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| **Course Code** | **12BT208** | **Duration** | **3hrs** |
| **Course Name** | **HEAT TRANSFER OPERATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Recall the numerical expression of thermal conductivity. | | CO1 | R | 1 |
| 2. | What is the rate of heat transfer per unit area as called as? | | CO2 | U | 1 |
| 3. | Define the expression of Reynold’s number. | | CO2 | U | 1 |
| 4. | List the different types of boiling. | | CO2 | R | 1 |
| 5. | Recall the principle behind black body radiation. | | CO1 | R | 1 |
| 6. | Quote the expansion of LMTD. | | CO1 | R | 1 |
| 7. | Define steam economy. | | CO1 | R | 1 |
| 8. | Give examples of different feeding methods available in a reactor. | | CO2 | U | 1 |
| 9. | List the types of condensation. | | CO3 | R | 1 |
| 10. | Recall the unit of heat transfer coefficient. | | CO1 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Explain the law of heat conduction and heat transfer coefficients. | | CO1 | U | 3 |
| 12. | Define fouling factor and list the preventive methods. | | CO2 | An | 3 |
| 13. | Describe the law of thermal conductivity of composite materials. | | CO1 | R | 3 |
| 14. | Explain the law of radiation with an example. | | CO1 | U | 3 |
| 15. | Differentiate drop wise and film wise condensation. | | CO3 | An | 3 |
| 16. | Analyze the mass balance equation for single | | CO3 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. | a. | Derive the expression for heat flux in one dimensional conduction through a composite wall. | CO1 | R | 8 |
|  | b. | What is thermal conductivity? Derive heat transfer rate for a plane wall. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. |  | Derive heat transfer expression through a hollow cylinder. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Derive thermal conductivity equation and also derive the steady-state heat transfer through a hollow spherical shell. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Derive the dimensional equation for convective heat transfer | CO3 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Define Mass Transfer. Explain on Molecular Diffusivities. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 22. |  | Define Fourier’s Law for Thermal Conductivity and Newton’s law of cooling. | CO2 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Distinguish Natural and Forced Convections. | CO3 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Give a detailed account on Heat Exchanger equipment with neat diagrams. | CO3 | C | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Explain the principles of diffusion and mass transfer coefficient. |
| CO2 | Understand the principles of gas liquid operations. |
| CO3 | Describe vapour liquid operations in biotech industries. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 | 10 | 0 | 0 | 0 | 0 | 26 |
| CO2 | 1 | 15 | 24 | 3 | 0 | 0 | 43 |
| CO3 | 1 | 12 | 15 | 15 | 0 | 12 | 55 |
|  | | | | | | | **124** |



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| **Course Code** | **19BT2018** | **Duration** | **3hrs** |
| **Course Name** | **ENZYME ENGINEERING AND TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Recall the unit of enzyme activity. | | CO1 | R | 1 |
| 2. | List out the models that describe the interaction between active site and substrate. | | CO1 | R | 1 |
| 3. | Identify the enzyme that catalyzes the isomerization reactions. | | CO1 | R | 1 |
| 4. | Determine the Km of enzyme if the initial velocity is reduced to one- half of the maximum velocity. | | CO4 | A | 1 |
| 5. | Name few the methods used in purification of enzymes | | CO5 | R | 1 |
| 6. | Draw and label the parts of a packed bed bioreactor. | | CO3 | R | 1 |
| 7. | Identify the type of inhibition observed with inhibitor that can bind only to the enzyme substrate complex. | | CO6 | A | 1 |
| 8. | Recall an enzyme used in the antiblood clotting. | | CO2 | R | 1 |
| 9. | Name the immobilization technique that may be accomplished without the solid matrix. | | CO3 | U | 1 |
