Sample Quesion Paper 01
Class: XII Biotechnology
(Theory) (045)

Time: 3 Hours, Max. Marks: 70

General Instructions

- All questions are compulsory
- Question paper consists of 4 sections A, B, C and D
- Question numbers 1 to 6 are very short answer questions each carrying one mark
- Question numbers 7 to 14 are short answer questions each carrying two marks
- Question numbers 15 to 25 are also short answer questions each carrying three marks
- Question numbers 26 to 28 are long answer questions each carrying five marks
- There is no overall choice. However an internal choice has been provided in one
- question of three marks and two questions of five marks. You have to attempt only
- one of the choices in such questions.
- Use of calculators is not permitted. However, you may use log tables, if necessary.

Section A

1. How is oxygen provided in fermentors? [1]

Ans. Sparging/ forced aeration

2. Why is a pilot plant essential in microbial culture works? [1]

Ans. A mini version of the commercial plant is essential to validatelab processes on an intermediate scale before attempting commercial production.

3. As a biotechnologist, what would you suggest to a farmer for successful pollination or fertilization in plants. [1]

Ans. To utilize barnase/ barstar system.

4. Why do plant cells in culture require nutrient media for growth. [1]

Ans. Plant cells in culture cannot perform photosynthesis.

5. Why is splitting of animal cells essential? [1]

Ans. To periodically provide fresh nutrients and growing space to cells.

6. Name the first drug to be produced by mammalian cell culture? [1]

Ans. tPA / Tissue plasminogen activator.

Section B

7. Which type of restriction enzymes are used in RDT and why? [2]

Ans. Type II restriction enzymes are used because these can recognise and cut specific cleavage sites in palindromic sequences.

8. Explain in brief any two types of non-covalent interactions found in proteins. [2]

Ans. Ionic bonds
These involve interactions between the oppositely charged groups of a molecule. For example, the positively charged amino acid side chains of lysine and arginine can form salt bridges with the negatively charged side chains of aspartate and glutamate. These ionic interactions are also known as salt bridges because these are dominant bonds found in salts like sodium chloride wherein the positively charged sodium ion interacts with the negatively charged chloride ion.

Hydrogen bonds
Hydrogen bonds are formed by "sharing" of a hydrogen atom between two lectronegative atoms such as Nitrogen and Oxygen. In this case strongly polarised bonds between hydrogen and a small, very electronegative atom (N,O or F) allow a strong dipole-dipole bond to be formed with another small very electronegative element (N, O or F). Importantly, the very small sizes of these elements also allow them to approach each other so closely that a partial

covalent bond is also formed (e.g. O-H---N).

Van der Waals forces
These forces are weak attractions (or repulsions) which occur between atoms at close range. The Van der Waals types of forces are essentially contact forces, proportional to the surface areas in contact. Even though weak, these bonds can be important in macromolecules because the large surface areas involved can result in reasonably large total forces.

Hydrophobic interactions
Hydrophobic interactions can be best explained by taking an example of oil in water. The oil tends to separate out fairly quickly because the water forces them out. The hydrophobic interaction is thus a manifestation of hydrogen bonding network in water. In water, each molecule is potentially bonded to four other molecules through H-bonds.

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9. Which type of DNA library would you prefer for liver cells. Give proper explanation for making such a library. [2]

Ans. *c DNA library would be preferred*
mRNA molecules are highly unstable as they are easily degraded by RNAses. Therefore, mRNA molecules are copied into the more stable DNA (now called cDNA) before cloning. The construction of a cDNA library begins with the isolation of mRNA from a given cell type or tissue which are copied into cDNA using a special enzyme called reverse transcriptase. The procedure results in double-stranded cDNA which can be incorporated into vectors such as pBR322. These recombinant vectors are transformed into host bacterial cells eg. E. coli. This forms a cDNA library.

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10. How can you maximize protein stability during purification? Write any two parameters for the same. [2]

Ans. i) Maintenance of pH.
ii) Maintenance of physiological conditions (%CO_2, temperature)
iii) Use of inhibitors to prevent the action of proteolytic enzymes
iv) Avoidance of agitation or addition of chemicals which may denature the protein
v) Minimize processing time

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11. Number of genes is not related to the complexity of an organism. Give reasons. [2]

Ans. Due to the existence of overlapping genes, splice variants, post translational and post transcriptional modifications.

