MAHARASHTRA AGRICULTURAL UNIVERSITIES EXAMINATION BOARD, PUNE
SEMESTER END EXAMINATION
B.Sc.(Hons.) Agriculture

Semester : III (New) Term : I Academic year : 2023-2024
Course No : BIOCHM-231 Title : Fundamentals of Plant Biochemistry and Biotechnology
Credits : 3(2+1) Total Marks : 80
Day & Date : Time :

Note : 1. Solve **ANY Eight** questions form **SECTION "A"**
2. All questions from **SECTION "B"** are compulsory.
3. All questions carry equal marks.
4. Draw neat diagram wherever necessary.

SECTION "A"

Q.1. a) Distinguish between reducing sugar and non-reducing sugar. (4)

	Reducing sugar	Non-reducing sugar
1.	Carbohydrates with a free aldehyde (at C-1) group.	Aldehyde or ketone group is not free but or a free ketone (at C-2) group.
2.	They are in hemiacetal or hemiketal form	They are in acetal or ketal form.
3.	Do exhibit mutarotation.	Do not exhiblit mutarotation.
4.	Do form osazones with phenyl hydrazine.	Do not form osazones.
5.	Do form oximes with hydroxylamine. Examples – Glucose, Fructose, Lactose,	Do not form oximes. Examples – Sucrose, Glycogen, Insulin Maltose, Cellobiose

b) Enlist different properties of water and write its importance.

properties of water (2)

1. Expansion on freezing.
2. Uniquely high surface tension.
3. Uniquely high heat capacity.
4. High solvent power.

Importance of water : (2)

i) Serves as a medium in which substances undergo fundamental changes.
ii) Provides hydrogen for the reduction of CO_2 in photosynthesis.
iii) Water is necessary reactant for the hydrolytic splitting of carbohydrates, fats and proteins.
iv) Water is solvent and dispersion medium for all protoplasmic constituents.
v) Acts as a transporting medium for all the cell nutrients.
vi) Absorption, secretion and excretion would not be possible without water.

Q.2. a) Define Carbohydrates, classify polysaccharides on the basis of composition with appropriate examples.

Ans. Carbohydrates are aldehydic or Ketonic derivatives of polyhydroxy alcohols. (1)

Classification.

Polysaccharides – On the basis of functions (3)

i) Hemopolysaccharides, Starch, inulin
ii) Heteropoly saccharides – Pecting, Gymus etc.

b) What are lipids chemically? Explain the significance of lipids.

Ans. Chemically lipids are esters of fatty acid with glycerol. (1)

Significance of lipid. (3)

1. Lipid provides energy to body. One grame lipid produces 9.3 kilocalories of heat.
2. It can be stored in body as a food reserve.
3. It is important constituents of cell membrane.
4. It protect internal organs.
5. It posses high insulating capacity.
6. It synthesis hormones
7. Antibiotic agent

Q.3. a) Define Fatty acids. Give its classification with suitable example.

Ans. Definition of Fatty Acids (1)

Fatty acids may be defined as organic acid that occur in a natural triglyceride and is a monocarboxylic acid ranging from C_4 to C_{28} atoms in straight chains and will usually have either a saturated hydrocarbon chain or may contain from one to six double bonds.

Classification (3)

1) Saturated fatty acid :- Contain no double bond, chain is saturated.

e.g. Butyric acid (4), Caproic acid (6) Caprylic acid (8) Capric acid (10), Lauric acid (12), Myristic acid (14), Palmitic acid, (16) Stearic acid (18), Arachidic acid (20) Behenic acid (22) Lignoceric acid (24) , Cerotic acid (26) Montanic acid (28) **[Figures in the bracket is number of carbons].**

2) Unsaturated fatty acid :- Contain one or more double bond in chain and degree of unsaturation depends on the no. of double bond present in it.

Sub classified on the basis of degree of unsaturation.

a) Monoethenoid acids - contain one double bond e.g. oleic acid, palmitoleic acid

b) Diethenoid acids - contain two double bond e.g. Linoleic acid.

c) Triethenoid acid - contain three double bond e.g. Linolenic acid Eleostearic acid

d) Tetraethenoid acids - contain four double bond e.g. Arachidonic acid.

3) Branched chain fatty acids - Contain hydroxyl group in chain of fatty acid.