| 10. | Name the enzyme used in the detergent industry | | CO2 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Compare the activation energies of enzymatically catalyzed and uncatalyzed reactions. | | CO1 | An | 3 |
| 12. | Recall the chemical reaction and kinetic equation for non-competitive toxic compound inhibition reactions. | | CO6 | R | 3 |
| 13. | Classify the types of immobilized enzyme reactors. | | CO3 | An | 3 |
| 14. | Assess the elements of biosensor.­ | | CO3 | E | 3 |
| 15. | Outline the role of immunosensors. | | CO3 | An | 3 |
| 16. | Relate the biotransformation application of enzymes. | | CO2 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain in detail the Enzyme Commission’s system of classification of enzymes. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. |  | Derive the expression for competitive and uncompetitive inhibition reactions and explain it with the help of a line-weaver burk plot. | CO6 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | The following results were obtained for an enzyme- catalyzed reaction.  Estimate Km and Vmax by Lineweaver-Burk plot and Hanes woolf plot.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Substrate concentration (mmol L-1) | 5.0 | 6.67 | 10.0 | 20.0 | 40.0 | | Initial velocity (µmol L-1 min-1) | 147 | 182 | 233 | 323 | 400 | | CO4 | An | 12 |
|  |  |  |  |  |  |
| 20. | a. | Explain in detail the construction and working of a fluidized bed bioreactor. | CO3 | U | 8 |
|  | b | Assess the advantages and disadvantages of packed bed and fluidized bed bioreactor. | CO3 | U | 4 |
|  |  |  |  |  |  |
| 21. |  | Illustrate with a neat sketch various steps in extraction and purification of intracellular enzyme. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Elaborately explain the working of different types of electrochemical enzyme-based biosensors used in industry. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Assess various methods of enzyme immobilization with examples. | CO3 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Examine the application of enzymes in Food and pharmaceutical industries. | CO2 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand enzymes and enzymatic reactions. |
| CO2 | Relate the application of enzymes in various industries. |
| CO3 | Apply enzymes in free and immobilized form for various reaction. |
| CO4 | Analyze and solve problems related to enzymes and kinetics. |
| CO5 | Evaluate the processing and purification of enzymes . |
| CO6 | Hypothesize model for enzyme kinetics and inhibition types. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 3 | - | - | 15 | - | - | 18 |
| CO2 | 2 | - | 15 | - | - | - | 17 |
| CO3 | 1 | 25 | - | 18 | 3 | - | 47 |
| CO4 | - | - | 1 | 12 | - | - | 13 |
| CO5 | 1 | - | - | 12 | - | - | 13 |
| CO6 | 3 | - | 13 | - | - | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19BT2020** | **Duration** | **3hrs** |
| **Course Name** | **DOWNSTREAM PROCESSING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Identify the filter cake type if increasing pressure causes increase in specific cake resistance. | | | CO2 | R | 1 |
| 2. | Recall the SI unit of specific cake resistance and what does it implies? | | | CO2 | U | 1 |
| 3. | Give an example of high value low volume product | | | CO1 | R | 1 |
| 4. | Give an example for an intracellular protein | | | CO1 | R | 1 |
| 5. | Calculate extraction factor, if volume of aqueous to organic phase is 2:1 and partition coefficient is 130. | | | CO3 | A | 1 |
| 6. | Determine the amount of protein adsorbed per amount of adsorbent from a solution with 1mg/l of protein. The feed will exhaust 90% of solute and K=3 liter/g based on linear isotherm. | | | CO3 | A | 1 |
| 7. | Name the separation mechanism in reverse osmosis | | | CO4 | U | 1 |
| 8. | Differentiate the theoretical models for membrane separation | | | CO4 | An | 1 |
| 9. | Calculate ionic strength of 2 M NH4SO4 solution | | | CO5 | A | 1 |
