SAMPLE QUESTION PAPER

BIOTECHNOLOGY (045)

Class XII (2022-23)

Max.Marks:70 Time allowed: 3 hours

General Instructions:

i) All questions are compulsory.

ii) The question paper has five sections. All questions are compulsory.

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.

SECTION A		
1.	Male sterility is widely used in crops such as maize, sunflower for hybrid production. Male sterile plants are created by introducing a gene encoding- (a) Barnase protein (b) TA29 (c) Barstar protein (d) Coat protein	1
2.	Body builders prefer to drink buffalo milk to build muscle mass. Determine the reason for this? (a) Easier to digest (b) Lower fat content (c) Higher calcium and phosphorus content (d) Balanced calorie source	1

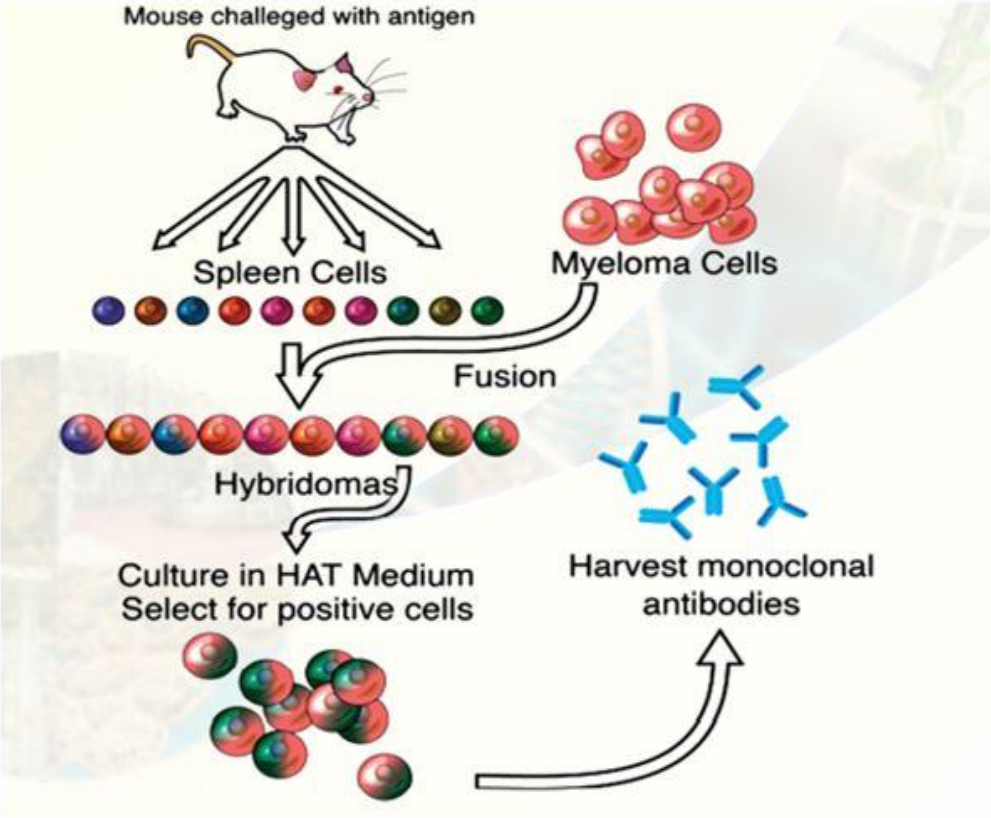
3.	An industrially important secondary metabolite which is used as a red pigment in lipstics and dye for silk is obtained from- (a) Datura stramonium (b) Lithospermum erythrorhizon (c) Digitalis lanata (d) Coptis japonica	1
4.	Proteome of a given cell is dynamic because : (a) In response to Internal 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
5.	Artificial seeds are produced by- (a) Encapsulating somatic embryos in calcium alginate beads (b) Desiccating the somatic embryos with or without coating (c) Hydrating the somatic embryos (d) Hydrating the zygotic embryos.	1
6.	Being a researcher, you want to improve the deficiency of certain amino acids in cereals and legumes. Choose the technique out of the following which will be the best to achieve your goal: (a) Plant tissue culture (b) Adding fertilizers to soil (c) Protein engineering (d) Vegetative Propagation	1
7.	Foreign DNA is directly introduced into the recipient cell using a fine micro-syringe to transform it. The probable advantage this provides could be: a) No specialised equipment required b) No damage to cells c) Low transduction rate d) Precision of delivery	1

