Biomolecules

Very Short Answer Type Questions

1. **Medicines are either man made (i.e., synthetic) or obtained from living organisms like plants, bacteria, animals etc. and hence the latter are called natural products. Sometimes natural products are chemically altered by man to reduce toxicity or side effects. Write against each of the following whether they were initially obtained as a natural product or as a synthetic chemical.**
   - **a. Penicillin** --------
   - **b. Sulfonamide** ----
   - **c. Vitamin C** --------
   - **d. Growth hormone** ----------

A: a. Penicillin ---------- Natural
   b. Sulfonamide ---------- Synthetic
   c. Vitamin C ---------- Natural
   d. Growth hormone ---------- Natural

2. **Select an appropriate chemical bond among ester bond, glycosidic bond, peptide bond and hydrogen bond and write against each of the following.**
   - **a. Polysaccharide** ----------
   - **b. Protein** ----------
   - **c. Fat** ----------
   - **d. Water** ----------

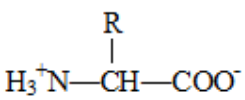
A: a. Polysaccharide ---------- Glycosidic bond
   b. Protein ---------- Peptide bond
   c. Fat ---------- Ester bond
   d. Water ---------- Hydrogen bond

3. **Give one example for each of amino acids, sugars, nucleotides and fatty acids?**

A: Glutamic acid ----- amino acid
   Sucrose ---------- sugars
   Adenylic acid------ nucleic acid
   Palmitic acid ------ fatty acid

4. **Explain the zwitterionic form of an amino acid.**

A: At physiological pH carboxyl group of amino acid exist almost as $R—COO^-$ and amino group predominantly $R—NH_3^+$. The existence of an amino acid at physiological pH as a dipolar form with no net charge is called as zwitterions.



5. **What constituents of DNA are linked by glycosidic bond?**

A: Pentose sugar and Nitrogen base.

6. **Glycine and alanine are different with respect to one substituents on the α-carbon. What are the other common substituent groups?**

A: Hydroxyl methyl (serine), Sulfur (cysteine), Carboxyl (Aspartic acid) and amino groups (Lysine).

7. Starch, Cellulose, Glycogen, Chitin are polysaccharides found among the following. Choose the one appropriate and write against each.

a. Cotton fibre ----------
b. Exoskeleton of cockroach ----
c. Liver ----------
d. Peeled potato ----------

A: a. Cotton fibre ---------- Cellulose
b. Exoskeleton of cockroach ---- Chitin
c. Liver ---------- Glycogen
d. Peeled potato ---------- Starch

Short Answer type Questions

1. Explain briefly the metabolic basis for 'living'.

A. Metabolic pathways can lead to a more complex structure from a simpler structure (Anabolic pathways). [For example lactic acid becomes cholesterol or sucrose formation from CO_2 and water in mesophyll] or lead to a simple structure from a complex structure (catabolic pathways) [glucose becomes lactic acid in our skeletal muscle). Anabolic pathways consume energy whereas catabolic pathways lead to the release of energy. For example when glucose is degraded to lactic acid in our skeletal muscle, energy is liberated called Glycolysis. Living organisms have learnt to trap this energy and store in the form of chemical bonds. Whenever requires, this energy is utilized for biosynthetic, osmotic and mechanical work that we perform. The most important form of energy currency in living systems is adenosine triphosphate (ATP).

2. Is rubber a primary metabolite or a secondary metabolite? Write four sentences about rubber.

A. Rubber is a secondary metabolite. Rubber is an elastic hydro carbon polymer that was originally derived from latex, a milky colloid produced by some plants. The purified form of natural rubber is the chemical polyisoprene. It is used extensively in many products, as a synthetic rubber. It is normally very stretchy and flexible and extremely water proof.

3. Schematically represent primary, secondary and tertiary structures of a hypothetical polymer using protein as an example.

A. The sequence of amino acids, i.e., the positional information in a protein is called the primary structure of a protein. A protein is imagined as a line, the left and represented by the first

amino acid called N – terminal amino acid and the right end represented by the last amino acid called C – terminal amino acid in proteins, only, right handed helices are observed. Other regions of the protein thread are folded into other forms in what is called the secondary structure. In addition, the long protein chain is also folded upon itself like a hollow woolen ball giving rise to the tertiary structure.

4. Nucleic acid exhibits secondary structure. Justify with example.

A. Nucleic acids exhibit a wide variety of secondary structure. For example, one of the secondary structures exhibited by DNA is Watson – Crick model. According to this, DNA exists as a double helix. The two strands of polynucleotides are antiparallel, i.e., run in the opposite direction. The back bone is formed by the sugar – phosphate, sugar chain. The nitrogen bases are projected more or less perpendicular to this back bone but face inside. A combines with T, by two hydrogen bonds whereas G combines with C by three hydrogen bonds. One full turn of the helical strand would involve ten base pairs. The length of one coil is $34A°$ and the distance between base pair is $3.4A°$. This type of DNA is called the B - DNA.

5. Comment on the statement living state is a non – equilibrium state to be able to perform work.

A. Several chemical compounds are present in a living organism called metabolities or biomolecules are present at concentrations characteristic of each of them. For example the blood concentration of glucose in a normal healthy individual is $4.5 – 5.0 m\mu$. All living organisms exist in a steady state characterized by concentrations of each of these biomolecules. These are in a metabolic flux. Any chemical or physical process moves spontaneously to equilibrium. The steady state is a non equilibrium state. The systems cannot work at equilibrium. As living organisms work continuously, they cannot afford to reach equilibrium. Hence the living state is a non – equilibrium steady state to be able to perform work.