| 10. | Illustrate the significance of critical moisture content | | | CO6 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Project the sequence of downstream processing steps involving recovery of intracellular products from microbial fermentation broth. | | | CO1 | An | 3 |
| 12. | Explain the role of filter aid in batch filtration process. | | | CO2 | U | 3 |
| 13. | Differentiate the adsorption isotherm based on mechanism. | | | CO3 | An | 3 |
| 14. | Identify the problem associated with organic solvent-based protein precipitation approaches. | | | CO5 | U | 3 |
| 15. | Differentiate gradient chromatography and isocratic chromatography. | | | CO4 | An | 3 |
| 16. | List the different stages in lyophilization. | | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | |  | Project the process details and performance of mechanical disruption of cells in bead mill, high-pressure homogenizer, ultrasonic treatments depending on cell types. | CO1 | R | 12 |
| 18. | |  | Animal cells are cultivated on the surface of microcarriers with a density of 1.02g/cm3 and a diameter of 150µm. A 50 liter stirred tank is used to cultivate cells grown on microcarriers to produce a viral vaccine. After growth, the stirring is stopped and the microcarriers are allowed to settle. The microcarrier free fluid is then withdrawn to isolate the vaccine. The tank has a liquid height to diameter ratio of 1.5; the carrier- free fluid has a density of 1.g/cm3 and a viscosity of 1.1cP.  a) Estimate the settling time by assuming that these beads quickly reach their maximum terminal velocity.  b) Estimate the time to reach this velocity. | CO2 | An | 12 |
| 19. | |  | The enzyme phosphoglycerite kinase isolated from yeast, can be adsorbed on cellulose. The adsorption follows Langmuir isotherm. The maximum uptake is 70mg cm-3 adsorbent; half of this maximum occurs when the solution contains 50mg liter-1 of the enzyme. We have 1.5 liters of the feed containing 220mg liter-1 of the enzyme. How much cellulose should we add to get a 90% recovery of the solute? | CO3 | A | 12 |
| 20. | | a. | Deduce the expression for residual concentration of target compound in heavy phase after counter-current staged extraction process. | CO3 | U | 6 |
|  | | b. | A clarified fermentation beer H containing 260mg/liter of the actinomycin D is to be extracted using butyl acetate L. Because the beer’s pH is 3.5, the equilibrium constant K is 57. You plan to let H equal 450 liters/hr and L equal 37 liters/hr; you hope to recover 99%of the antibiotic in the feed. Determine how many stages you will need to accomplish this separation. | CO3 | A | 6 |
| 21. | | a. | Elaborate the structural and operational differences between different membrane modules. | CO5 | U | 6 |
|  | | b. | Explain the utility of microfiltration membrane in downstream processing also highlighting their associated limitations. | CO5 | U | 6 |
| 22. | |  | The fermentation broth contains the recombinant protein as aggregates. Suggest the chromatography method to be used for the separation of monomers from dimers and higher aggregates. Summarize its basic principle, materials used and procedure. | CO4 | A | 12 |
| 23. | |  | A sample with ions M, M+, M-, M2- is introduced into a column and observed that the ion M2- was eluted at last. Elaborate on its basic principle, materials used and procedure for the separation. | CO4 | A | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | | a. | Discuss the Crystallization theory and why do you choose it as finishing operation. | CO6 | R | 6 |
|  | | b. | Summarize the various drying equipment used in bioprocess industry. | CO6 | R | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the fundamentals of product isolation and separation techniques. |
| CO2 | Distinguish various techniques for product recovery and polishing. |
| CO3 | Explain operating principles across different solid(liquid)-liquid separation process |
| CO4 | Analyze product recovery in solid liquid separation processes. |
| CO5 | Compare the performances of different extraction techniques |