8.	A piece of young hypocotyl was cultured in MS medium in a plant tissue culture lab. This is a type of- (a) Organ culture (b) Callus culture (c) Explant culture (d) Mass cell culture	1
9.	Molecular Biologists prefer to use artificial vectors with MCS. List a benefit for this choice. (a) Flexibility in choice of insert size (b) Flexibility in choice of vector size (c) Flexibility in choice of host organism (d) Flexibility in choice of restriction enzyme	1
10.	Native enzyme Subtilisin is inactivated by bleach, in detergents because of oxidation of methionine at position 222. Choose a strategy that will help overcome this problem: (a) Use Pepsin instead of Subtilisin (b) Eliminate use of bleach (c) Substitute another amino acid at position 222 (d) Use Amylase instead of Subtilisin	1
11.	Culture based approaches for detecting pathogens, as compared to PCR based assays are (a) Faster, safer but less specific (b) Slower but safer and more specific (c) Slower, less safe and less specific (d) Slower, less safe but more specific	1
12.	A 100 Kb DNA fragment has to be cloned in a host cell. Which vector should be used for this experiment? a) Plasmid b) Cosmid c) BAC d) Bacteriophage lambda	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 and Reason are true and the reason is the correct explanation of the assertion B. Both Assertion and Reason are true but the reason is not the correct explanation of the assertion C. Assertion is true but Reason is false D. Both Assertion and Reason are false	
13	**Assertion-**The functional property of whey protein exploited in confectionery is browning. **Reason**-Whey proteins undergo maillard reaction providing colour and aroma to food items	1
14	**Assertion**- Foaming is a problem in most microbiological processes. **Reason**- It is caused due to the presence of fatty acids and silicones in the culture medium.	1
15	**Assertion**- Whey mixed with herbs and honey is administered to the sick to treat ailments like jaundice and infected skin lesions. **Reason** - Whey proteins elevates the levels of glutathione which protects the cells from harmful oxygen intermediates.	1
16	**Assertion-**It's difficult to count genes even if we know where the genes are in a given genome **Reason-** There is no simple correlation between the intuitive complexity of an organism and the number of genes in its genome.	1
	SECTION B	
17	Depict the production and mode of action of tissue plasminogen activator through diagram or flowchart.	2
18	X is a valuable tool in plant breeding, wherein variation in tissue culture regenerated plants from somatic cells can be used for the development of crops with novel traits. Identify 'X'. State any one example where this tool can be used for crop improvement. OR Leaf explants of brinjal are showing multiple shoot regeneration in a plant tissue culture laboratory. Which plant regeneration pathway is depicted here? In this process, what would happen if either auxins or cytokinins are high in the medium?	2

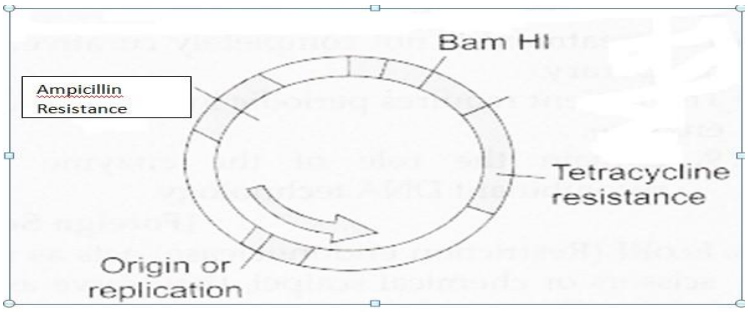
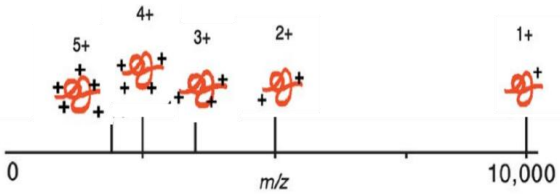
19	Given below is a list of the first 06 residues of the beta helix in myogloblin from different organisms. Based on this information, which amino acids (a) are most conserved, and (b) are highly variable.	2