4) Cyclic fatty acid – posses ring structure e.g. chaulmoogric acid and hydnocarpic acid

b) Explain the mechanism of enzyme action.

Ans. Mechanism of Enzyme Action (2)

The enzyme combines with the substance on which it acts (substrate) to form an enzyme - substrate complex called Michaelis complex

$E + S \longrightarrow E S$

Enzyme is liberated and the substrate is broken into the products of the reaction

$ES \longrightarrow E + P$ (products)

Active site :- The region of an enzyme surface that binds the substrate molecule and catalytically transforms it.

Functional groups present at the active site. (2)

Amino acids such as aspartic acid, glutamic acid, lysine, serine etc. the side chain groups - COOH, - NH_2, - CH_2OH etc. serve as catalytic groups at active site.

Q.4. a) Define essential amino acids ? Classify amino acids on the basis of composition with suitable examples

Ans. **Definition :** Amino acids are organic acids which contain both basic (amino - NH_2) and acidic (carboxyl COOH) groups. (1)

Classification on the basis of composition as. (3)

1. Simple amino acid
2. Hydroxy anino acid
3. Sulphur containing amino acids
4. Acidic or discorboxycylic amino acid.
5. Basic amino acids
6. Aromatic amino acids
7. Aromatic amino acids
8. Heterocyclic amino acid
9. Non protein amino acid

Q.4. b) Define nucleic acids. Explain the types of RNA (1)

Definition : The nucleic acids are biopolymers of high molecular weight with mononucleotide as their repeating units.

Types of RNA (3)

1. Transfer RN0041(T-RNA)
2. Messenger RNA (m-RNA)
3. Ribosomal RNA (r-RNA)

Q.5. a) What are proteins ? Classify proteins on the basis of composition with suitable examples.

Ans. Definition : any of a class of nitrogenous organic compounds which have large molecules composed of one or more long chains of amino acids and are an essential part of all living organisms, especially as structural components of body tissues such as muscle, hair, etc., and as enzymes and antibodies. (1)

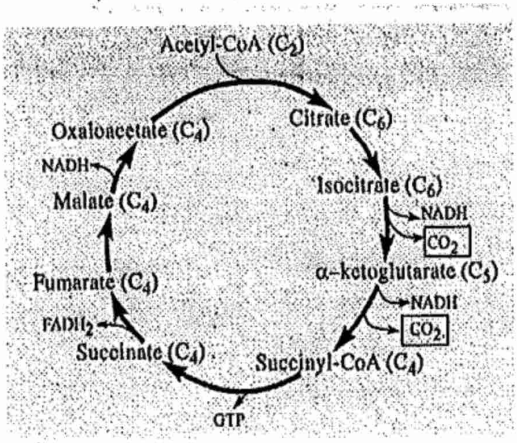
Protein classified as (3)

Simple protein – sub classified on solubility
Complex protein-subclass on prosthetic gross
Derived protein – subclass on hydrolysis stage

Q.5. b) Explain in brief TCA cycle involved in aerobic respiration.

Total energy output from glucose - One mole of glucose gives 38 moles of ATP (8 ATP from anaerobic glycolysis + 30 moles from TCA cycle). (1)

With Diagram (3)



Q.6. a) Define biomolecules. Enlist the biomolecules of life and state the characteristics.

Ans. Definition of Biomolecule : A biomolecule or biological molecule is any molecule that is present in living organisms, including large macromolecules such as proteins, carbohydrates, lipids, and nucleic acids, as well as small molecules such as primary metabolites, secondary metabolites, and natural products.

Biomolecule : (1)

1. Water (1)
2. Carbohydrates
3. Proteins
4. Lipids
5. Nucleic acid
6. Enzymes

Characteristics of Biomolecules : -

1) Most of them are organic compounds. (2)
2) They have specific shapes and dimensions
3) Functional group determine their chemical properties.
4) Many of them are asymmetric
5) Macromolecules are large molecules and are constructed from small building block molecules.
6) Building block molecules have simple structure.
7) Biomolecules first gorse by chemical evolution.

b) Describe ß- oxidation of fatty acids with generation of ATP molecules

Ans. Beta oxidation of fatty acid (5 steps)

1. Activation of fatty acid (4)
2. Formation of unsaturated Acyl. COA
3. Formation of Beta hydroxyl Acyl-COA
4. Formation of Beta – Ketoacyl-COA
5. Thiolytic cleavage of acyl-COA.

