SAMPLE QUESTION PAPER
BIOTECHNOLOGY (045)
Class XII (2024-25)

Max. Marks: 70 **Time allowed: 3 hours**

General Instructions:

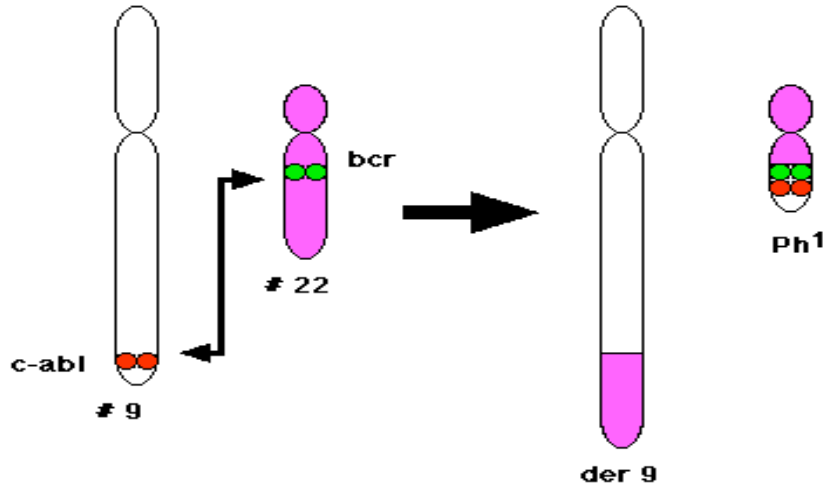
(i) *All questions are compulsory.*
(ii) *The question paper has five sections and 33 questions.*
(iii) *Section–A contains 12 Multiple choice questions and 4 Assertion-Reasoning based questions of 1 mark each; Section–B has 5 short answer questions of 2 marks each; Section –C has 7 short answer questions of 3 marks each; Section-D has two case-based question of 4 marks; Section-E has three long answer questions of 5 marks each.*
(iv) *There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.*
(v) *Wherever necessary, neat and properly labeled diagrams should be drawn.*

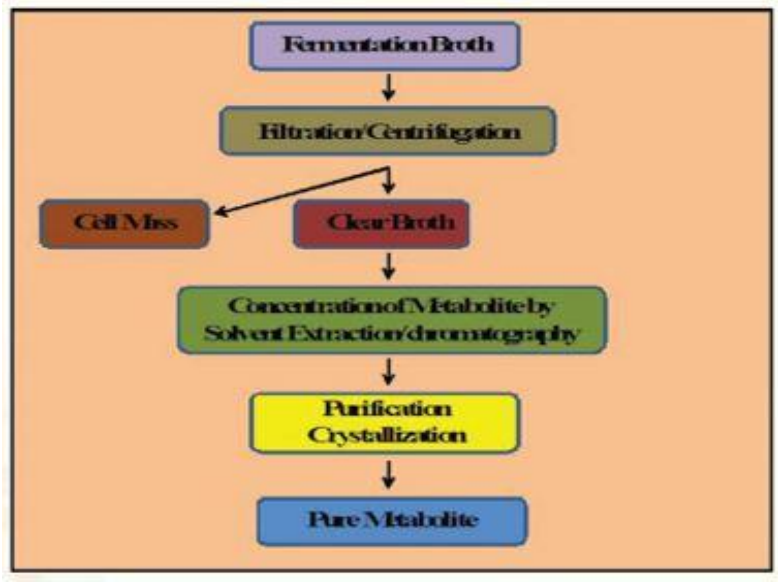
Section - A **Q. No. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.**		
1	An approach that utilises analysis of genome present in different environment to screen presence of variety of molecules. A. Metagenomics B. Proteomics C. Strain preservation D. Mutant selection	1
2	In animal cell culture, the CO_2 levels in the incubator is usually maintained at- A. 1-2% B. 3-4% C. 5-10% D. 11-15%	1
3	Even if we know where the genes are in each genome, it's difficult to count them due to: (i) splice variants (ii) overlapping genes (iii) Post – trancriptional events (iv) Mutations A. (i), (iii) B. (i), (ii) C. (iii), (iv) D. (ii), (iv)	1

