula of $C_nH_{2n}O_n$.

Depending upon the number of carbon atoms, monosaccharides are of five types –

(i) Triose – Having 3 carbon atoms

(ii) Tetroses – Having 4 carbon atoms

(iii) Pentose – Having 5 carbon atoms

(iv) Hexose – Having 6 carbon atoms

(v) Heptose – Having 7 carbon atoms

10. Fats perform various functions in living organisms :

(i) Fats serve as food reserves in both plants and animals.

(ii) Fats act as cushion to absorb mechanical impact around organs like heart.

(iii) Fats function in insulation and temperature regulation of body.

(iv) Fats are used in synthesis of hormones.

11. (d) **12. (b)**

13. (d) : Chitin is often known as fungal cellulose. It is soft and leathery. Therefore, it procudes both strength and elasticity. It becomes hard when impregnated with certain proteins and calcium carbonate. In chitin, the basic unit is not glucose, but a nitrogen containing glucose derivative known as N-acetyl glucosamine. Chitin is an unbranched configuration.

14. (c) : Raffinose is a non reducing sugar and does not have a free aldehyde or ketone group.

15. (i) (c) : R represents transition state. The difference in average energy content of substrate from transition state is called activation energy.

(ii) (a) : R represents transition state. Transition state is formation of unstable intermediate structure state. During this, substrate bonds are broken and new bonds are established that transform the substrate molecule into products. This state is transient and highly unstable.

(iii) (b)

(iv) (a)

16. (i) (b) : In the given figure, P Q, R, S and T represent primary level, alpha helix (secondary level), tertiary level, quaternary level and beta-pleated sheet (secondary level of protein structure respectively).

(ii) (a)

(iii) (d) : Adult haemoglobin is an example of quaternary level of protein structure.

(iv) (d) : Tertiary structure (R) of protein is stabilised by several types of bonds - hydrogen bonds, ionic bonds, van der Wall's interaction, covalent bonds and hydrophobic bonds.

(v) (c)

17. (a) The differences between fibrous and globular protein are as follows :

S.No.	Fibrous protein	Globular protein
(a)	These are thread like proteins.	These are round proteins.
(b)	They are non-enzymatic.	They may be enzymatic.
(c)	These are insoluble in water Example – Myosin, elastin.	These are soluble in water Example : egg albumin, serum globulin.

(b) Haemocyanin and haemoglobin.

18. The given figure is of cholesterol. It has several functions:

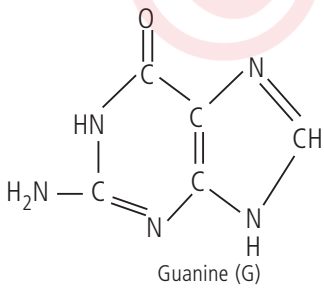
(i) It is useful in absorption of fatty acids.

(ii) It is a constituent of animal cell membrane.

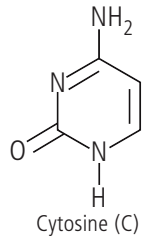
(iii) It helps in forming bile salts.

(iv) It is a component of vitamin D.

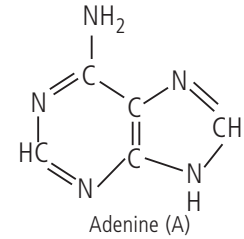
19.



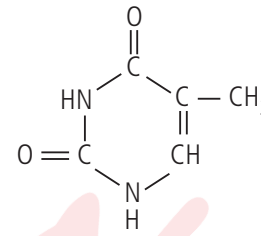
Guanine (G)



Cytosine (C)



Adenine (A)



Thymine (T)

OR

The differences between homopolysaccharides and heteropolysaccharides are as follows :

Homopolysaccharides	Heteropolysaccharides
They are formed by polymerisation of only one type of monosaccharide monomers. Examples – Starch, glycogen, chitin.	They are produced by condensation of two or more types of monosaccharides or their derivatives. Examples – Peptidoglycan

20. (a) Enzymes are proteinaceous substances which are capable of catalysing chemical reactions of biological origin without themselves undergoing any change.

(b) Triglycerides are glycerides in which the glycerol is esterified with three fatty acids. Three molecules of water are eliminated during formation of triglyceride.

21. Essential amino acids are those amino acids which the human body cannot synthesise frow raw materials and are obtained from dietary proteins, *e.g.*, leucine and valine.

The amino acids that can be synthesised in our body to meet the biological needs are called non-essential amino acids, *e.g.*, glycine and alanine.