Q.7 a) Write the scope and importance of biochemistry in Agriculture.

Ans. Scope and importance of biochemistry in Agriculture (1)

Modern biochemistry has two branches, descriptive biochemistry and dynamic biochemistry. **Descriptive biochemistry** is concerned with the qualitative and quantitative characterization of the various cell components and the **dynamic biochemistry** deals with the elucidation of the nature and the mechanism of the reactions involving these cell components. While the former branch is more a concern of the organic chemist, the latter branch has now become the language of modern biochemistry.

Importance

1) To evaluate nutritive value of cereals, pulses, poultry and cattle feeds. (3)
2) Development and exploitation of better genotypes.
3) Removal and inactivation of toxic or anti nutritional factors present in food grains in general and grain legumes in particular by breeding and chemical treatments. e.g. BOAA in Lakh dal, Trypsin inhibitors of soybean, Aflatoxins of groundnut.
4) Food preservation and processing technology and post harvest physiology of fruit crops and vegetables and their nutritional quality.
5) Biochemistry of disease and pest resistance.

6) Biochemistry of drought resistance. Proline and hydroxyproline imparts drought resistance to Jowar.
7) Formulation of balanced diet.
8) Use of nonconventional sources of protein foods *viz.*, single cell proteins, fish protein concentrates, mushrooms and leaf proteins.
9) Developments in the field of intermediary metabolism i.e. synthesis and degradation of constituents of living tissues.

b) Define enzyme. Give the functions of enzymes.

Ans: **Definition of Enzyme:** Catalytically active protein of biological origin or organic catalyst produced by living cells. (1)

Functions (3)

1) To accelerate or retard or bring about reaction
2) Regulate reaction
3) To make possible the metabolic reactions
4) To facilitate reaction
5) To break down larger molecule to small molecule
6) To carry out flow of reaction smoothly.

Q.8 **Define anther culture. Explain procedure and advantages of anther culture.**

Defination: Regeneration of whole plant from anther or pollen in the culture medium is called as anther culture. (1.0)

The procedure of anther culture is as below. (3.5)

1. Do not collect the flower buds from the plants until the laboratory is ready.
2. Collect the flower-buds using a pair of forceps in a non-sterile petri dish and measure the length of each bud using a cm-scale.
3. Chill the buds at 7° to 8° C for 12 days in a refrigeration unit.
4. Surface-sterilize the buds in a Petri dish containing 0.01% solution of H_gCI_2. (with Tween-20 added as wetting agent) for 10 minutes.
5. Rinse the buds 3-4 times with sterile double distilled water in a sterile air-cabinet
6. Carefully tease, open the buds and remove the anthers using forceps and a dissecting needle.
7. Group the dissected anthers form each bud separately as they are removed
8. Remove one anther from each group for acetocarmine staining in order to determine the stage of pollen development.
9. Remove the filaments from anthers prior to their culture to avoid callusing from the filament.
10. Place the anthers on the culture medium (Appendix II).
11. Incubate the cultures at 25°C in dark.
12. After about 2 weeks of incubation check the cultures for detection of young embryos by gently brushing the anthers on a microscope slide in a drop of acetocarmine stain and observe it under a microscope.
13. Shift the cultures to light (3000 lux) at this stage. The growth of the young embryos to complete plantlet is observed after 4-5 weeks of culture.
14. Separate the plantlets with forceps and discard the remaining anther tissue.
15. For quicker development of the plantlets, transfer them to root inducing medium.

Applications of anther culture (3.5)

Haploid production – Major application of pollen / anther culture is production of haploid plants. It takes much time to produce haploid plants by conventiona breeding methods (many generations of inbreeding or backcrossing). As pollens are haploid, plants developed from these are homozygous (haploids

Protoplast isolation – Used for protoplast isolation as single pollen (unicellular) are available

Transformation – Used in transgenic plant formation, it can be done with less time consumption

Crop improvement – In-vitro anther culture is used for improvement in vegetable and cereal crops e.g. asparagus, sweet pepper, watermelon, cabbage broccoli, wheat etc.

Q.9 Define Micropropagation. Describe the stages and applications of Micropropogation.

Ans: Micropropagation : *In vitro* clonal propagation is called micro propagation. (1)

Stages of Micro-Propagation: (3.5)

Stage 0: This is the initial step of micro-propagation in which stock plants has to be grown under controlled condition before using for culture initiation.