4	Avocado growers in Kerela want to find a way to genetically engineer their crop to prevent it from ripening during shipping. This can be achieved by introducing- A. genes for carotenoid biosynthesis. B. gene from *Bacillus amyloliquefaciens.* C. ethylene forming gene(s). D. gene for protein containing sulphur rich amino acids.	1
5	Microbial species used for commercial production of citric acid is- A. Saccharomyces cerevisiae B. Aspergillus niger C. Streptomyces griseus D. Aspergillus oryzae	1
6	To reduce the possibility of religation of vector without picking insert, the following method or methods may be used- (i) Use of DNA Ligase (ii) Use of Alkaline Phosphatase (iii) Use of two different Restriction enzymes for cloning (iv) Hybridoma technology Select the correct answer from options below A. (i), (iv) B. (ii), (iii) C. (iii), (iv) D. (ii), (iv)	1
7	In a comparative cDNA microarray, the cDNA obtained from the normal and diseased cells are labelled with red and green fluorescent dyes respectively. The yellow colour of the spot indicates- A. Gene is expressed only in normal cells. B. Gene is not expressed either in normal cells or in diseased cells. C. Gene expressed only in diseased cells. D. Gene expressed in equal measure in both types of cells.	1
8	Which disease has its locus on chromosome no 1 and 6? A. Huntington's disease B. Migraine C. Alzheimer’s disease D. Cystic fibrosis	1
9	A molecular disease which leads to increased hydrophobic interactions within the haemoglobin protein is- A. Thalassemia B. Sickle Cell anaemia C. Mad Cow D. SCID	1
10	Interleukin-2 produced using CHO cell line is used for- A. anaemia therapy. B. cancer therapy. C. stroke. D. treatment of autoimmune disease.	1

11	Proteome of a given cell is dynamic because: A. In response to internal and external changes the biochemical machinery of the cell could be changed. B. In response to internal and external changes the biochemical machinery of the cell could not be changed. C. No direct relationship exists between internal and external changes in the biochemical machinery of the cell. D. Indirect relationship exists between internal and external in changes the biochemical machinery of the cell.	1
12	A novel gene that codes for the epitope has been introduced into yeast cells to produce- A. Hepatitis B Vaccine B. Subtilisin C. EPO D. tPA	1
Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below: A. Both **Assertion** (A) and **Reason** (R) are the true and Reason (R) is a correct explanation of Assertion (A). B. Both **Assertion** (A) and **Reason** (R) are the true but **Reason** (R) is not a correct explanation of **Assertion** (A). C. **Assertion** (A) is true and **Reason** (R) is false. D. **Assertion** (A) is false and **Reason** (R) is true.		
13	**Assertion (A)** - Patients who are administered monoclonal antibodies against CD3, can accept renal allograft. **Reason (R)** - Monoclonal antibodies block T cell function	1
14	**Assertion (A)** - Foaming is a problem in most microbiological cultures. **Reason (R)** - It is caused due to the presence of fatty acids and silicones in the culture medium.	1
15	**Assertion (A)** - Yeast cells having YEp plasmid can grow on a medium lacking leucine and hence can be selected **Reason (R)** - *LEU2* gene codes for an enzyme required for the synthesis of amino acid leucine.	1
16	**Assertion (A)** - Long-term callus and cell suspension cultures and plants developed from such cultures may have chromosomal variations called somaclonal variations. **Reason(R)** - Somaclonal variations may lead to improvement in crops like disease resistance in potatoes.	1