12. Calculate the generation time of a bacterial population in which the number of bacteria increase from 10^4/ml to 10^7/ml during four hours of exponential growth. [2]

Ans.

$$u = \frac{2.303(\log X_t - \log X_0)}{t}$$

$$u = \frac{2.303(\log 10^7 - \log 10^4)}{4}$$

$(X_0 = 10^4,\ X_t = 10^7,\ t = 4\ hours)$

Solving the above equation by using the values, we get,

$$u = 1.73 / hr$$

$$t_d = \frac{0.693}{1.73}$$

$$= 0.4\ hrs$$

$$0.4 \times 60 = 24 \min s$$

OR

n = 3.3 (Log 10 – Log 10)

=3.3 (7 - 4)

= 10

t = 240 minutes / 10 d

= 24 minutes

13. Ti plasmid vector of Agrobacteriuntumefaciens is disarmed. Where is the gene of interest incorporated in Ti plasmid? [2]

Ans. Ti plasmid vectors are disarmed because they do not require any chemical or equipments to transfer the gene of interest into plant cells. The gene of interest is

incorporated in the T- DNA region of Ti plasmid.

14. Why are serum and antibiotics essential as growth supplements for animal cells in culture? [2]

Ans. Serum is a source of various amino acids, hormones, lipids, vitamins, polyamines and salts containing various ions. Serum also contains growth factors required for proliferation and attachment of animal cells to culture vessels.
Antibiotics control the growth of bacterial and fungal contaminants.

Section C

15. How are pUC 19 vectors used for the selection of recombinants? [3]

Ans. Insertional inactivation of Lac Z gene leads to suppression of its activity. This ensures selection of recombinant cells which appear white in colour from non-recombinant cells which appear blue in colour (Blue-White selection).

16. Yeast cells have been transformed with Yep vector containing our gene of interest. How would you select the recombinants over cells not containing the plasmid? [3]

Ans. Yep contains LEU 2 gene which codes for an enzyme required for the synthesis of amino acid leucine. Recombinant yeast cells will grow on a medium lacking leucine and hence can be selected over cells not containing the plasmid (which cannot grow on such a medium).

17. Describe the principle of MALDI technique. Write its two main uses in protein studies. [3]

OR

What are the principles behind Iso electric focusing and SDS PAGE techniques? Why is 2D electrophoresis better than single dimension electrophoresis?

Ans. A popular method called Matrix Assisted Laser Desorption Ionisation (MALDI) is used to

volatalise and protonate peptides and proteins. In this procedure, the sample is transferred from a condensed phase to a gas phase with the help of a solid matrix. This technique determines the molecular weight of proteins by separating molecular ions according to their mass/charge ratio.
Uses: To obtain protein structural information such as peptide mass or amino acid sequences.
To identify the type and location of amino acid modification within proteins.

OR

Principle of IEF: Separation of proteins on the basis of their different pI values.
Principle of SDS PAGE: Separation of proteins on the basis of their size.
2D electrophoresis is better because proteins are separated into 2D patterns with high resolution on the basis of charge and size.