Position → Organism↓	1	2	3	4	5	6
Human	D	I	P	G	H	G
Chicken	D	I	A	G	H	G
Alligator	K	L	P	E	H	G
Turtle	D	L	S	A	H	G
Tuna	D	L	T	T	M	G
Carp	D	F	E	G	T	G

20	A doctor has to prescribe a protein rich diet to sportsmen to improve their performance. What are the two parameters that the doctor should consider while prescribing these protein sources. Explain.	2
21	 (a) Identify the technique shown above. (b) State any three applications of the technique.	2

SECTION C

22	(a) Chymotrypsinogen is inactive form of enzyme chymotrypsin. Which molecular alteration converts it into active form? (b) The catalytic triad in chymotrypsin leads to a charge relay system. Justify OR Haemoglobin protein of a normal individual has to be compared with that of a person with sickle cell anaemia in a pathology laboratory. Represent the steps of the technique, which can be used for the same, in the form of a flow chart.	3
23	Given below are few transgenic crops approved by US Food and Drug Administration along with the improved character. Name the genes A to F introduced for the improved character. Crop — Gene — Improved character Canola — A — Hybrid production Corn — B — Insect resistance Cotton — C — Insect resistance Papaya — D — Virus resistance Potato — E — Insect and virus control Soyabean — F — Weed control	3
24	In animal cell culture, osmolarity of the culture medium has significant role in cell growth and function. Justify. Which ingredients decides osmolarity of the medium	3
25	You have the gene sequence of a protein which has a proteolytic activity. How will you establish through tools of bioinformatics that this protein: (a) Has homologues in other organisms (b) Belongs to the chymotrypsin family (c) Has a database that can we used to trace the evolutionary history of this proteolytic protein	3
26	What are type II restriction endonucleases (RE)? Give an example of a type II RE that generates flush ends and the sequence recognized by it. Mention two other enzymes and their utility in cloning experiment.	3

27	Bioinformatics databases provide resources for gene level sequences such as RefSeq, Homologene , Paralogs and UniGene and BLAST . Which of these would you use as most suitable starting point for : i) Avoiding redundancy in EST data. ii) For inferring relations among organisms. iii) Information retrieved from this resource will be used in designing gene chips.	3
28	a) Identify the vector shown below :  b) How can we use LEU2 gene as a selectable marker?	
	SECTION D	
29	Mass Spectrometry Mass spectrometry (MS) has emerged as an important tool in biotechnology. It is extremely useful in obtaining protein structural information such as peptide mass or amino acid sequences. The molecular ions are generated either by a loss or gain of a charge (e.g. electron ejection, protonation or deprotonation). After the ions are formed, they can be separated according to their m/z ratio and finally detected. A protein with a molecular weight of 10,000 dalton generates five different peaks with the ions containing 5, 4, 3, 2, and 1 charges, respectively, as shown below.  (a) What happens if there is a loss of charge from a biomolecule? (b) Mass spectrometry is an analytical tool. Justify the statement. (c) Calculate the m/z ratio each for protein ions containing 5, 4, 3 and 2 charges. OR (c) A protein has a molecular weight of 20,000 daltons and it forms two protein ions containing 6 and 7 charges, What will be it's mass/charge ratio ?	4

