BIOTECHNOLOGY – CODE NO. 045
SESSION 2026-27
MARKING SCHEME

SECTION A		
1	C. Drosophila	1
2	B. methionine	1
3	B. activating the serine residue for nucleophilic attack	1
4	D. Ensures constant cell concentration	1
5	D. Producing Virus free plants	1
6	B. primers	1
7	C. Accumulation of toxic products	1
8	B. Phenol red acts as a visual indicator, simplifying pH monitoring and maintenance of optimal cell culture conditions.	1
9	A. identical with zygotic embryos and without seed coats	1
10	D. Monoclonal antibody	1
11	D. (i), (iii), (ii), (iv), (v)	1
12	A. SV 40 vectors and papilloma virus vectors	1
13	A. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).	1
14	C. Assertion (A) is true, but Reason (R) is false.	1
15	B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).	1
16	B. Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).	1
SECTION B		
17	Specific growth rate is an index of rate of growth of the cells in a particular environment. In other words, specific growth rate is characteristic of the microorganism and is a function of the growth environment including temperature, pH, medium composition and levels of dissolved oxygen. (1) A microbial strain with higher specific growth rate will have low doubling time and vice versa. td=0.693/μ (1)	2

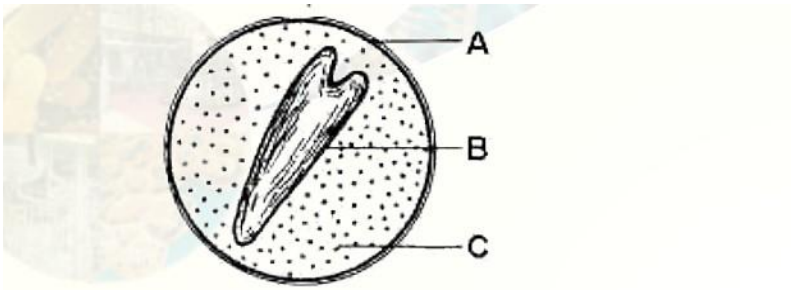
18	***Attempt either option A or B.*** A. • DNA template to be amplified. • Primers which are oligonucleotides, usually 10-18 nucleotides long that hybridise to the target DNA region one to each strand of the DNA. Two primers of such a sequence are required so that they can hybridise. • DNA polymerase which is stable at temperatures above 80^{o}C. Taq polymerase which has been isolated from a thermostable bacterial species is used. • Deoxynucleotide triphosphates and buffer. (O.5X4) **OR** B. I. Microinjection: Foreign DNA is directly injected into recipient animal and plant cells using fine syringe under a phase contrast microscope. (1) II. Biolistics: Microscopic particle of gold and tungsten are coated with DNA of interest and bombarded onto cells with a particle gun. (1) III. Electroporation: A pulse of high voltage is applied which makes temporary pores in plasma membrane facilitating uptake of DNA. (Any two) (1)	2
19	Baffle flasks have V- shaped notches or indentations in the sides of the flask. (1) This improves the growth of the microbes by improving the efficiency of oxygen transfer due to increased turbulence of the agitated culture medium. (1)	2
20	Protoplasts are plant cells without cell wall and can be isolated by enzymatic methods (cellulases, hemicellulases and pectinases) from leaf, seedling and calli etc. (1) As the protoplast lack cell wall, they can be utilized for a) Various biochemical and metabolic studies. b) Fusion of two somatic cells to create somatic hybrids. c) Fusion of enucleated and nucleated protoplasts to create cybrids. d) Genetic manipulation. (Any two) (0.5+0.5)	2
21	Polyclonal antibodies are heterogeneous mixture that bind to multiple different epitopes on a single antigen because they are produced by various populations of B lymphocytes, each recognizing a different part of the antigen. Monoclonal antibodies, in contrast, are highly specific and bind to only a single epitope on an antigen. (1) This specificity of monoclonal antibodies is because they are produced by a single clone of immortalized B lymphocytes (hybridoma), derived from one antigen-activated B cell that recognizes that particular epitope. (1)	2
	SECTION C	
22	OKT3 acts as an immunosuppressant by binding to the CD3 molecule on the surface of T cells, which are key players in acute graft rejection. (1)	3