| CO6 | Apply separation techniques for bio product recovery. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 14 |  |  | 3 |  |  | 17 |
| CO2 | 1 | 4 |  | 12 |  |  | 17 |
| CO3 |  | 12 | 14 | 3 |  |  | 29 |
| CO4 |  | 1 | 24 | 4 |  |  | 29 |
| CO5 |  | 15 | 1 |  |  |  | 16 |
| CO6 | 15 |  | 1 |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19BT2027** | **Duration** | **3hrs** |
| **Course Name** | **BASICS OF BIOINFORMATICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Recite any one scope of bioinformatics. | | CO1 | R | 1 |
| 2. | List any one protein database. | | CO1 | R | 1 |
| 3. | Recall anyone pitfall of biological databases. | | CO2 | R | 1 |
| 4. | Express any one need for databases. | | CO2 | U | 1 |
| 5. | Identify the item with highest score among Match, Mismatch, and Gap. | | CO3 | R | 1 |
| 6. | Cite any one difference between local and global sequence alignment. | | CO3 | U | 1 |
| 7. | Define phylogenetics. | | CO4 | R | 1 |
| 8. | Define node in a phylogenetic tree. | | CO4 | R | 1 |
| 9. | Report any one use of protein structure modeling. | | CO5 | U | 1 |
| 10. | Convince anyone requirement for molecular docking. | | CO6 | E | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Chart any three examples of elementary protocols. | | CO1 | A | 3 |
| 12. | Illustrate any three examples of nucleotide databases. | | CO2 | An | 3 |
| 13. | Define local sequence alignment. | | CO3 | R | 3 |
| 14. | Construct phylogentic tree from the following Newick format  (((B, C), A), (D, E)). | | CO4 | A | 3 |
| 15. | Compare homology and threading. | | CO5 | E | 3 |
| 16. | Write any three requirements of molecular docking. | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Explain the central dogma of molecular biology. | CO1 | R | 12 |
| 18. |  | Classify biological databases. | CO2 | An | 12 |
| 19. |  | Show the alignment of CGTGAATTCAG (sequence 1), GACTTAC (sequence 2) by Needle Man–Wunsch algorithm and represent the final alignment with scores Match =1, Mismatch = -1, and Gap: -1. | CO3 | U | 12 |
| 20. |  | Recite the steps involved in molecular phylogenetic tree construction. | CO4 | R | 12 |
| 21. |  | Describe the homology modeling method for predicting protein structure. | CO5 | U | 12 |
| 22. |  | Explain in detail the dot matrix method for sequence alignment. | CO1 | An | 12 |
| 23. |  | Solve the alignment of GGTGAATTCAT (sequence 1) and GACTTAC (sequence 2) using Smith Waterman algorithm and represent the final alignment with scores Match =5, Mismatch = -3, and Gap: -4. | CO3 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain in detail about molecular docking. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Gain knowledge on Biological databases and tools. |
| CO2 | Understand the significance of biological databases and their utilization. |
| CO3 | Apply the knowledge of Bioinformatics skill to solve the biological problems in Genomics and  Proteomics. |
| CO4 | Analyze different types of Biological databases and resources. |
| CO5 | Evaluate the vital role drugs interacting to the target. |
| CO6 | Create databases and tools of Drug like molecules. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 14 | - | 3 | 12 | - | - | 29 |
| CO2 | 1 | 1 | - | 15 | - | - | 17 |
| CO3 | 4 | 13 | 12 | - | - | - | 29 |
| CO4 | 14 | 3 | - | - | - | - | 17 |
| CO5 | - | 13 | - | - | 3 | - | 16 |
| CO6 | - | - | 3 | 12 | 1 | - | 16 |
|  | | | | | | | **124** |

**Graphical user interface, application

Description automatically generated with medium confidence**

**SUPPLEMENTARY EXAMINATION – JUNE 2023**

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| **Course Code** | **19BT2040** | **Duration** | **3hrs** |
| **Course Name** | **PLANT AND ANIMAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | List the micronutrients in MS media. | | | CO1 | R | 1 |
| 2. | Recall the hormones used in plant tissue culture. | | | CO1 | R | 1 |
| 3. | Define Cell Line. | | | CO2 | R | 1 |
| 4. | Infer on plant genetic transformation. | | | CO2 | U | 1 |
| 5. | Recall the size of Ri plasmid. | | | CO2 | R | 1 |