22. (a) (i) Carotene

(ii) Lycopene

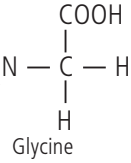
(b) Lipids

(c) Phospholipids, Glycolipids

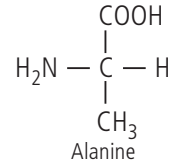
23. (a) Basic amino acid – Arginine

Aromatic amino acid – Tyrosine

(b)



Glycine



Alanine

24. On the basis of shape, proteins can be classified into two categories; fibrous and globular.

Fibrous proteins - They are thread like proteins which may occur singly or in groups. They are tough, non-enzymatic and structural proteins. Fibrous proteins generally possess secondary structure. *E.g.*, keratin of skin and hair.

Globular proteins - They are rounded in outline and lacks contractibility. Globular proteins may be enzymatic or non-enzymatic and possess tertiary or quaternary structure. *E.g.*, egg albumin, serum globulin.

25. (a) 10 base pairs.

(b) Complementary base pairing is the phenomenon where a particular nitrogen base always binds to a specific nitrogen base, *e.g.*, guanine bonds to cytosine.

(c) The distance between consecutive base pairs is 3.4 Å.

26. **(a)** Many plants, fungi and microbes of certain genera and families synthesise a number of organic compounds which are not involved in primary metabolism *e.g.*, photosynthesis, respiration, protein and lipid metabolism and seem to have no direct function in growth and development of plants. Such compounds are secondary metabolites. These compounds are accessary rather than central to the functioning of the plants in which they are found. These are derivatives of primary metabolites.

(b) Concanavalin A is a mannose/glucose binding lectin and is a secondary metabolite.

27. Glycogen is a branched polymer of glucose. It is readily soluble in water. It consists of α-D glucose units, mostly linked by 1-4, α glycosidic linkage, and is highly branched *via* frequent 1-6 linkages. Glycogen is found mostly in muscles and liver of animals and is also called animal starch. It gives red colour with iodine solution. It has about 30,000 glucose residues and a molecular weight of about 4.8 million. The straight part is helically twisted with each turn having six glucose units. The distance between two branching points is 10-14 glucose residues. In a polysaccharide chain of glycogen, the right end is called reducing end and the left end is called non-reducing end.

OR

(i) Chitin is a complex carbohydrate or homopolymer which is found as the structural component of fungal walls and exoskeleton of arthropods.

(ii) Glycosidic bond is formed during the condensation of monosaccharides for the formation of oligosaccharides or polysaccharides. A molecule of water is usually produced at each condensation.

(iii) Peptidoglycan is formed of heteropolysaccharide chains cross linked by short polypeptide. It is found in cell wall of bacteria and blue green algae.

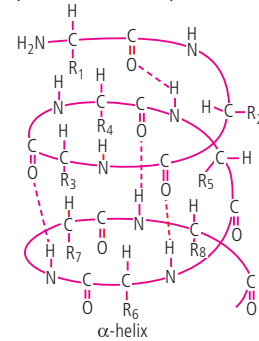
28. The structure of a protein can be studied at four levels of organisation – primary, secondary, tertiary and quaternary.

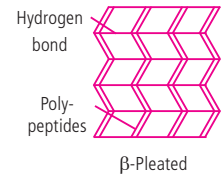
(i) Primary structure – It is the basic structure of a protein. It is the linear sequence of amino acids in a polypeptide chain. The left end of the protein primary structure is represented by the first amino acid (N) while the right end is represented by last amino acid (C). The first amino acid is called the N-terminal amino acid and the last amino acid is called C-terminal amino acid.

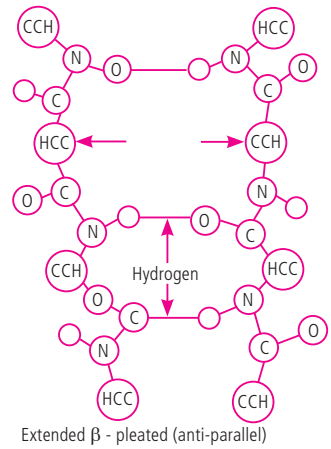
(ii) Secondary structure : It is the development of new stearic relationships of amino acids present in the linear sequence inside the polypeptides. There are mainly two types of secondary structures – α helix, and β-pleated.

(a) α helix – In α helix, the polypeptide chain is coiled spirally, generally in right handed manner. At places the helix is less regular, forming random coils. The helix is stabilised by hydrogen bonds between oxygen of carboxylic group (—CO group) of one amino acid residue and amino group of next amino acid residue. Each turn of helix has ~ 3.6 amino acids and a 13-member ring formed by H-bonding. It is found in several proteins, *e.g.*, keratin, myosin, tropomyosin, fibrin, etc.