30	Growth kinetics is an autocatalytic reaction which implies that the rate of growth is directly proportional to the concentration of cell.. As the cell divides, we shall have Doubling time which is the time taken by the population to double through one round of cell division is inversely related to specific growth rate. (a) In a microbiology laboratory, one bacterial culture is marked "X" with generation time 20 s and other bacterial culture is marked "Y" with generation time 30 s. Which bacterial culture will proliferate rapidly? (b) Using the above table, Calculate the number of divisions the population must have undergone to increase from 10^4 to 10^7 in 24 hours. (c) Using the above table ,Calculate the generation time (doubling time) of a bacterial population in which the number of bacteria increases from 10^8 cells/ml to 10^{14} cells/ml during four hours of exponential growth. OR (c) Explain any two different ways to measure microbial growth.	4

No. of cell division	0	1	2	3	n
No. of cells	1	2	4	8	2^0
Mathematically	N_0	$N_0 \times 2^2$	$N_0 \times 2^2$	$N_0 \times 2^2$	$N_0 \times 2^2$

SECTION E

31	Several medically important protein pharmaceuticals have been produced using animal cell culture and recombinant DNA technology. Represent the animal cell line used for the production of the following proteins and their therapeutic use in a tabular form. (a) Erythropoietin (b) Factor VIII (c) Follicle Stimulating Hormone (FSH) (d) Interleukin 2 (IL 2) (e) Monoclonal antibodies (mAbs) OR (a) Differentiate between- (i) Defined and Serum-supplemented medium (ii) Anchorage-dependent and Anchorage-independent cells (b) Explain how pH is maintained in animal cell cultures. Mention two advantages of maintaining pH during such cultures.	5

32	a) Dr. Sharma discovered first restriction enzyme ever from a bacteria called *Thermus aquaticus,* strain DR 15. Name the enzyme. b) Design two primers (5 nucleotide long each) for the given sequence: 5'GATTCATTGCGCGCATTACTCGCATT3' c) Recognition sites are generally palindromic in nature. Does it point towards the structure of restriction enzymes being that of a homodimer or heterodimer? Give reason for your answer. d) A bacteriophage is known to infect *E.coli* with pili. How can it be modified to serve as a suitable vector? (1+1+1+2) OR a) Schematically explain the formation of recombinant plasmid. (2) b) 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? (3)	5
33	(a) A group of students are trying to isolate recombinant insulin .After processing the fermentation broth, they observed no yield .What could be the most possible reason for this? (b) A recently discovered microbial strain gives us the desired metabolite in nanomolar concentration. Suggest two ways of improving the production of the desired metabolite. (c) *Pichia pastoris* has many advantages as a eukaryotic expression host. Justify giving two reasons. OR a) A professor told her students to ready a bacterial culture in 12 hours sharp. Suggest her students two ways to enhance the growth of bacterial cells in the lab so that they are able to fulfill the requirement. b) Write any two commercial significance of microbial cell culture. c) There are many ways of measuring microbial growth. Which technique is considered the best and why?	5

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Marking Scheme

BIOTECHNOLOGY (045)

Class-XII (2022-23)

SECTION-A		
1	(a) Barnase protein	1
2	(c) Higher calcium and phosphorus content	1
3	(b) *Lithospermum erythrorhizon*	1
4	(a) In response to Internal and external changes the biochemical machinery of the cell could be changed.	1
5	(a) Encapsulating somatic embryos in calcium alginate beads	1
6	(c) Protein engineering	1
7	(d) Precision of delivery	1
8	(c) Explant culture	1
9	(d) Flexibility in choice of restriction enzyme	1
10	(c) Substitute another amino acid at position 222	1
11	(c) Slower, less safer and less specific	1
12	(c) BAC	1
13	A) Both Assertion and Reason are true and the reason is the correct explanation of the assertion	1
14	(C) Assertion is true but Reason is false	1
15	(A) Both Assertion and reason are true and reason is the correct answer for the assertion.	1

