BIOMOLECULES

Teacher Orientation Detail

-1.Carbohydrates- These are optically active polyhydroxy aldehydes or ketones due to presence of chiral `C' or the compounds which produce these on hydrolysis except dihydroxy acetone is not optically active.

2. Classification-

(i) Monosaccharide's –

(ii) Oligosaccharides-

(iii) Polysaccharides-

3. Sugar-

(i)Reducing Sugars-

(ii)Non Reducing Sugars-

4. Glucose-

5. Preparation

(i)From Sucrose

$C_{12}H_{22}O_{11} + H_2O$ -------> $C_6H_{12}O_6 + C_6H_{12}O_6$ (Only from sucrose)

(ii)From Starch

$(C_6H_{10}O_5)_n + nH_2O$ ---> $C_{12}H_{22}0_{11} + H_20$ ---> $2C_6H_{12}O_6$

6.Structure

(i)Fischer structure –

$CHO — (CHOH)_4 — CH_2OH$

7. Glycosidic Linkage:

8. Proteins:

9. Amino Acids:

10. Classification

Fibrous Protein	Globular Protein

11. Denaturaion of Protein: 12. Enzymes:

14. Vitamins:

15. Nucleic Acids: These are biomolecules which are long chain polymers of nucleotides. They are:

(i) Deoxyribonucleic acid (DNA)

(ii) Ribonucleic acid (RNA)

16. Composition of Nucleic Acid:

17. Nucleoside: 18. Nucleotide: 19.DNA : 20. RNA: is of three types- messenger RNA(m-RNA), ribosomal RNA(r-RNA) and transfer RNA (t-RNA). RNA helps in protein synthesis.

Student Orientation
Concept :Biomolecules

Concept detail

1.Carbohydrates- These are optically active polyhydroxy aldehydes or ketones due to presence of chiral `C' or the compounds which produce these on hydrolysis except dihydroxy acetone is not optically active.

2. Classification-

(i) Monosaccharide's – Those carbohydrates which cannot get hydrolysed e.g. glucose ,fructose, galactose etc.

(ii) Oligosaccharides- Those carbohydrates which give to or more monosaccharide's on hydrolysis e.g. sucrose on hydrolysis gives glucose and fructose. Raffinose on hydrolysis gives glucose, fructose and galactose.

(iii) Polysaccharides- Those carbohydrates which on hydrolysis give large number of monosaccharide's hydrolysis.eg starch, cellulose, glycogen.

3. Sugar-

(i)Reducing Sugars- Those which reduce Fehling's or Tollen's reagent. They have free aldehydic groups, eg , glucose, fructose , galactose

(ii)Non Reducing Sugars- Those which do not reduce Fehling's or Tollen's reagent. They do not have free functional group ,e.g., sucrose

4. Glucose- It is a monosaccharide's with molecular formula $C_6H_{12}O_6$

5. Preparation

(i)From Sucrose

$C_{12}H_{22}O_{11} + H_2O$ -------> $C_6H_{12}O_6 + C_6H_{12}O_6$ (Only from sucrose)

(ii)From Starch

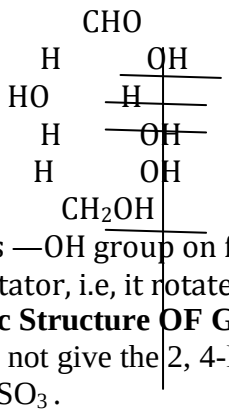
$(C_6H_{10}O_5)_n + nH_2O$ -------> $C_{12}H_{22}0_{11} + H_20$ ------> $2C_6H_{12}O_6$

6.Structure

(i)Fischer structure –

$CHO — (CHOH)_4 — CH_2OH$

(+) Glucose has `D' configuration as shown



`D' means —OH group on first chiral `C' from the bottom is on right hand and + means it is dextro rotator, i.e, it rotates plane polarized light towards right.

(ii) Cyclic Structure OF Glucose: the straight chain is unable to explain the following reactions.

(a) It does not give the 2, 4-DNP test, Schiff's Test and does not form the hydrogensulphide product with $NaHSO_3$.

(b) The pentacetate of glucose does not react with NH_2OH, indicating the absence of free aldehydic group.

(iii) Glucose exist in 2 different crystalline forms α and β forms. These are called anomers. They differ in optical rotation, they also differ in melting point.