<table>
<tr><th colspan="3">Section - B</th></tr>
<tr><td>17</td><td>The following table lists the common cloning vectors with the size of insert that can be cloned into them.
Mark A, B, C and D in the table.
<table><tr><th>Vector Type</th><th>Insert size (kb)</th></tr><tr><td>Plasmid</td><td>0.5-8</td></tr><tr><td>A</td><td>9-23</td></tr><tr><td>Cosmid</td><td>B</td></tr><tr><td>C</td><td>50-500</td></tr><tr><td>YAC</td><td>D</td></tr></table></td><td>2</td></tr>
<tr><td>18</td><td>Based on microscopic observation, how can pathologist differentiate between cancerous and non-cancerous cells?</td><td>2</td></tr>
<tr><td>19</td><td><u>Attempt either option A or B.</u>
A. What is inverted microscope and why is it used instead of compound microscope for observing animal cells in culture?
OR
B. Why are B lymphocytes fused with myeloma cells in hybridoma technique? Give an important application of this technique.</td><td>2</td></tr>
<tr><td>20</td><td>Why is 2D Gel Electrophoresis considered a suitable technique for studying Proteomics?</td><td>2</td></tr>
<tr><td>21</td><td>Which database was created to manage the redundancy in EST data? What is the role of the curator in Bioinformatics?</td><td>2</td></tr>
<tr><th colspan="3">Section - C</th></tr>
<tr><td>22</td><td>A. Why has sickle cell trait been selected in population where malaria is endemic?
B. What is the molecular basis of sickle cell anaemia?
C. How can we differentiate between a normal RBC and Sickle cell RBC?</td><td>3</td></tr>
<tr><td>23</td><td>Why is the nutrient medium autoclaved before using it for culturing microbes? How would you sterilize a heat-labile substance such as antibiotic solution?</td><td>3</td></tr>
<tr><td>24</td><td>A. Identify (a), (b), (c) and (d) in the following table showing some industrially important plant secondary metabolites, their plant source and uses-
<table><tr><th>Product</th><th>Plant source</th><th>Uses</th></tr><tr><td>Vincristine</td><td>(a)</td><td>Anticarcinogenic</td></tr><tr><td>(b)</td><td>Papaver spp</td><td>Analgesic</td></tr><tr><td>Quinine</td><td>Cinchona officinalis</td><td>(c)</td></tr><tr><td>Taxol</td><td>Taxus spp.</td><td>(d)</td></tr></table></td><td>3</td></tr>
</table>

	B. The indiscriminate use of such valuable medicinal and other plants has brought them to near extinction. Suggest a possible solution to this .	
25	How does the charge relay system operate in chymotrypsin?	3
26	The gene for a eukaryotic polypeptide hormone was isolated, cloned and over-expressed in a bacterium. After the polypeptide was purified from the bacterium, it failed to function in the organism from which the gene was isolated. Suggest all the possibilities why the recombinant protein was inactive.	3
27	Illustrate essential steps involved in raising a chimeric mouse using stem cell technology.	3
28	*Attempt either option A or B.* A. Selection is an important step in genetic engineering. You are given ampicillin and tetracycline antibiotics. Using these antibiotics, which selection technique could be used to differentiate between recombinant and non-recombinant cells? **OR** B. Which microbial cells have been used extensively for functional expression of eukaryotic genes and why?	3
Section - D		
29	The below figure depicts a process used in diagnosis of a disease.  A. Identify the mutation and the disease shown in the diagram. (1) B. Which technique can help in the identification of this technique? (1) *Attempt either subpart C or D.* C. Write down the steps occurring during nick translation. (2) **OR** D. How do extent of severity of the disease be detected in the above process?	4