16	A) Both Assertion and Reason are true but the reason is not the correct explanation of the assertion	1

SECTION-B

17	Tissue Plasminogen Activator (tPA) Diagram /Flow chart (Either one)	

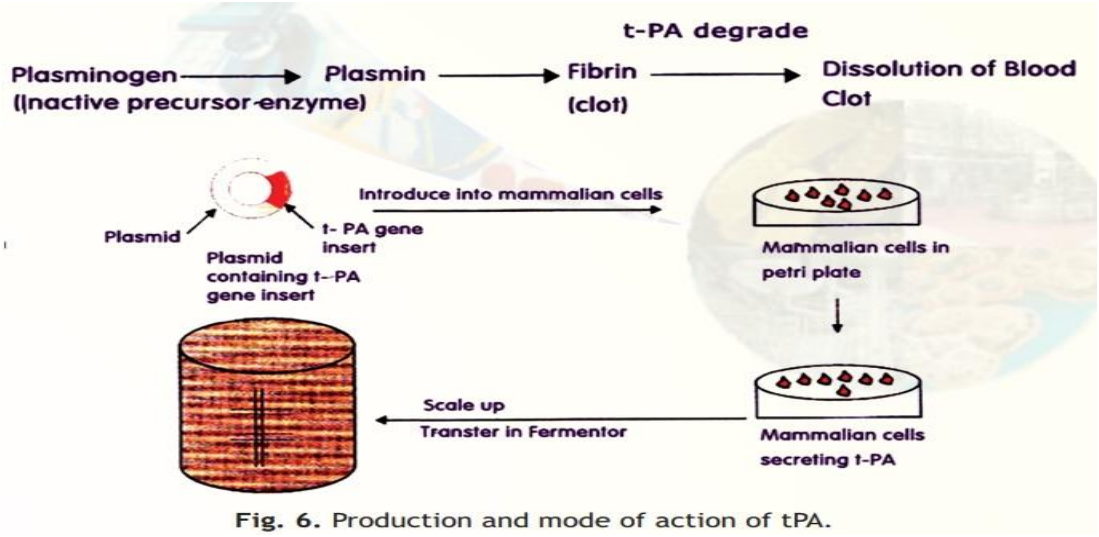
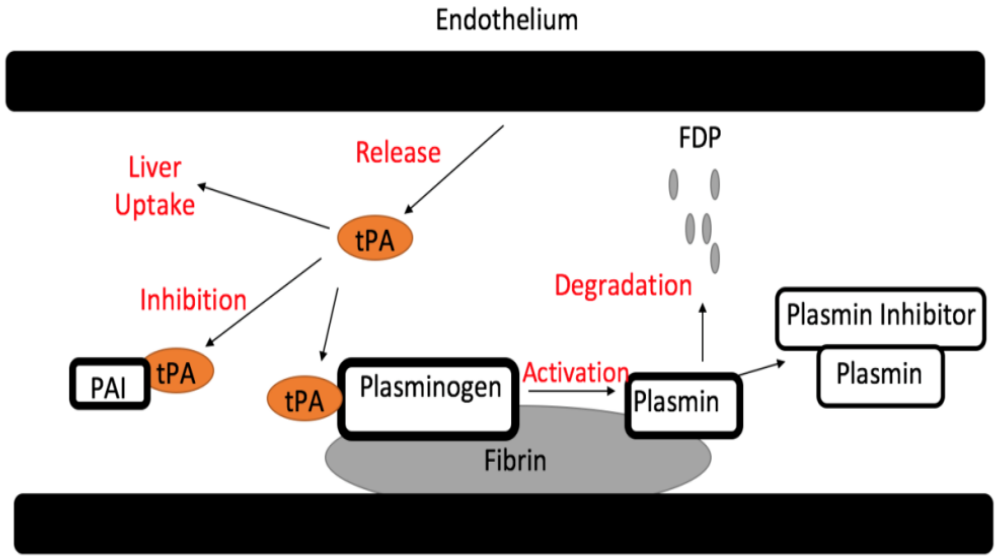


Fig. 6. Production and mode of action of tPA.