| 6. | List marker genes used in plant genetic transformation. | | | CO3 | R | 1 |
| 7. | Cite one example for pest and disease resistance trangenic plants. | | | CO3 | U | 1 |
| 8. | Calculate the number of cells in 1 ml of A549 cell suspension. | | | CO4 | A | 1 |
| 9. | Identify the role of trypsin in animal cell culture. | | | CO5 | R | 1 |
| 10. | Infer the role of growth factors cell cultures. | | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Infer the role of CO2 in culturing of animal cells. | | | CO1 | An | 3 |
| 12. | Interpret the significance of somatic embryogenesis in plant tissue culture. | | | CO2 | A | 3 |
| 13. | Recall the features of Ri plasmid. | | | CO3 | R | 3 |
| 14. | Identify the name of antibiotics used in animal cell culture and write the concentration of the same in 1ml of the medium. | | | CO4 | U | 3 |
| 15. | Discuss the importance of Trypan blue assay. | | | CO5 | U | 3 |
| 16. | Identify the role of microcarriers in animal cell culture. | | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | | a. | Explain the process of plant cell suspension culture and discuss its applications in drug development. | CO1 | U | 12 |
| 18. | | a. | Illustrate on the methods of gene transfer in the development of transgenic crops with suitable diagrams. | CO2 | An | 12 |
| 19. | | a. | Explain the process of micropropagation methods in plant tissue culture with suitable examples. | CO1 | A | 12 |
| 20. | | a. | Evaluate the strategies of development of disease resistance transgenic plants and its applications. | CO3 | E | 12 |
| 21. | | a. | Describe the types of reporter and marker genes used in plant genetic transformation with suitable examples. | CO3 | R | 12 |
| 22. | | a. | Discuss about serum and serum free medium in animal cell culture. | CO4 | U | 12 |
| 23. | | a. | Describe the steps involved for primary culture and subculturing of animal cells. | CO5 | U | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | | a. | Describe *In vitro* fertilization and ethical issues in animal biotechnology. | CO6 | U | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge in plant biotechnology and its applications. |
| CO2 | Gain the knowledge about to increase the production in agriculture products. |
| CO3 | Prepare them to work in the Agricultural industries. |
| CO4 | Demonstrate *In vitro* cell culture, fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness |
| CO5 | Development of transgenic animals for breed development for enhanced milk production |
| CO6 | Adapt appropriate ethical guidelines in animal biotechnology |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 12 | 12 | 3 |  |  | 29 |
| CO2 | 2 | 1 | 3 | 12 |  |  | 18 |
| CO3 | 16 | 1 |  |  | `12 |  | 29 |
| CO4 |  | 15 | 1 |  |  |  | 16 |
| CO5 | 1 | 15 |  |  |  |  | 16 |
| CO6 | 3 | 13 |  |  |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **19BT2040** | **Duration** | **3hrs** |
| **Course Name** | **PLANT AND ANIMAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Name the first media developed in plant tissue culture. | | CO1 | R | 1 |
| 2. | Define callus. | | CO1 | R | 1 |
| 3. | Recall the significance of somatic embryo. | | CO2 | R | 1 |
| 4. | Infer the role of haploid plants. | | CO2 | U | 1 |
| 5. | Recall the size of Ri plasmid. | | CO2 | R | 1 |
| 6. | List the reporter genes used in plant transformation. | | CO3 | R | 1 |
| 7. | Cite one example for herbicide resistant trangenic plants. | | CO3 | U | 1 |
| 8. | Recall confluency | | CO4 | R | 1 |
| 9. | Define transformed cell line | | CO5 | R | 1 |
| 10. | Infer gene knockout technique | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Infer somaclonal variation in tissue culture established plants. | | CO1 | An | 3 |
| 12. | Interpret the significance of green-house technology in plant tissue culture | | CO2 | A | 3 |
| 13. | Recall the features of Ti plasmid. | | CO3 | R | 3 |
| 14. | Name three types of monolayer cell lines. | | CO4 | R | 3 |
| 15. | Illustrate micromanipulation in embryos. | | CO5 | U | 3 |