30	**Isolation of microbial product** Once the fermentation is complete, it is necessary to recover the desired metabolite. Minimally, this will involve separation of the cells from the fermentation broth. But it may also include, purification of the metabolite with or without cell disruption; cell disruption will be necessary if the metabolite is intracellular. Such operations are referred to as downstream processing. The steps involved in isolation of the desired microbial product are: (1) separation of cells from the fermented broth, (2) cell disruption if the product is intracellular or concentration of the broth if the product is extracellular (3) initial purification of the metabolite, (4) metabolite-specific purification in which the metabolite of interest is purified to a high degree, and (5) polishing of the metabolite (bringing it to 98 -100% purity) where it is further concentrated and formulated for use.  A. Cite an example of pure metabolite that can be obtained from above depicted flow chart. B. Suggest a suitable term which includes all the steps mentioned above. *Attempt either subpart C or D.* C. In the second step mentioned above, "Which part will you use to isolate intracelluar product?" **OR** D. Why is it generally recommended to have minimum number of steps in these isolation processes?	4
	Section - E	
31	*Attempt either option A or B.* A. A protein with molecular weight of 10,000 contains 4, 3, 2, and 1 charge. Calculate the m/z ratio of protein ions at which Mass spectrometer detects them. Draw the Mass spectrum corresponding to the above mentioned ions.	5

	OR B. A doctor has to prescribe a protein rich diet to sportsmen to improve their performance. What are the three parameters that the doctor should consider while prescribing these protein sources?	
32	*Attempt either option A or B.* A. Write the basic steps with principles (starting from an explant) involved in obtaining a regenerated plant. Suggest any two applications of plant tissue culture. **OR** B. Indicate how intergeneric somatic hybrids can be made. Give an example. What are cybrids? How are edible vaccines advantageous over recombinant vaccines produced by bacterial fermentation?	5
33	*Attempt either option A or B.* A. Who invented the dideoxynucleotide chain termination method? Schematically explain the method. **OR** B. Why is the dye termination method considered better than chains termination technique? (Any two) Why is the autoradiogram read from bottom to top (anode to cathode)? Why do bacteria produce restriction enzymes and how do they protect their own DNA from its action?	5

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Marking Scheme
BIOTECHNOLOGY (045)
Class-XII (2024-25)

Max. Marks:70 **Time allowed: 3 hours**

<table>
<tr><th>S. No.</th><th>Section - A</th><th>Marks</th></tr>
<tr><td>1</td><td>A. Metagenomics</td><td>1</td></tr>
<tr><td>2</td><td>C. 5-10%</td><td>1</td></tr>
<tr><td>3</td><td>B. (i) and (ii)</td><td>1</td></tr>
<tr><td>4</td><td>C. ethylene forming gene(s)</td><td>1</td></tr>
<tr><td>5</td><td>B. Aspergillus niger</td><td>1</td></tr>
<tr><td>6</td><td>D. (ii) and (iii)</td><td>1</td></tr>
<tr><td>7</td><td>D. Gene expressed in equal measure in both types of cells.</td><td>1</td></tr>
<tr><td>8</td><td>B. Migraine</td><td>1</td></tr>
<tr><td>9</td><td>B. Sickle Cell Anaemia</td><td>1</td></tr>
<tr><td>10</td><td>B. cancer therapy</td><td>1</td></tr>
<tr><td>11</td><td>A. In response to internal and external changes the biochemical machinery of the cell could be changed.</td><td>1</td></tr>
<tr><td>12</td><td>A. Hepatitis B vaccine</td><td>1</td></tr>
<tr><td>13</td><td>A. Both Assertion and Reason are true and Reason is the correct explanation of Assertion.</td><td>1</td></tr>
<tr><td>14</td><td>C. Assertion is true but Reason is false</td><td>1</td></tr>
<tr><td>15</td><td>A. Both Assertion and Reason are true and the reason is the correct explanation of the assertion.</td><td>1</td></tr>
<tr><td>16</td><td>B. Both assertion and reason are true but reason is not the correct explanation of assertion</td><td>1</td></tr>
<tr><th colspan="3">Section-B</th></tr>
<tr><td>17.</td><td><table>
<tr><th>Vector Type</th><th>Insert size (kb)</th></tr>
<tr><td>Plasmid</td><td>0.5-8</td></tr>
<tr><td>Bacteriophage lambda</td><td>9-23</td></tr>
<tr><td>Cosmid</td><td>30-40</td></tr>
<tr><td>BAC</td><td>50-500</td></tr>
<tr><td>YAC</td><td>250-1000.</td></tr>
</table></td><td>0.5 X 4</td></tr>
</table>