(b) β-pleated – In this structure, two or more polypeptide chains get interconnected by hydrogen bonds. A sheet is produced instead of a rod as in α-helix. Hence, this is often called pleated sheet or β-pleated sheet. The polypeptide chain may be parallel or antiparallel.








Collagen helix

(iii) Tertiary structure : The helical polypeptide chain is further coiled and folded to form a complex structure. Tertiary structure gives the protein a three dimensional conformation. The tertiary structure is stabilised by several types of bonds – hydrogen bonds, ionic bonds, van der Waal's interactions, covalent bonds, hydrophobic bonds. Some examples of tertiary structures are – α keratin, plasma proteins, immunoglobulins, etc. The bonds required to form tertiary structure can be easily broken by high energy radiations, high temperature, drastic changes in pH and salts of heavy metals.

(iv) Quaternary structure : The quaternary structure of a protein is the association of several protein chains or subunits into a closely packed arrangement. The subunits in a quaternary structure must be specifically arranged for the entire protein to function properly. This is found only in multimeric proteins, *e.g.*, haemoglobin (4 polypeptides, 2α and 2β).

OR

Lipids are fatty acid esters of alcohols and related substances which are insoluble in water but get dissolved in a number of non polar organic solvents. Lipids are mainly classified into three types –

Simple lipids, compound or conjugated lipids and derived lipids.

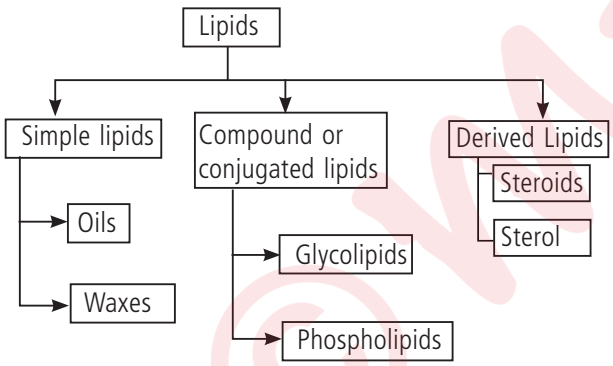


Fig : Different types of lipids

(i) Simple lipid – They are esters of fatty acids and glycerol. They are mainly triglycerides *i.e.* three molecules of fatty acid linked with one molecule of glycerol.

(ii) Compound lipid – These are esters of fatty acids with alcohol, but contain extra groups in addition to alcohol and fatty acid.

(iii) Derived lipid – These are lipids which are derived from the hydrolysis of simple and compound lipids, *e.g.*, cholesterol.

29. (a) The differences between starch and glycogen are as follows :

S.No.	Starch	Glycogen
(a)	It is the storage polysaccharide of most plants.	It is the polysaccharide food reserve of animals, bacteria and fungi.
(b)	Starch consists of two components amylose and amylopectin.	It consists of glucose residues arranged in highly branched chains.

(b) Mucopolysaccharides are slimy substances or mucilages which possess acidic or aminated polysaccharide formed from galactose, mannose and sugar derivatives. They occur inside plant cell walls outside the cells or bodies of bacteria and many aquatic plants.

(c) Functions of polysaccharides are as follows:

(a) Starch and glycogen are the major storage foods of organic world.

(b) Chitin is the structural carbohydrate of fungal walls and exoskeleton of arthropods.

(c) Cellulose is the structural substance of cell walls in most of the plants.

(d) Agar is a polysaccharide used in tissue culture, laxative and food.

(e) Peptidoglycan forms cell wall of bacteria and cyanobacteria.

(f) Pectins are structural heteroglycans of the middle lamella of plant cell walls.

(g) Heparin acts as an anticoagulant.

OR

(a) Primary metabolites are biomolecules essentially required for basic metabolic processes and these are produced in generous quantities. They can be easily extracted from the plant.

Secondary metabolites are derivatives of primary metabolites. These are produced in small quantities and their extraction from the plant is difficult.

(b) DNA is genetic material which carries all the hereditary information. It has the property of replication essential for passing genetic information from parent cell to its daughters or from one generation to the next. Developmental stages occur in the life cycle of an organism by an internal clock of DNA-functioning.

(c) Proteins are amphoteric as they act as acids and alkalies both. Due to the presence of their ionisable α-amino acid and α-carboxylic group, they can act sometimes as acids and sometimes as bases depending on the pH of their media.