Anomers are isomers which have a different configuration across C-1 (first chiral 'C' atom).

7. Glycosidic Linkage: The linkage between two monosaccharide units through oxygen is called the glycosidic linkage.

8. Proteins: These are micro molecules made up of amino acids joined via a peptide link (-(-CONH-)- is the peptide linkage). These are required for growth and development of the body.

9. Amino Acids: These contain an amino ($-NH_2$) and an acidic (-COOH) group and are therefore amphoteric in nature. In solution they exist in the form of zwitter ion.

10. Classification

Fibrous Protein	Globular Protein
(i) Polypeptide chains run parallel or anti-parallel and held together by hydrogen and disulphide bonds.	(i) Chains of Polypeptide coil around to give a spherical shape.
(ii) Generally insoluble in water. e.g. Keratin, collagen,myosin,fibroin.	(ii) Usually soluble in water. e.g., insulin, thyroglobin,albumin, haemoglobin and fibrinogen gets converted into fibrous protein fibroin on clotting of blood.

11. Denaturaion of Protein: The protein in native state, when subjected to a physical change like temperature, pH etc undergoes uncoiling and looses it's biological activity. The 2^o and 3^o structures are destroyed, only 1^o structure is retained.

Renaturation of Protein:

Some proteins regain their biological activity by reversible process it is called Renaturation of Proteins. In such a cases, when temperature in pH of a denatured proteins is brought back to conditions in which the native protein is stable, secondary and tertiary structures of proteins are restored to which leads to recovery of biological activity.

12. Enzymes: These are biocatalyst and generally globular proteins e.g., invertase,zymase,phenyl, alaninehydroxylase, urease etc.

13. Vitamins: They are organic compounds required in the diet in small amounts to perform specific biological functions for maintenance of optimum growth and health of the organism. They are classified as follows

(i) Fat Soluble Vitamins: Vitamin A,D,E and K. They are stored in liver and adipose tissues.

(ii) Water Soluble Vitamins: B group vitamins and vitamin C. They need to supplied regularly in diet as they are excreted in urine and cannot be stored(except vitamin B_{12}) in our body.

Their deficiency causes diseases.

Biotin (Vit H) is however neither fat nor water soluble. It's deficiency leads to loss of hair.

14. Nucleic Acids: These are biomolecules which are long chain polymers of nucleotides. They are:

(i) Deoxyribonucleic acid (DNA)

(ii) Ribonucleic acid (RNA)

They are responsible for protein synthesis and transfer of genetic characteristics to offspring's.

15. Composition of Nucleic Acid:

They are made up of pentose sugar(β-D-2-deoxyribose in DNA and β-D-ribose in RNA), phosphoric acid and a nitrogen containing heterocyclic compound(base).

DNA- Bases present are Adenine(A), Thymine(T),Guanine(G) and Cytosine(C).

RNA- contains Adenine(A), Guanine(G), Cytosine(C) and Uracil(U).

16. Nucleoside: The unit formed by the attachment of a base to n1'-position of sugar (Base+Sugar).

17. Nucleotide: Nucleoside and phosphoric acid at 5'-position. Nucleotides are bonded by phosphodiester linkages between 5' and 3' carbon atoms of pentose sugar (Base+ Sugar+ Phosphoric Acid).

18.DNA : has a double helical structure with AT and GC linked together through 2 and 3 hydrogen bonds respectively. It is responsible for transfer of genetic characteristics.

19. RNA: is of three types- messenger RNA(m-RNA), ribosomal RNA(r-RNA) and transfer RNA (t-RNA). RNA helps in protein synthesis.

20. Biological Functions of Nuclei Acid: DNA is chemical basis of hereditary and have the coded message for proteins to be synthesized in the cell. RNA carry out the protein synthesis in the cell.