1

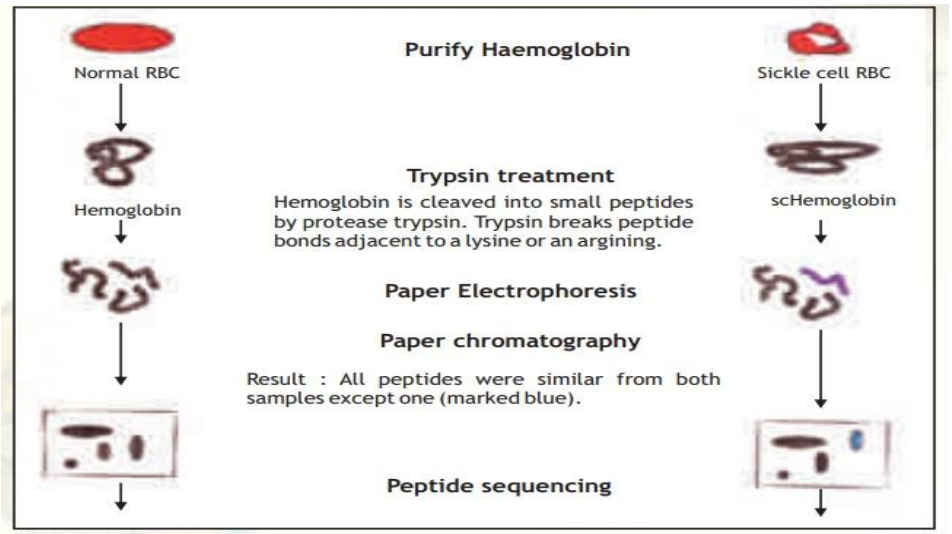
Flow chart



1

18	Somaclonal variations It helps in production of mutants e.g. disease resistance in Potato **OR** Organogenesis If auxins are high in the medium, it promotes rooting while if cytokinins are high, shoot formation is promoted.	1+1
19	G amino acid is most conserved A amino acid is most variable.	1 1
20	**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. (Any two)	1 1
21	a) Production of MoAb (0.5 mark) b) This technology has revolutionized the area of diagnostics and antibody-based therapies. 1) The availability of monoclonal antibodies has helped in the early detection of many infectious diseases like hepatitis and AIDS. 2) Therapeutic mAb – **OKT3** Therapeutic mAb - Herceptin OKT-3 is monab-CD3, an immunosuppressant drug given intravenously to reverse the acute rejection of transplanted organs such as the heart, kidney and liver. **Herceptin (trastuzumab)** is a monoclonal antibody approved for therapy of early-stage breast cancer that is Human Epidermal growth factor Receptor 2-positive (HER2+). (1.5 marks)	2

SECTION-C

22	(a) In chymotrypsinogen, the substrate binding site is blocked and hence the enzyme is inactive. In-situ activation of trypsin involves a proteolytic cut in chymotrypsinogen which results in a conformational change, exposing the substrate binding pocket. (b) 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 **OR**  Fig. 6. Protein fingerprinting **Protein fingerprinting/ peptide mapping**	1+2 ½ x 6
23		½ x 6

Crop	Gene	Improved Character
Canola	(A) Barnase Barstear	Hybrid production
Corn	(B) BtCrylA(c)	Insect Resistance
Cotton	(C) BtCrylA(c)	Insect Resistance
Papaya	(D) Coat protein	Virus Resistance
Potato	(E) BtCrylllA & Coat protein	Insect & virus control
Soyabean	EPSP synthase	Weed control