| 16. | State three ethical issues in animal biotechnology | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Explain the nutritional composition of MS media and the role of hormones in organogenesis with suitable examples. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Illustrate the protocol to develop transgenic crop using agrobacterium mediated gene transfer technique with a neat diagram. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | Explain the steps involved in micropropagation of banana plantlets for commercial production. | CO1 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Evaluate the strategy of development of insect resistance Bt cotton transgenic plant and its significance. | CO3 | E | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe the steps involved in biolistic method of gene transfer in development of transgenic plants. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Summarize the process involved in scale up of animal cell culture. | CO4 | E | 12 |
|  |  |  |  |  |  |
| 23. | a. | Discuss on physicochemical properties of animal cell culture medium. | CO5 | U | 6 |
|  | b. | Explain the process of *In Vitro* fertilization and its importance. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Debate on stem cell technology in the development of transgenic animals and its significance. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge in plant biotechnology and its applications. |
| CO2 | Gain the knowledge about to increase the production in agriculture products. |
| CO3 | Prepare them to work in the Agricultural industries. |
| CO4 | Demonstrate *In vitro* cell culture, fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness |
| CO5 | Development of transgenic animals for breed development for enhanced milk production |
| CO6 | Adapt appropriate ethical guidelines in animal biotechnology |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 12 | 12 | 3 |  |  | 29 |
| CO2 | 1 | 1 | 3 | 12 |  |  | 17 |
| CO3 | 5 |  |  | 12 |  |  | 17 |
| CO4 | 4 | 1 |  |  | 12 |  | 17 |
| CO5 | 13 |  | 3 |  | 12 |  | 28 |
| CO6 |  | 4 |  |  | 12 |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **19BT2042** | **Duration** | **3hrs** |
| **Course Name** | **BIOPHARMACEUTICAL TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define Biopharmaceutical technology. | | CO1 | U | 1 |
| 2. | Infer Bioavailability. | | CO1 | U | 1 |
| 3. | List two features of a capsule. | | CO2 | R | 1 |
| 4. | Recall any method employed in coating of tablets. | | CO2 | R | 1 |
| 5. | What are Parenterals? | | CO3 | R | 1 |
| 6. | List the most common base used in preparation of ointments. | | CO4 | R | 1 |
| 7. | Give an example of a rDNA product approved for pharmaceutical application. | | CO5 | U | 1 |
| 8. | Mention two examples of external antiseptics. | | CO4 | R | 1 |
| 9. | Expand “FDA”. | | CO6 | R | 1 |
| 10. | Name  the country that first marketed Thalidomide. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Discuss various routes of drug administration. | | CO1 | U | 3 |
| 12. | Analyze the role of FDA in Pharmaceutical sector. | | CO6 | An | 3 |
| 13. | Recall the quality control procedures in manufacture of capsules. | | CO2 | U | 3 |
| 14. | What are antacids? | | CO3 | U | 3 |
| 15. | Relate the process of  protective reflex and expulsion process. | | CO4 | An | 3 |
| 16. | Discuss the durability testing carried out for tablets. | | CO3 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. |  | Write a detailed note on Drug metabolism different source of drugs and routes of drug administration. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Briefly explain the basic principles of Pharmacokinetics with suitable example. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Enumerate the manufacturing methods involved in the manufacture of tablets. | CO3 | E | 12 |
|  |  |  |  |  |  |