Stage I: The preparation of explants from stock plants is followed by its establishment j in a suitable culture medium. The steps involved in this stage are: (a) Explant isolation, (b) Surface sterilisation, (c) Washing, (d) Establishment of explant on appropriate culture medium.

Stage II: This stage involves the multiplication of shoots or rapid somatic embryo formation using a defined culture medium. It Includes: (i) Multiplication through the growth and proliferations of meristems excised from apical and axillary shoot of the parent plant. (ii) Induction and multiplication of adventitious meristems (iii) Multiplication of calli derived from any kind of explant and subsequently shoots development either through organogenesis or embryogenesis.

Stage III: Shoots obtained from stage II are transferred to the next rooting or storage medium. These shoots are directly established in soil as micro-cuttings to develop roots.

Stage IV: Transfer of plantlets to sterilized soil for hardening under greenhouse environment into the suitable compost mixture or soil in pots under controlled condition of light, temperature, humidity.

Applications:- (3.5)

1) Micro propagation of a hybrid has the greatest multiplication advantage since it can be result in large number of elite plants from a very small tissue clump taken from the hybrid plant.
2) Maintenance of inbred lines for producing FI hybrids
3) Maintenance of male sterile genotypes of wheat and onion are useful in hybridization.
4) selective propagation of dioecious plants Eg:- female plants of papaya, male plants of Asparagus
5) Multiplication of particular heterozygous superior genotype with increased productivity Eg:- oil palm

6) shoot cultures of some species are maintained as slow growth culture for germplasm conservation
7) Rapid production of disease free material
8) Tissue culture can be used to minimize the growing space in commercial nurseries for maintenance of shoot plant

Q.10 Define Biotechnology. Discuss the scope and importance of Biotechnology in promoting human welfare.

Ans. It is the controlled use of biological agents such as microorganisms or cell or cellular components for beneficial use of human kind. (1)

Scope of biotechnology. (3.5)

1. Bioprocessing
2. Engineering of organisms for specific use.
3. Genetical improvement/pharmaceutical products.
4. Human gene therapy.
5. Production of bio pesticides/bio fertilizer.
6. Production of monoclonal antibodies.
7. Transgenic plants.
8. Rapid clonal multiplication
9. Molecular marker assisted selection in plant breeding

Importance of biotechnology (3.5)

1. Biotechnology is the third wave in biological science.
2. This discipline represents the fusion basic and applied science.
3. The challenges to meet the increased production of crops is now possible with biotechnology.
4. As the resources are limited, biotechnology is only answer to the increased population.

SECTION "B"

Q.11. Define the following terms. (1mark for each)

1.Buffer solution : It is one that resist a change in pH on the addition of acid or bases more effectively than an equal volume of water..

2. Biochemistry : It is defined study of chemical nature and chemical behavior of living Matter.

3. Polysaccharide : These are compounds of sugar and yield more than 10 molecules of monosaccharide.

4. **Isomerism:** The term isomer was applied to equal parts to different compounds with same molecular formula and the phenomenon was called isomerism.

5. **Restriction enzyme :** An endonuclease, which cut (cleaves) a DNA molecule within certain specific sites that have specific base sequence

6. Totipotency : The ability inherent property of a cell (or) tissue to give rise to whole plant irrespective of their ploidy level and the form plant of specialization

7. Callus : A mass of unorganized cells, capable of growth on a nutrient medium.

8. Explant : Any plant part which is used to initiate the tissue culture is called as explants.

Q.12. Do as directed (1 mark for each)

1. Who called as father of biochemistry?

Ans : Antoin Lavoiser is called as father of biochemistry.

2. Linoleic is --------fatty acid.

Ans : **Unsaturated**

3. List out sulpher containing amino acids.

Ans : **Methionine, Cysteine**

4. Write example of milk sugar.

Ans : **Lactose** is the example of milk sugar.

5. Who suggested the term protein?

Ans: The term protein was suggested by **Berzalis.**

6. Who is father of plant tissue culture :
Ans: G.Haberlandt

7. Give contribution of Guha and Maheshwari.

Ans: **First haploid plants were produced from pollen grains of *Datura*.**

8. Give two examples of the commonly used auxins in tissue culture.

Ans: **IAA, IBA, NAA, 2,4 D**

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