24	Membrane integrity maintained Helps to maintain the shape and size of cells. Salt, glucose and amino acids (any two) are the major ingredients that determine osmolality of the medium.	1x3
25	(a) →BLAST search→ Find out→ homologous sequences in other organisms by looking for gene sequence of given proteolytic enzyme. (b) Look for conserved domain and find whether belongs to domain of Chymotrypsin or to other family of proteins (c) ALI database can be used for Phylogenetic (Evolutionary) analysis and alignment of proteins.	1 1 1
26	R.E. type II recognize a specific DNA sequence and cut within the sequence generating sticky/flush ends. In recombinant DNA technology, we use type II RE as they are highly specific in their action. Alu I with the restriction site (One strand) 5' AGCT'3 and Sma 1 with the restriction site 5 'CCC GGG' 3(flush ends) (One strand) The functions of a) Alkaline phosphatase b) DNA ligase. *The role of alkaline phosphatase is to prevent self re-ligation of the vector *The role of DNA ligase is to make 3'-5' phosphodiester bond.	1 1 ½ ½
27	*: i) UniGene database* *ii) Homologene database* *iii. RefSeq database*	1 1 1
28	*a) p BR 322*	1
	b) LEU2 gene codes for an enzyme required for the synthesis of amino acid leucine. Yeast cells having this plasmid can grow on a medium lacking leucine and hence can be selected e.g. Yep	1 ½ ½

SECTION- D

29	(a) The molecular ions are generated either by a loss or gain of a charge (e.g. electron ejection, protonation or deprotonation) (b) Mass spectrometry is used in- (i) Obtaining protein structural information such as peptide mass or amino acid sequence (ii) Identifying the type and location of amino acid modification within proteins. (any one) (c) (c)m/z= $(M+ nH)^{n+}/ n^{+}$ For n=5, m/z= 10,000+ 5/5= 2001 For n=4,m/z= 10,000+ 4/4= 2501 For n=3, m/z= 10,000+ 3/3= 3334.3 For n=2, m/z= 10,000+ 2/2=5001 **OR** (c) m/z= $(M+ nH)^{n+}/ n^{+}$ For n=6, m/z= 20,000+ 6/6= 3334.33 For n=7, m/z= 20,000+7/7=2858.14	1 1 2
30	a) As generation time is inversely related to specific growth rate, hence bacterial culture marked " X " with generation time 20s will **proliferate rapidly.** b) n = 3.3 (Log 10^7 – Log 10^4) = 3.3 (7 – 4) = 10 c) First calculate the number of divisions the population must have undergone to increase from 10^8 to 10^{14} in 24 hours. n = 3.3 (Log 10^{14} – Log 10^8) = 3.3 (6) = 19.8 t_d = 240 minutes / 20 = 12 minutes **OR** c) (i) Measurement of Dry mass and Wet mass (ii) Using spectrophotometer (iii) Using Slide counting Chamber (iv) Using Coulter chamber (*Any two*)	1 1 2

SECTION- E

31

Proteins	Animal cell line used	Therapeutic use
Erythropoietin	CHO cells	Anemia
Factor VIII	CHO cells	Hemophilia A
Follicle Stimulating Hormone (FSH)	CHO cells	Infertility
Interleukin 2 (IL 2)	CHO cells	Cancer therapy
Monoclonal antibodies (mAbs)	Hybridoma cells	Cancer therapy & Autoimmune diseases

½ x10

OR

(a) (i) A defined medium has known chemicals, of fixed composition and can support growth of selected cells.Serum is an essential component of animal cell culture media and is a source of growth factors and hormones. — 2

(ii) Anchorage dependent cells grow as adherent cells whereas anchorage-independent cells grow as suspension cultures.

(b) Most common buffering system used to maintain pH in animal cell Culture is Bicarbonate-CO_2system.Carbon dioxide from cells or atmosphere interacts with water and leads to drop in pH. — 2

$$H_2O + CO_2 \text{《----》} H_2CO_3 \text{《-----》} (H^+) + (HCO3^-)$$

Increase in Bicarbonate concentration neutralizes the effect of increased Carbon dioxide according to the following equation:

NaHCo3 ---> (Na+)+(HCO3-)

The increased HCO3- ions derive the above equation to its left until equilibrium is reached at pH 7.4 — 1