ACTIVITY

Self-Quiz

1. The monomers used to synthesize proteins are called:

a. nucleotides

b. amino acids

c. fatty acids

d. sugars

e. glycerol

2. A nucleoside contains:

a. a pentose sugar

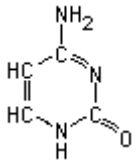
b. a purine or pyrimidine base

c. one or more phosphate group

d. all of these

e. a and b, but not c

3. The molecule shown below is:



a. a purine base

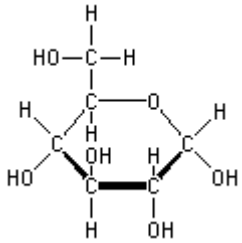
b. a pyrimidine base

c. a sugar

d. a fatty acid

e. an amino acid

4. The molecule shown below is:



a. a purine base

b. a pyrimidine base

c. a sugar

d. a fatty acid

e. an amino acid

5. Sulfur is found in:

a. DNA

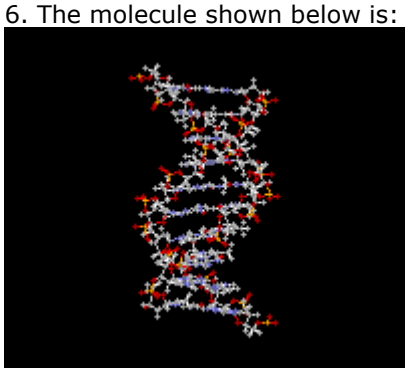
b. RNA

c. sugars

d. lipids

e. proteins

6. The molecule shown below is:



a. DNA

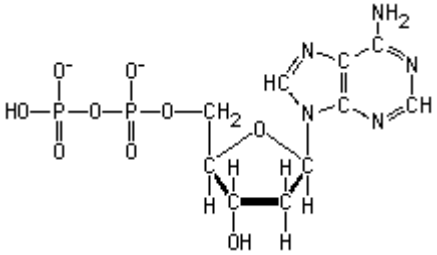
b. RNA

c. a phospholipid

d. a polysaccharide

e. a membrane

7. The molecule shown below is:



a. dATP

b. dADP

c. dAMP

d. a polysaccharide

e. a sugar

8. What kind of molecule is represented by the structure below?

$CH_3CH_2CH_2CH_2CH{=}CHCH_2CH_2CH_2CH_2CH_2CH_2COOH$

a. a sugar

b. an unsaturated fatty acid

c. a saturated fatty acid

d. a disaccharide

e. a phospholipid

9. Which of the following items is a polymer of glucose?

a. starch

b. glycogen

c. cellulose

d. lactose

e. a, b, and c, but not d

10. Lipid bilayers are created from:

a. phospholipids

b. triglycerides

c. fatty acids

d. glycerol

e. proteins

INSTANT DIAGNOSIS

1 What are monosaccharides?
2 What are reducing sugars?
3 Write two main functions of carbohydrates in plants.
4 Classify the following into monosaccharides and disaccharides. Ribose, 2-deoxyribose, maltose, galactose, fructose and lactose.
5 What do you understand by the term glycosidic linkage?
6 What is glycogen? How is it different from starch?
7-- What are the hydrolysis products of (i) sucrose and (ii) lactose?
8 What is the basic structural difference between starch and cellulose?

FORMATIVE ASSIGNMENT

1 What is the effect of denaturation on the structure of proteins?
2How are vitamins classified? Name the vitamin responsible for the coagulation of blood.
3Why are vitamin A and vitamin C essential to us? Give their important sources.
4What are nucleic acids? Mention their two important functions.
5 What is the difference between a nucleoside and a nucleotide?
6 The two strands in DNA are not identical but are complementary. Explain.
7 Write the important structural and functional differences between DNA and RNA.
8 What are the different types of RNA found in the cell?

LEVEL WISE ASSIGNMENT

LEVEL1

Q1 – Which functional groups are present in monosaccharides?
Ans - —OH and —CHO or —OH and >CO
Q2 – Name an aldopentone, aldohexone and ketohexone.
Ans – Ribose,glucose and fructose respectively.
Q3 – What is animal starch?
Ans – Glycogen.
Q4 – Which types of bonds are present in a protein molecule?
Ans – Peptide bonds, hydrogen bonds, sulphide bonds, ionic bonds etc.
Q5 – Which α-helix or β-helix is more stable?

Ans – α-helix is right handed and is more stable due to intermolecular H bonding between first and fourth amino acid.
Q6 – The sequence of bases in one strand of DNA is TACGGACA. What is the sequence of bases of complementary strand of DNA.
Ans – ATGCCTGT.