| 20. |  | Describe the process involved in the preparation of ointment. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe in detail the parameters considered in the formulation of analgesics. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 22. |  | Evaluate the advances made in production of human insulin using rDNA technology. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 23. |  | Illustrate the significance of Clinical Trial regulations and phases involved in release of a Pharmaceutical drug. | CO6 | An | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Evaluate various steps involved in the establishment of Good Laboratory Practices and Good Manufacturing Practices. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Explain about drug development, principles, mechanism of actions of drug. |
| CO2 | Outline on preparation of biotechnology oriented pharmaceutical products. |
| CO3 | Demonstrate various testing and quality assurance of different form of drug preparation. |
| CO4 | Compare the pharmaceutical products available in the market. |
| CO5 | Evaluate the recent advances in drug manufacturing. |
| CO6 | Relate the regulations in clinical trial and management |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 27 |  |  |  |  | 29 |
| CO2 |  | 2 | 3 | 12 |  |  | 17 |
| CO3 | 1 | 15 | 3 |  |  |  | 19 |
| CO4 | 2 |  |  | 15 |  |  | 17 |
| CO5 | 1 |  |  |  | 12 |  | 13 |
| CO6 | 2 | 27 |  |  |  |  | 29 |
|  | | | | | | | **124** |



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| **Course Code** | **19BT2054** | **Duration :** | **3hrs** |
| **Course Name** | **ENVIRONMENTAL BIOTECHNOLOGY** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | List different types of environmental pollution. | CO1 | R | 1 |
| 2. | Name the liquid component of oil spill in oceans due to human activity. | CO1 | R | 1 |
| 3. | Differentiate between point and nonpoint sources of water pollution. | CO1 | An | 1 |
| 4. | Tabulate different layers of atmosphere. | CO1 | R | 1 |
| 5. | Identify the major hydrocarbon present in biogas. | CO2 | R | 1 |
| 6. | Define Lagoons. | CO3 | R | 1 |
| 7. | Mention the full form of CPCB. | CO4 | R | 1 |
| 8. | Write the reason for high adsorption capacity of activated carbon in treating wastewater. | CO6 | C | 1 |
| 9. | Determine the number of bacterial strains present in Oil Zapper. | CO6 | A | 1 |
| 10. | Define biofertilizer. | CO6 | R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Categorize on the nature of different environmental pollutants. | CO1 | An | 3 |
| 12. | Write the technical solutions to prevent water pollution. | CO2 | C | 3 |
| 13. | Summarize the environmental impact of solid wastes. | CO3 | E | 3 |
| 14. | Illustrate the scientific understanding on acid rain. | CO4 | U | 3 |
| 15. | Identify the sources of xenobiotic compounds. | CO5 | R | 3 |
| 16. | Examine the actions of Vesicular Arbuscular Mycorrhiza (VAM). | CO6 | A | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23, Q No. 24 is Compulsory)** | | | | | |
| 17. |  | Discuss the importance of microbes as bioadsorbent for the removal of heavy metal contaminated wastewater. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. | a. | Illustrate the significance of suspended and attached growth biological reactors in wastewater treatment under aerobic conditions | CO2 | An | 4 |
|  | b. | Describe the treatment process and importance of Activated Sludge and Rotating Biological Contractor in wastewater treatment | CO2 | A | 8 |
|  |  |  |  |  |  |
| 19. |  | Recognize the principle and working mechanisms of settling chamber, cyclone separator and venturi scrubber with schematic diagrams. | CO3 | R | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain how microbial populations can be promoted to degrade xenobiotic hydrocarbon and recalcitrant compounds. | CO4 | C | 12 |
|  |  |  |  |  |  |
| 21. |  | Summarize *in situ* and *ex situ* bioremediation of soil pollutants with examples. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain in details on the biological activity of *Bacillus thuringiensis* against the insects. | CO6 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Review on the basic understanding of composting and vermicomposting process for solid waste management. | CO3 | U | 12 |