<table>
<tr><td>18</td><td>
<table>
<tr><th>Cancerous cells</th><th>Non-cancerous cells</th></tr>
<tr><td>They do not exhibit contact inhibition.</td><td>They exhibit contact inhibition.</td></tr>
<tr><td>They pile on each other due to uncontrolled growth.</td><td>Don’t pile on each other.</td></tr>
<tr><td>More rounded in shape.</td><td>Less rounded in shape.</td></tr>
</table>
</td><td>1
0.5
0.5</td></tr>
<tr><td>19</td><td><u>Student to attempt either option A or B.</u>
A. In animal cell cultures, cells are at the bottom of the containers and hence can be visualized only by an inverted microscope in which the optical system is at the bottom with the light source on top.
OR
B. Monoclonal antibodies are produced by fusing antigen-activated B lymphocytes that have been immortalised with myeloma cells so that so that the hybrid cells retain the ability of B cells to secrete antibody and the ability of myeloma cells to grow indefinitely.
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. (any one)</td><td>2

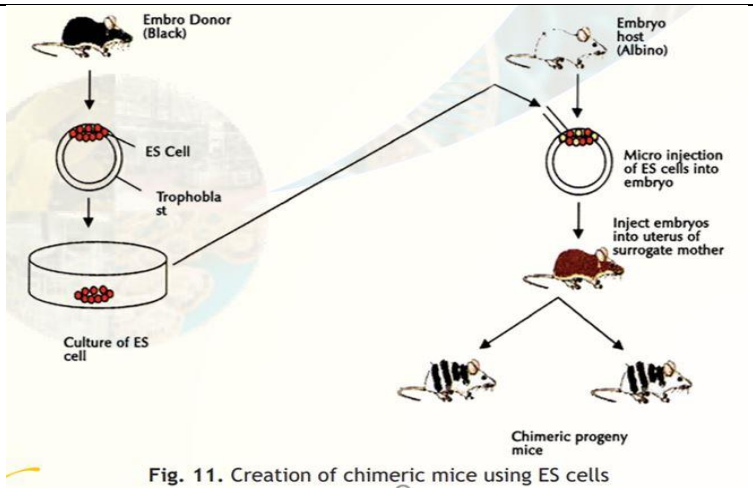
1

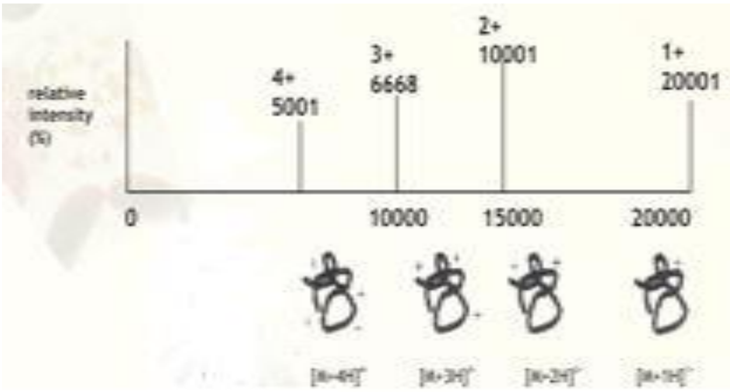
1</td></tr>
<tr><td>20</td><td>Both IEF and SDS-PAGE are powerful techniques which separate proteins on the basis of Isoelectric point and Molecular weight respectively.
Proteins are separated over a large surface area in two perpendicular directions/ the resolution obtained is very high.
(Any two points)</td><td>1