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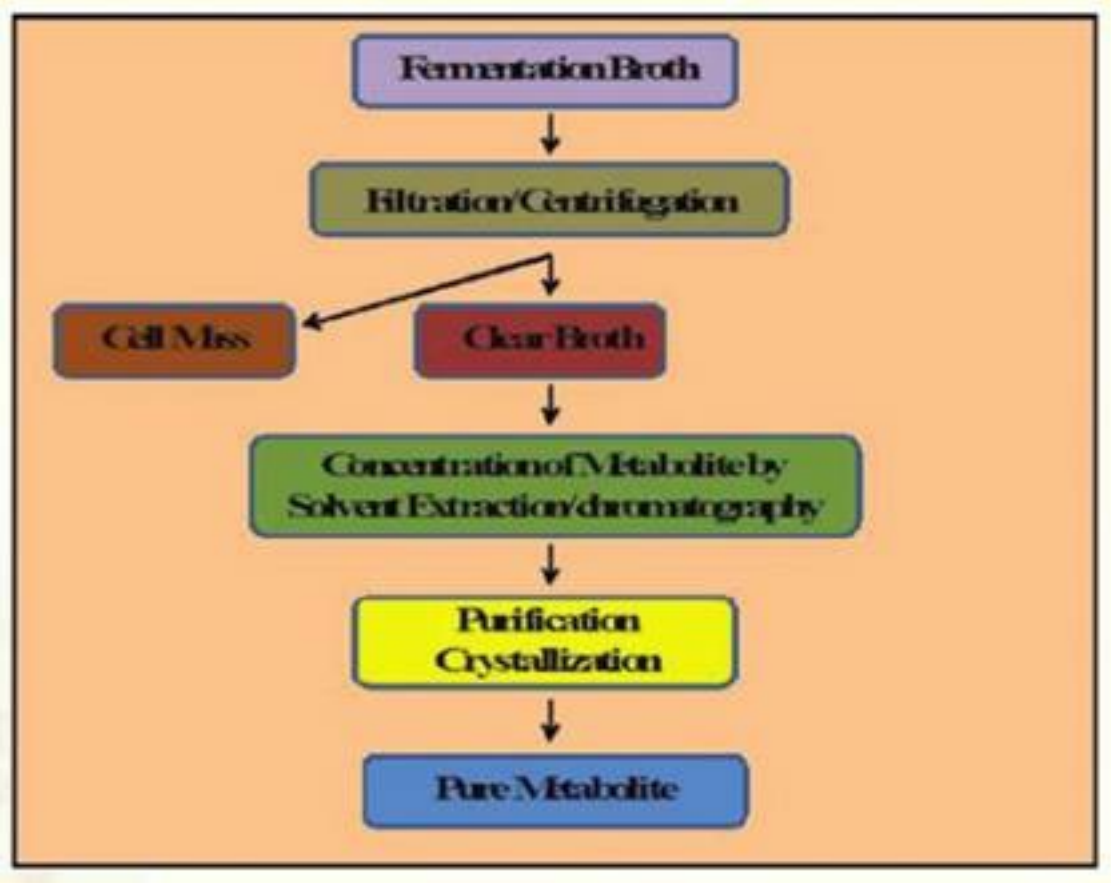
18. How is an extracellular protein purified from a fermentation medium? Illustrate the steps with a flowchart. [3]

Ans. Steps in flowchart:



19. What are SNPs? Explain the relevance of studying these citing any two of their important applications. [3]

Ans. SNPs or single nucleotide polymorphisms are common variants in DNA that can have any one of the four DNA bases (A, T, G, C) at a single site, so that different individuals may have different bases at these positions.

Relevance of studying SNPs using any 2 of the following applications:
1. DNA fingerprinting
2. Medicine
3. Population genetics
Ancestral relationships

20. Graphically differentiate between fed batch and continuous cultures. Which type of culture system is most suitable for obtaining maximum amount of cellular products? [3]

Ans.

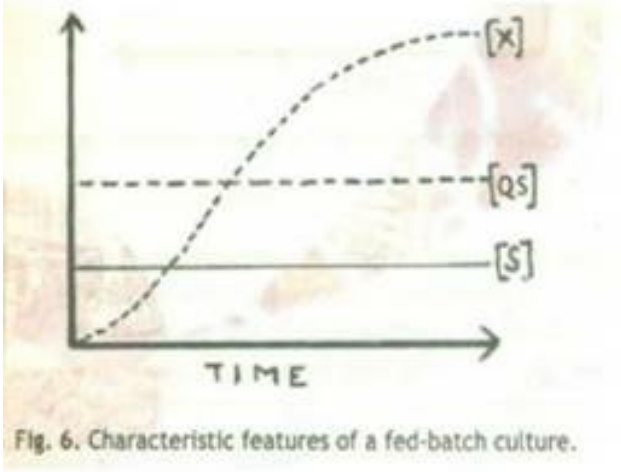


Fig. 6. Characteristic features of a fed-batch culture.