6. Dynamic state of body constituents is a more realistic concept than the fixed concentrations of body constituents at any point of time. Elaborate.

A. All living organisms contain biomolecules in certain concentrations, which have a turn over. They are constantly being changed into some other biomolecules and also made from some other biomolecules. This breaking and making occurs through chemical reactions called metabolism. Each of the metabolic reactions results in the transformation of biomolecules.

Example: Removal of CO_2 from amino acids making into an amine removal of amino group in a nucleotide base. Majority of metabolic reactions do not occur in isolation but are linked to some other reactions. Metabolities are converted into each other by a series of linked reactions called metabolic pathways. Flow of metabolities through metabolic pathways has a definite rate and direction like automobile traffic. This metabolic flow is called the dynamic state of body constituents.

LONG ANSWER TYPE QUESTIONS

1. What are secondary metabolities ? Enlist them indicating their usefulness to man.

A. Metabolic products that do not have identifiable functions in the host organism are called secondary metabolities. They are alkaloids, flavinoids, rubber, essential oils, antibiotics, coloured pigments, scents, gums and spices.

Alkaloids

1) Alkaloids from plant extract have been used as ingredients in potions (liquid medicine) and poisons.

2) Ancient people used plant extracts containing alkaloids for treating a large number of ailments including snake bite, fever and insanity.

Flavinoids

These are widely distributed group of polyphenolic compounds with healthy related properties which include anticancer, antiviral, anti inflammatory activities, effects on capillary fragility and can ability to inhibit human platelet aggregation.

Rubber

1) Uncured rubber is used for cements for adhesive, insulating and friction tapes. The flexibility of rubber if often used in hose, tyres and rollers for a wide variety of devices.

2) Its elasticity makes it suitable for various kinds of shock absorbers.

3) It is impermeable to gases; it is useful in the manufacture of articles such as air hoses, balloons, bulls and cushions.

Essential oils

1) An essential oil is a concentrated hydrophobic liquid containing volatile aroma compounds from plants.

2) These are known as volatile oils, ethereal oils or aetherolea. These are used in aromatherapy.

Antibiotics

1) Antibiotics are defined as chemicals of natural organic origin that will till certain harmful pathogens.

2) They should not be toxic or have side effects to the host.

3) An antibiotic is a substance that harms or destroys the bacteria that cause infection and disease. We take antibiotics to fight bacterial infections.

Spices

1) Asafoetida is a good remedy for whooping cough and stomach ache caused due to gas.

2) Cardamom (elachi) helps to control bad breadth and digestive disorder.

2. What are the processes used to analyze elemental composition, organic constituents and inorganic constituents of a living tissue? What are the inferences on the most abundant constituents of living tissue? Support the inferences with appropriate data.

A. Take a living tissue (a vegetable or a piece of liver) and grind it in trichloroacetic acid with the help of mortar and pestle. The thick slurry obtained was strained through a cheese cloth or cotton, two fractions are formed. The first one is filtrate or acid soluble pool which consists of thousands of organic compounds and the second one is retentate or acid insoluble fraction. All the carbon compounds that we get from living tissues can be called biomolecules.

Weigh a small amount of living tissue and dry it. After the evaporation of water the material is burnt to oxidize all the carbon compounds. The remaining ash contains inorganic elements like sodium, potassium, calcium and magnesium and inorganic compounds like sulphate, phosphate, etc., therefore chemical analysis gives elemental composition of living tissue in the form of hydrogen, oxygen, chlorine, carbon, etc. From a biological point of view the organic constituents are classified into amino acids, nucleotide bases, fatty acids, etc.

3. Nucleic acids exhibit secondary structure. Describe through Watson – Crick model.

A. Nucleic acids exhibit a wide variety of secondary structure. For example, one of the secondary structures exhibited by DNA is Watson – Crick model. According to this, DNA exists as a double helix. The two strands of polynucleotides are antiparallel, i.e., run in the opposite direction. The back bone is formed by the sugar – phosphate, sugar chain. The nitrogen bases are projected more or less perpendicular to this back bone but face inside. A

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4. What is the difference between a nucleotide and nucleoside? Give two examples of each with their structure.

A.

Nucleotide	**Nucleoside**
1. Heterocyclic compounds (nitrogen bases) + monosaccharide and a phosphate group is called Nucleotide 2. Ex : Adenylic acid, thymidylic acid guanylic acid, uridylic acid and cytidylic acid	1. Heterocyclic compounds nitrogen bases + monosaccharide (sugar) is called nucleoside 2. Ex : Cytidine, uridine, adenosine, guanosine, thymidine and inosine

5 Describe various forms of lipid using a few examples.

A. Lipids are organic compounds which are insoluble in water. They are fats and fatty acids, oils, triglycerides, phospholipids, steroids, waxes, etc.

Fatty acids

They have a carboxyl group attached to an R group. The R group could be a methyl or ethyl or higher number of CH_2 groups. For example palmitic acid has 16 carbons including carboxyl carbon. Fatty acids could be saturated or unsaturated.

Glycolipids

They are composed mainly of mono – di and tri substituted glycerols, the most well known being the fatty acid esters of glycerol called Triglycerides. In these compounds, the three hydroxyl groups of glycerol are each esterified usually by different fatty acids. They function as a food store.

Phospholipids

Some lipids have phosphorous and phosphorylated organic compound in them called phospholipids. They are found in cell membrane. Ex: Lecithin.