	This binding blocks the normal function of the T cells, thereby preventing them from attacking the transplanted organ. (1) When OKT3 therapy is over, the existing OKT3 molecules gradually clear from the body. OKT3 can resume their normal immune functions within a week. (1)	
23	Processing raw information i.e. • DNA sequence information is processed into genes • proteins encoded by the genes can be inferred • Gene function can be determined • the regulatory sequences can be identified • Inferring phylogenetic relationships (Any three points)	3
24	A. X-Impeller (0.5) Y-Cooling Jacket (0.5) Z-Sparger (Air bubbles) (0.5) B. Yes, this can be considered as strain improvement. (0.5) The transgene/ foreign gene is introduced through RDT which is a method of genetic engineering that results in improved characters. (1) *For Visually impaired students* A. Small scale fermentors of capacity 10-100 liters are used in research laboratories. (0.5) These are used by the scientists in research, to optimize various parameters for the growth of microbes. (0.5) The laboratory scale fermentors are also used by scientists, to produce enough quantities of metabolites from microbes for research purposes. (0.5) B. Yes, this can be considered as strain improvement. (0.5) The transgene/ foreign gene is introduced through RDT which is a method of genetic engineering that results in improved characters. (1)	3
25	***Attempt either option A or B.*** A. Whey proteins result in the elevation of a tripeptide glutathione (gamma-glutamyl cysteinyl glycine) in cells. (1) This peptide is a reducing compound and has a broad range of functions including detoxification of xenobiotics. (1) Protection of cellular components from the effect of oxygen intermediates and free radicals. (1) **OR** B. PER – Protein Efficiency ratio : Weight gain by consuming 1gm of food protein. BV – Biological value : It measure the amount of protein nitrogen that is retained from a given amount of protein nitrogen consumed. BCAA profile – Essential for the biosynthesis of muscle proteins.	3

26	A. Isolation of genomic DNA. (0.5) Digestion of fragment by specific Restriction enzyme. (0.5) Separation of fragments. (0.5) Perform Agarose gel electrophoresis. (0.5) B. RFLP pattern would be exactly same in case of identical twins. (1)	3
27	Read the gel bottom to top A. 5' ACTAGCGATG 3' Make complementary 3' TGATCGCTAC 5' (1) B. To terminate the chain (1) C. ddNTP is different because it lacks 3'-OH group (1) *For Visually impaired students* A. 5' TCTGGGCTACTCGGGCGT 3' (1) B. Dideoxy chain termination method. (1) C. Automated DNA squenator does not make use of radio lables, so it is considered safer. (1)	3
28	A. Homologous Recombination/Creation of gene knock out (1) B. Inner Cell Mass (ICM) (0.5) Stage: Blastocyst (0.5) Reason: The ICM contains pluripotent embryonic stem cells capable of forming all tissues, making it ideal for regenerative and genetic disorder studies. (1) *For Visually impaired students* A. Finite cell lines have a limited lifespan and will eventually stop dividing. Continuous cell lines, on the other hand, are immortal and can grow indefinitely in culture. (1) B. The HER2 receptor is a cell surface protein that normally receives growth signals, promoting cell growth and multiplication. In HER2-positive breast cancer, these receptors are often overexpressed, leading to excessive growth signaling and uncontrolled proliferation of cancer cells. (1) Herceptin works by specifically binding to the HER2 receptors on the surface of these cancer cells. This binding blocks the receptors from receiving the growth signals, effectively disrupting the signaling pathway that drives cancer cell growth and thus inhibiting the progression of breast cancer. (1)	3
SECTION D		
29	A. P is abl gene and Q is bcr gene. (1) B. Philadelphia chromosome. (1) C. (i) FISH - Fluorescence in Situ Hybridization. (ii) Fluorescence in Situ Hybridization based on fluorescently labelled probes. (2)	4

	OR D. Karyotyping requires metaphase arrested chromosomes and is also not an easy procedure. (2) *For Visually impaired students* A. A is abl gene and B is bcr gene. (1) B. Philadelphia chromosome. (1) C. (i) FISH - Fluorescence in Situ Hybridization. (ii) Fluorescence in Situ Hybridization based on fluorescently labelled probes. (2) **OR** D. Karyotyping requires metaphase arrested chromosomes and is also not an easy procedure. (2)	
30	A. The molecular ions are generated either by a loss or gain of a charge (e.g. electron ejection,protonation or deprotonation). (1) B. Mass spectrometry is used in- • Obtaining protein structural information such as peptide mass or amino acid sequence • Identifying the type and location of amino acid modification within proteins. (1) (any one) C. m/z= (M+ nH)n+/ n+ For n=4,m/z= 10,000+ 4/4= 2501 For n=2, m/z= 10,000+ 2/2=5001 **OR** D. 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 (2) *For Visually impaired students* A. The molecular ions are generated either by a loss or gain of a charge (e.g. electron ejection,protonation or deprotonation). (1) B. Mass spectrometry is used in- • Obtaining protein structural information such as peptide mass or amino acid sequence • Identifying the type and location of amino acid modification within proteins. (1) (any one) C. Ionization Chamber / Ion Source Mass Analyzer Detector Vacuum System Electromagnet Amplifier (0.5x4)	4