Continuous culture

21. How does the metagenomics approach help to identify novel genes present in the environment? Explain the process. [3]

Ans. Metagenomics approach has been developed to identify and select microbial genes synthesizing novel molecules. This approach directly utilizes the large number of microbial

genomes present in an environmental niche, for example in soil, in water such as ocean or in human gut. These genomes are contributed by both the culturable and the nonculturable variety of microbes and together constitute what has been termed as metagenome. The collective DNA is extracted from a sample of soil, water or any other environmental niche. It is subjected to restriction digestion using restriction endonucleases and the fragments are cloned into suitable vectors. The clones are then screened for presence of a variety of molecules. The clones expressing novel molecules or molecules with improved characteristics are used for large-scale production by fermentation techniques.

22. What are edible vaccines? How are they better than conventional vaccines? Give any two points. [3]

Ans. The genes encoding antigenic proteins can be isolated from pathogens and expressed in plants. Such transgenic plants or their tissues producing antigens can be eaten for vaccination / immunization. These are called edible vaccines.

Edible vaccines offer following advantages over conventional vaccines:
1. Low cost
2. Alleviation of storage problems
3. Easy delivery system by feeding (any other relevant point)

23. What are somatic hybrids? How are they produced? [3]

Ans. Plants raised by tissue culture of somatic hybrid cells formed by fusion of plant cell protoplasts are called as somatic hybrids.
Procedure: Isolation of plant cell protoplasts and their fusion. Selection of hybrid cells and raising by plant tissue culture.

24. Give a brief outline of the technique for production of monoclonal antibodies. Why are monoclonal antibodies preferred over serum antibodies in diagnostics and therapeutics? [3]

Ans. In Hybridoma technology, mAbs are produced by fusing antigen-activated B lymphocytes that have been immortalised with myeloma cells using polyethylene glycol. This

technique was developed by Ceasar Milstein and George Kohler (Nobel Prize winners). The hybrid cells retain the ability of B cells to secrete antibody and the ability of myeloma cells to grow indefinitely. The hybrid clones when grown in culture produce epitope-specific mAb. Antibodies bind to specific domains of antigens known as epitopes. The antibodies present in serum are a heterologous population released by different populations of B-Iymphocytes and therefore are known as polyclonal antibodies. The polyclonal antibodies can bind to related epitopes and are therefore do not give accurate results in diagnostics. Monoclonal antibodies (mAbs), on the other hand bind specifically to an epitope on an antigen and therefore are useful in detecting specific antigens (diagnostics) or blocking their binding by other molecules. Monoclonal antibodies provide accurate results and are therefore used in diagnostics.
Hybridoma technology has revolutionized the area of diagnostics and antibody-based therapies. The availability of monoclonal antibodies has helped in early detection of many infectious diseases like hepatitis and AIDS.

25. How would you scale up kidney cells grown in culture? [3]

Ans. Kidney cells are anchorage dependant. Hence scale up is done by culturing the kidney cells using roller bottles with micro carrier beads. The culture bottles are kept in CO_2 incubators for the growth of cells. This system largely increase the surface area for the growth of anchorage dependant animal cells and therefore scale up of cultured animal cells is achieved.

26. Give reasons for the following: [5]

a) BCAA enriched diet is recommended to atheletes before and after exercise.
b) Give the scientific relevance of usefulness of whey.

Ans. (a) BCAA are essential for biosynthesis of muscle proteins/ help in anabolic muscle building activity/protect existing muscle mass/reduce muscle breakdown/act as an energy source/carbon part is used as fuel and nitrogen part is used to make alanine which turns into glucose in liver.

(b) Whey is used to cure spectrum of illnesses like jaundice, infected skin lesions, urinary

tract infections. Whey protein results in the elevation of tripeptide glutathione in cells which helps in the detoxification of xenobiotics and protects cells from the action of free radicals.

27. Why do ddNTPs cause chain termination during Sanger's DNA sequencing method? Write the DNA fragments formed by chain termination for the given original DNA strand. 3' ATGCTAGC 5'. (4)

OR

How would you detect a specific microbial contamination from a given water sample using PCR. Give a brief explanation of the process.