30. (a) Polysaccharides are long chain sugars and contain more than ten monosaccharide units as building blocks. Polysaccharides differ from each other in the identity of their recurring monosaccharide units, in the length of their chains, in the types of bond linking units and in the degree of branching. The right end of a polysaccharide is reducing end while the left end is non reducing. Polysaccharides are primary concerned with two important functions, *i.e.*, structural

function and the energy storage. Polysaccharides are of two types based on their composition – homopolysaccharides and heteropolysaccharides.

(i) Homopolysaccharides : Homopolysaccharides are complex carbohydrates which are formed by polymerisation of only one type of monosaccharide monomer. Some homopolysaccharides serve as storage forms of monosaccharides that are used as fuels, *e.g.*, starch and glycogen. Other homopolysaccharides take part in forming the structural framework of the cell wall in plants and skeleton in animals, *e.g.*, cellulose and chitin.

(ii) Heteropolysaccharides : Heteropolysaccharides are complex carbohydrates which are produced by condensation of two or more types of monosaccharides or their derivatives *e.g.*, agar, chitin, etc.

(b) Differences between oligosaccharides and polysaccharides are as follows :

S.No.	Oligosaccharides	Polysaccharides
1.	They contain 2 – 9 monosaccharide residues.	Polysaccharides possess more than ten monosaccharide residues.
2.	Oligosaccharides are soluble in water.	Polysaccharides are usually insoluble in water.
3.	They are commonly sweet to taste.	Sweetness is absent.
4.	Transport of carbohydrates occurs in oligosaccharide state.	Polysaccharides are not involved in transport.
5.	Storage in oligosaccharide state is less common.	Storage occurs in polysaccharide state.
6.	They form component of external surface of plasma membrane and cell coat. Examples : Sucrose, Maltose, Raffinose.	They form component of cell wall. Example : Starch, Glycogen, Cellulose.

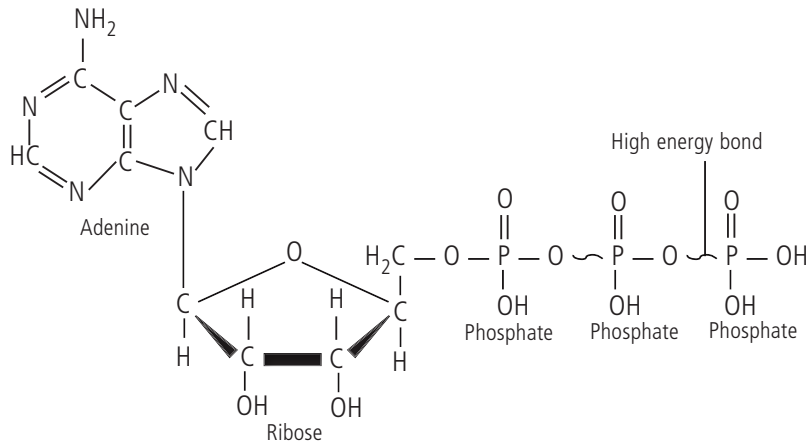
(c) Amylose in starch is responsible for formation of a deep blue colour in the presence of iodine. The iodine molecule slips inside of the amylose coil. Iodine is not very soluble in water therefore the iodine reagent is made by dissolving iodine in water in the presence of potassium iodide. This makes a linear tri-iodide ion complex which is soluble that slips into the coil of starch causing an intense blue black colour.

OR

(a) The differences between purine and pyrimidine are as follows :

S.No.	Purine	Pyrimidine
1.	Purines are large-sized nitrogen containing biomolecules.	Pyrimidines are small-sized nitrogen containing biomolecules.
2.	A purine is nine-membered.	A pyrimidine is 6-membered.
3.	It is a double ring.	It is a single ring.
4.	A purine contains four nitrogen atoms at 1, 3, 7 and 9 positions.	A pyrimidine has nitrogen atoms at two places, 1 and 3 positions.
5.	Purine bases are of two types, : adenine (A) and guanine (G).	Pyrimidine bases are of three types : cytosine (C), thymine (T) and uracil (U).

(b) The structure of ATP is as follows :



ATP is called as energy currency of cell because the second and third phosphates of ATP are attached by high energy bonds. There bonds have high transfer potential because they are held against great electrostatic repulsion. The last phosphate bond easily build up and break down to store or release energy. High energy is used in many important metabolic pathways.

(c) PUFA or polyunsaturated fatty acids contain more than one double bond. They are recommended by physicians to persons having hypertension, high blood cholesterol and other cardiovascular diseases.

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