	OR D. The sample is transferred from a condensed phase to a gas phase with the help of a solid matrix. Ion formation in MALDI is achieved by directing a pulsed laser beam onto a sample suspended or dissolved in a matrix. The matrix absorbs the laser light energy and vaporises. In the gas phase, the matrix plays a role in sample ionisation. The charged molecules are directed by electrostatic lenses from the ionisation source to the mass analyser. (2)	
SECTION E		
31	***Attempt either option A or B.*** A. I. 5' GAATTC 3' (1) 3' CTTAAG 5' (1) Sticky ends II. 5'GTATTAGCTG 3' 5' AATTCTATAAAACG 3' 3'CATAATCGACTTAA 5' + 3' GATATTTTGC 5' (1) III. *E* refers to genus name, co the species name, the capital R refers to the strain name (RY13) and (I) roman numeral refers to it being the first enzyme to be isolated from this strain. (2) **OR** B. Insertional activation will occur in the recombinant plasmid, Lac Z gene will be inactivated. (1) We can differentiate between recombinants from non-recombinants by using chromogenic media/Blue and white selection method. Transformed *Ecoli* cells with pUC19 contain selectable marker gene Lac Z. Lac Z gene codes for the enzyme B-galactosidase, whose activity can cleave a colourless substrate called X- gal into a blue coloured product, hence blue colonies. This region also contains polylinker and thus insertion of foreign DNA(Recombination) into any of the restriction site will result in altered non-functional enzyme, no cleavage of the X-gal substrate, Colonies will appear white. (4)	5
32	***Attempt either option A or B.*** A. I. The following are the major concerns about GM Crops. (a) Genetically modified plants may cause some allergic or toxic reactions in the long run. (b) Transgenic plants may lead to proliferation of new microbial and insect strains. (c) Transgenic plants pose the ecological risk of developing into weeds. (d) Non-target and beneficial organisms may also be effected. (e) Transgene may escape through pollen grains and may cause gene contamination in natural populations.	5

	(f) The GM crops may lead to the change in the evolutionary pattern. (g) The antibiotic resistance marker genes used to produce transgenic crops may horizontally transfer into microbes and thus exacerbate the problem of antibiotic resistance in human and animal pathogens. (Any 3) II. (a) Delayed fruit ripening. (b) Longer shelf life. **OR** **B.** I. Genetically engineered *Arabidopsis* plants with three genes introduced from a bacterium produce PHB (poly hydroxyl butyrate) globules exclusively in their chloroplast without affecting Plant growth and development from leaves. The large-scale production of PHB is easily achieved by extraction from leaves of genetically engineered Populus. (2) II. Artificial seeds are the embryos raised in tissue culture and encapsulated in protective chemicals like calcium alginate which form an artificial seed coat and prevents them from desiccating. They can be utilized for the rapid and mass propagation of elite plant species as well as hybrid varieties.  The diagrammatic representation of an artificial seed. The artificial seed coat (A), somatic embryo at torpedo stage (B) and artificial endosperm (C). (3)	
33.	***Attempt either option A or B.*** A. I. 2-D gel electrophoresis. First dimension by Iso electric focusing, Second dimension by SDS-PAGE. Principle of IEF- Separation of the proteins is on the basis of their Isolectric pH (pI). Ampholytes (Polyamino- Polycarboxylic acids) are used in generating the pH gradient. SDS-PAGE- Separation of the proteins is on the basis of their molecular mass. As two processes (IEF and SDS –PAGE) are carried at right angle to each other, thereby increasing the resolution. Proteins are separated into 2-D patterns with high resolution as two properties of the proteins have been exploited in their separation- charge and size. II. Thermal and pH stability, solvent tolerance, solubility, catalytic potency. (any 2)	5

OR

B.

I. The single substitution of valine for glutamic acid (val/glu are at the 6th position of the haemoglobin beta chain) dramatically changes the structure of scHb making it form fibres within the RBC resulting in the deformation of the cell (sickling). Since the disease is due to this molecular alteration, it is called molecular disease.

II. V.M Ingram

- The principle of protein fingerprinting is to generate peptide maps after proteolytic cleavage and separation of the peptides.
- Generation of peptides from protein using trypsin (a proteolytic enzyme)
- Performing paper electrophoresis
- Then paper chromatography at 90 ^{0} C to the direction of electrophoresis and
- separation of peptides based on partition coefficient in the given solvent system.
- visualization of the peptides using ninhydrin. On examining this peptide and determining its amino acid sequence, Valine substitution for glutamic acid in the peptide is observed.

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