Ans. 3'OH group is absent in ddNTP's which cause termination of growing DNA chain during Sanger's DNA sequencing method.
DNA fragments formed by chain termination in all the four tubes for the given strand. 3' ATGCTAGC 5'

OR

Selective amplification of microbial gene (in test water sample) using microbe specific primers by PCR.
Brief explanation of the process with PCR technique.

28. Explain how cDNA microarray technique can be used to study cellular response to the environment? Support your answer with a flowchart for the same. (5)

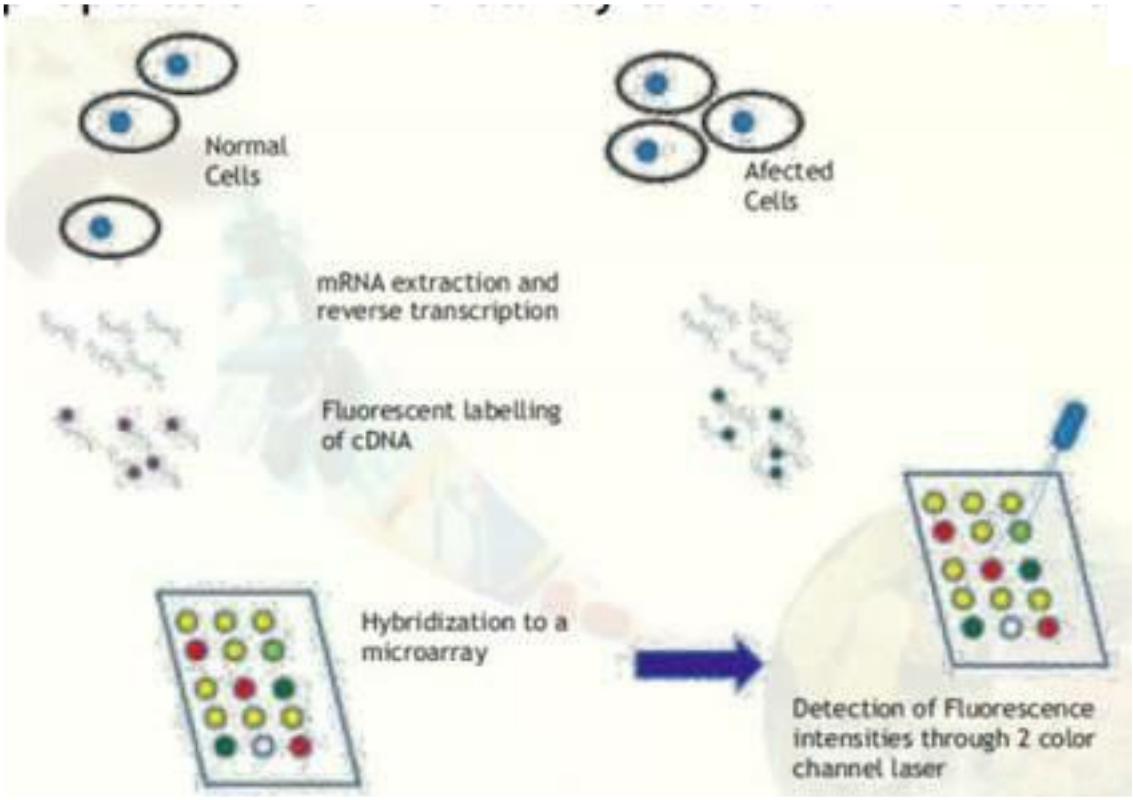
OR

a) Which information can be retrieved from the following databases?
i) EMBL
ii) PDB
iii) PALI

b) Give two reasons for completely sequencing a genome.

Ans. Cellular response to the environment can be studied by comparing the amounts of many different mRNA in normal and affected cells (eg. Cancerous cells). (Explanation of

preparation of microarray and cDNA microarray technique). **[5]**



Major steps involved in comparative microarray hybridization experiments between normal and affected (for example, cancerous) cells.

OR

a) i) EMBL – Nucleotide sequence
ii) PDB – 3D structure of proteins
iii) PALI – Phylogenetic analysis and alignment of proteins

b) Provides a means of discovery of all the genes/ shows relationship between genes/ tools for future experimentation/ organizes all genetic information about organisms *(any two points)*