1</td></tr>
<tr><td>21</td><td>Unigene was created to manage redundancy in EST data. A curator is the one who checks the newly submitted data in bioinformatics for accuracy.</td><td>1
1</td></tr>
<tr><td colspan="3">Section - C</td></tr>
<tr><td>22</td><td>A. Sickled RBCs resist malarial infection hence safeguarded that population.
B. The substitution of glutamic acid with valine in ScHb results in increase in hydrophobic interaction between the Hb molecules resulting in aggregation and ultimately leading to deformation of RBC to a sickle shape.
C. Shape of the Sickle cell RBC is like that of SICKLE.</td><td>1
1

1</td></tr>
</table>

23	Autoclaving is an important process in microbial cell culture. Autoclaving means heating the desired nutrient or equipment at 15psi at 121^0C for 15-20 minutes. The nutrient medium is autoclaved before using it for culturing microbes to destroy the microbes (fungal spores and bacteria) present in the medium. To sterilize a heat-labile substance such as an antibiotic solution, we make use of techniques like ultra-filtration. In this technique, we make use of membrane filters whose pore size is usually less than 0.5mm.	1 1 0.5 0.5
24	A. (i) Cathranthus roseus (ii) Codeine (iii) Antimalarial (iv) Anticarcinogenic B. A possible solution is provided by cell and root cultures.	0.5 x 4 1
25	A Chymotrypsin folds bringing together Asp102, His 57, Ser 195 in this sequence in space. Asp 102, His 57 and Ser 195 lie in this order forming a charge relay; The negatively charged aspartate carboxylate residue pulls the Ser –OH proton through His, leaving it with a negative charge. Ser195 becomes acidic due to the unique constellation of the three amino acid residues because the protein has folded uniquely in space.	1 1 1
26	• To have proper three dimensional folding. • Removal of introns is not there in the prokaryotes as they lack intron removal machinery. • Modification of proteins (Post-translational modification) is not there.	1 1 1
27	Stem cells could be used to create chimeric mice by taking ES cells from a black mouse and implant it into the embryo of an albino mouse (white). The progeny so developed had skin color of black and white	1 2

	 **Fig. 11.** Creation of chimeric mice using ES cells	
28	*Student to attempt either option A or B.* A. Replica plating. • Host cells are first plated (master plate) on solid media with the desired antibiotic overnight. • Velvet paper is aligned, pressed on master plate. • With the same alignment it is pressed onto the replica plate. • Keep it overnight, transformed colonies will not grow in replica plate. • The colonies having insert can easily be scored off from master plate by comparing the two plates. **OR** B. Yeast cells have been used extensively for functional expression of eukaryotic genes because of several features. Yeasts are the simplest eukaryotic organisms (unicellular) and like E. coli have been extensively characterised genetically, easy to grow and manipulate and large amounts of cloned genes or recombinant proteins can be obtained from yeast cultures grown in fermenters (large culture vessels). (Any two)	0.5 0.5 x 5 1 2
	Section - D	
29	A. Reciprocal translocation and the disease is CML B. FISH *Student to attempt either subpart C or D.* C. The enzymes, DNA polymerase I makes DNA and DNase I cuts DNA and are combined in a buffered reaction with dNIP's including dUTP labelled with a red or green fluorescence. **OR** D. The status of the disease could easily be identified by counting the number of cells, which appeared yellow. Further, it was possible to monitor the effect of chemotherapy and drugs by taking out samples and counting the number of cells appearing yellow.	1 1 2