LEVEL 2

Q1 – Name polysaccharides that make up starch and what is the difference between them.
Ans – Amylose which is linear polymer of α-glucose and amytopectin which is branched polymer of α-glucose. Amylose is water soluble where as amylopectine is water insoluble.
Q2 – What are anomers?
Ans – Monosaccharides which differ only in the orientation of the —OH group at C-1.e.g, α-glucose and β-glucose.
Q3 – Where does the water present in the egg go after boiling the egg?
Ans – On boiling during denaturation process water gets adsorbed/absorbed in the denatured proteins.
Q4 – Write two main functions of carbohydrates in plants.
Ans – (i)structural material (ii)reserved food material.
Q5 – WAns – During condensation of two monosaccharides, a water molecule given out and two monosaccharides get linked together by an oxide or ethereal linkage (—O—) called as glycosidic linkage.
Q6 – What are essential and non essential amino acid? Give two examples of each type.
Ans – Essential amino acids are those which are not produced in our body.e.g.,valine,leucine.
Non-essential amino acids are those which are produced by our body.e.g.glycine and alanine.
Q7 – How do you explain the amphoteric behavior of amino acids?
Ans – Amino acids have both acidic as well as basic group and they react both with acids as well as bases,therefore they are amphoteric in nature.

Q8 – What is the difference between a nucleoside and a nucleotide?
Ans - Nucleoside = sugar + base
Nucleotide = sugar + base + phosphoric acid

LEVEL3

Q1 – Give three differences between DNA and RNA.
Ans –

DNA	RNA
1. it has deoxyribose as sugar. 2. it contains thymine along with adenine, cytosine and guanine as bases. 3. it is responsible for maintaining heredity traits from generation to generation.	1.it contains ribose as sugar. 2.it contains uracil in place of thymine with other bases. 3. it is responsible for protein synthesis.

Q2 – Difference between globular protein and fibrous protein.
Ans –

Globular Protein	Fibrous Protein
1. they form α-helix structure. 2. they are water soluble. 3. they involve H bonding.	1. they have β-pleated structure. 2. they are water insoluble. 3. they have strong intermolecular forces of attraction.

Q3 – Give reactions with support cyclic structure of glucose.
Ans – (a)Glucose does not give 2,4-DNP test, Schiff`s test and sodium hydrogen suphide test.
(b)The pentaacetate of glucose does not react with NH_2OH indicating absence of free —CHO group.
(c)Glucose exists in two crystalline form α and β.
Q4 – Define with example
(a)Isoelectric point (b)Mutarotation (c)Transcription
Ans –
(a)Isoelctric point – the pH at which there is no net migration of any ion towards electrode.e.g,amino acids have isoelectric point at pH = 5.5-6.3
(b)Mutarotation - it is spontaneous change in optical rotation when an optically active substance is dissolved in water.e.g, α-glucose when dissolved in water changes its optical rotation from 111^o to $52.5^{o.}$
(c)Transcription – it is process by which m—RNA is generated from DNA.e.g,if DNA has base sequence ATACA then m—RNA has base sequence TATCGT.

Q5 – What happens when glucose reacts with
(a)HI (b) HNO_3 (c)Br_2 water
Ans –

(a) $C_6H_{12}0_6$ + HI ------> n-hexane C_6H_{14}
(b) $C_6H_{12}0_6$ + HNO_3 -------> saccharic acid
(c) $C_6H_{12}0_6$ +Br_2 water --------> gluconic acid

Q6 – Differentiate primary , secondary and tertiary structure of protein.
Ans – -In primary structure specific sequence of amino acid are present joined by covalent bonds.
-secondary structure is responsible for the shape of a protein. α-helix and β-pleated in which polypeptide chains have peptide bonds.
-tertiary structure represents overall folding of polypeptide chain and give rise to the fibrous or globular molecular shape.
Q7. Discuss the specificity and mechanism of enzyme action.
Ans. In case of enzymatic reaction the enzyme is so built that it binds to the substrate in a specific manner. Enzymatic reaction involves following steps (Lock and Key Model)-
Step (i): Binding of substrate(S) to enzyme (E) to form complex

E + S → [ES] (Enzyme substrate complex)

Step (ii): Product formation in complex

[ES] → EP (Enzyme product complex)

Step (iii): Dissociation of enzyme product complex, leaving enzyme unchanged

EP → E + P

The specificity of enzyme is due to presence of some specific regions called active site .

PROJECT

Draw the structure of the following:

(1) DNA
(2) RNA
(3) Pyranos structure of glucose