Advantages :

i) pH is important to maintain in balance/ enzyme functions/ binding of hormones/growth factors to cell surface receptors/Ion balance (Any two)

32

(a) TaqDI — 1

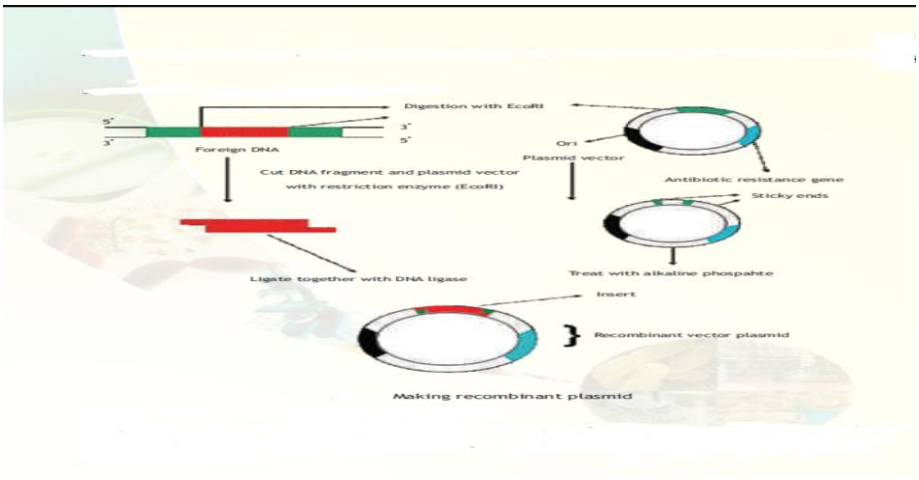
(b) 5' AATGC 3' and 5' GATTC 3' — 1

(c) Palindromic means the DNA sequence reads same when read from 5' to 3'. The Restriction enzyme is a homodimer. — ½

As it cuts both the strands of DNA simultaneously in 5' to 3' direction. — ½

(d) Foreign DNA can be inserted into bacteriophage single stranded, circular DNA of 6407 bp without disrupting any of the essential genes — 2

M13 is a filamentous phage which infects E. coli having a pilus (protrusion) which is selectively present in cells containing a F plasmid (called F+ cells).

	OR **a)**  **b) 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.	2 ½ ½*5
33	(a) Recombinant insulin is an intracellular protein so we need to process the cell mass and not the fermentation broth. (b) Strain improvement is done in order to maximize metabolite production by: i) Mutant selection : There are two methods - Physical method & Chemical Method ii) Genetic engineering (c) i) It has strong inducible promoters ii) It is capable of making post-translational modifications similar to those performed by human cells iii) Downstream processing is simpler as Pichia does not secrete its own proteins into the fermentation medium. **(*Any two*)** **OR**	1 1 1 1x2

	a) <u>Use of shake culture and Use of baffle flask</u> Baffle flask: One of the simplest ways is to produce a V- shaped notch or indentation in the sides of the flask. Such flasks are called baffle flasks . This improves the growth of the microbes by improving the efficiency of oxygen transfer due to increased turbulence of the agitated culture medium. Shakers: Continuous agitation of the culture medium also greatly improves the efficiency of the oxygen transfer and this improves the growth of the microbes. In the laboratory, this is done by the use of shakers . Shakers may be end-to-end type or rotatory type. These may be designed for use at the ambient temperature or in a controlled temperature environment (incubator shaker). b) 1. Production of whole microbial cells (for food, vaccines) 2. Production of primary metabolites (acids, alcohol) 3. Production of secondary metabolites (antibiotics) 4. Biotransformation reactions (enzymatic, steroid) 5. Exploitation of metabolism (microbial leaching, biodegradable waste treatment) 6. Synthesis of recombinant proteins (therapeutic proteins) Bioremediation/fermented food items/ recombinant proteins (Any two) **c)** Viable Plate Count is the best method since it does not count dead microbial cells.	1x2 1x2 1