30	A. Streptomycin/any other relevant antibiotic. B. Downstream processing. *<u>Student to attempt either subpart C or D.</u>* C. We will disrupt the cell and concentrate the product. **OR** D. Minimum the number of steps, more will be purity and yield of the metabolite.	1 1 2
	Section - E	
31	*<u>Student to attempt either option A or B.</u>* A. (i) The mass spectrometer detects the protein ions at m/z = 2501, 3334, 5001 and 10,001 respectively. (ii)  **OR** B. Essential amino acids and BCAA profile: Essential amino acids are those amino acids which have to be obtained from food and cannot be made in our cells. The branched chain amino acids (BCAA) are essential for the biosynthesis of muscle proteins. They help in increasing the bio-availability of high complex carbohydrates intake and are absorbed by muscle cells for anabolic muscle building activity. Biological value (BV) measures the amount of protein nitrogen that is retained by the body from a given amount of protein nitrogen that has been consumed. It has been observed that the BV of whey proteins is the highest compared to rice, wheat, soya and egg proteins. Protein efficiency ratio (PER)- PER is used as a measure of growth expressed in terms of weight gain of an adult by consuming 1g of food protein. The PER value of the following proteins are arranged in decreasing order- whey, milk, casein, soya, rice, wheat.	0.5x4 3 1 1 1 2
32	*<u>Student to attempt either option A or B.</u>* A. The basic technique of plant tissue culture involves the	0.5 x 6

	following steps: (i) Selection of suitable explants like shoot tip, leaf, cotyledon and hypocotyls. (ii) Surface sterilization of the explants by disinfectants (e.g. sodium hypochlorite) and then washing the explants with sterile distilled water. (iii) Inoculation (transfer) of the explants onto the suitable nutrient medium (which is sterilized by autoclaving or filter-sterilized to avoid microbial contamination)in culture vessels under sterile conditions (i.e., in laminar flow cabinet). (iv) Growing the cultures in the growth chamber or plant tissue culture room, having the appropriate physical conditions [i.e., artificial light (16 h photoperiod), temperature (~26 C) and relative humidity (50-60%)]. (v) Regeneration of roots and shoots from cultured plant tissues and their elongation. (vi) Transfer to the green house and then to fields. Applications of Plant cell culture- • Micropropagation • Producing virus free plants • Producing artificial seeds • Embryo rescue in interspecific & intergeneric hybrids • Generating haploids & triploids • Somatic hybrids & Cybrids • In vitro germplasm conservation • Somaclonal variations • Production of secondary metabolites (any 2) **OR** B. The protoplasts are isolated from two species of different plants and are allowed to fuse with each other in the presence of fusogenic agents like polyethylene glycol (PEG - most widelyused and most successful method for protoplast fusion) or by electro-fusion. The required fusion products (hybrid cells) are selected by various methods such as the use of different antibiotic markers or fluorescent dyes for two different protoplasts <u>Cybrids-</u> cytoplasmic hybrids (cybrids) through protoplast fusion in which the genomesof one of the partners is lost. Edible vaccines offer following advantages over conventional vaccines: - Low cost	2 1 1 1 2

	- Alleviation of storage problems - Easy delivery system by feeding (any other relevant point)	
33	*Student to attempt either option A or B.* A. Dr Frederick Sanger Sanger's Method: Whenever ddNTP comes in the DNA synthesis, further synthesis of DNA stops due to non-formation of 3'-5' phospodiester linkage as in ddNTP , there is 3' H (Instead of 3'OH) Structure of any ddNTP- (dideoxy ribose is a pentose sugar witoxygen atom removed from each 2' and 3' position. It must include the following reagents: - Single strand DNA which needs to be sequenced. - A primer with a free 3'-OH. - DNA polymerase - dNTPs - ddNTPs (1 % of total dNTPs) Method: - Primer extension in 4 different tubes each containing a specific ddNTP at low concentration. - Termination at the point where ddNTP is incorporated. - Gel electrophoresis. - Autoradiography-+reading of gel sequence. **OR** B. - Dye termination method is automated/ doesn't use radioactive isotopes so is safer/ uses single lane Agarose gels/fewer steps needed. (Any two reasons for 1M each) - An autoradiogram is read from bottom to top because for arriving at the original sequence from 3' to 5', every C is read as G, T as A, A as T and G as C as we arrive at the sequence from anode to cathode. - Bacteria produce restriction enzymes to restrict the multiplication of Phage genome. Bacteria protect their own DNA from phage action by methylation of its restriction site available in chromosomal DNA.	1 4 2 1 2

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