| **Compulsory Question** | | | | | |
| 24. |  | Illustrate the types of biosensors employed for the monitoring of environmental pollution. | CO6 | A | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Infer the biotechnological solutions to address environmental issues including pollution, mineral,  renewable energy and water recycling |
| CO2 | Appraise the opportunities for incorporating environmental quality into products, processes and  projects. |
| CO3 | Develop technologies for bioremediation and biodegradation |
| CO4 | Acquaint oneself with the pertinent legislation and methodology of pollutants |
| CO5 | Demonstrate the professional responsibility towards protecting the environment |
| CO6 | Apply scientific solutions for the development of environmental sustainable products |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 3 | 12 | - | 4 | - | - | 19 |
| CO2 | 1 | - | 8 | 4 | - | 3 | 16 |
| CO3 | 13 | 12 | - | - | 3 | - | 28 |
| CO4 | 1 | 3 | - | - | - | 12 | 16 |
| CO5 | 3 | - | - | - | 12 | - | 15 |
| CO6 | 1 | 12 | 16 | - | - | 1 | 30 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT1002** | **Duration** | **3hrs** |
| **Course Name** | **BASICS OF PYTHON PROGRAMMING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | | |
| 1. | Identify the expected output of the given pythonic code. | | CO1 | | U | 1 |
| 2. | Find the output of the functions round(2.567) and pow(2, 4). | | CO1 | | R | 1 |
| 3. | Predict the output of the following code. | | CO2 | | U | 1 |
| 4. | Construct the python code to print the following statement.  “New lines are indicated by \n” | | CO1 | | R | 1 |
| 5. | Write the python code to find the length of the element at index 2.  L=['w', 1 , "EXAM", 40, 21.9] | | CO2 | | U | 1 |
| 6. | Indicate the output of the given python snippet. | | CO2 | | U | 1 |
| 7. | Mention the different representations of a one-element tuple. | | CO2 | | R | 1 |
| 8. | Interpret the output of the given program. | | CO2 | | U | 1 |
| 9. | Recognize the output of the given code. | | CO1 | | U | 1 |
| 10. | Mention the special file that must be included in every python package. | | CO5 | | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | | |
| 11. | Interpret the output of the following python code. | | CO1 | | U | 3 |
| 12. | Develop a python code to calculate the length of a string without using a built-in function. | | CO2 | | A | 3 |
| 13. | Illustrate the iteration process over a list using ‘for’ loop and ‘while’ loop. | | CO2 | | U | 3 |
| 14. | Build a program to accept five characters from the user and store it in a tuple ‘T1’. | | CO2 | | U | 3 |
| 15. | Construct the python code that returns absolute value without using abs function. | | CO1 | | A | 3 |
| 16. | Differentiate between python Modules and Packages. | | CO6 | | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | | |
| 17. |  | Discuss about the following operators with suitable examples.   1. Arithmetic operator 2. Logical operator. | CO1 | U | | 12 |
|  |  |  |  |  | |  |
| 18. | a. | “Strings in Python are Immutable”. Explain this statement with suitable example. | CO2 | U | | 6 |
|  | b. | Construct the pythonic code to find the factorial of any number entered through the keyboard. | CO3 | R | | 6 |
|  |  |  |  |  | |  |
| 19. | a. | Assume a List L contains integer temperature (in Celsius) readings. Build a python code to count positive and negative readings in the List L. | CO2 | A | | 6 |
|  | b. | Create a python code to find the length of a list using 2 different ways. | CO1 | A | | 6 |
|  |  |  |  |  | |  |
| 20. | a. | Explain FIVE built-in functions used in tuple with suitable examples. | CO2 | R | | 6 |
|  | b. | Construct a python code to check whether the elements “i” and “h” belongs to the tuple Tuple\_a = (“b”, “i”, “o”, “t”, “e”, “c”, “h” ) and after printing the result, delete the tuple Tuple\_a. | CO2 | A | | 6 |
|  |  |  |  |  | |  |
| 21. |  | Develop a python code to calculate a student's Grade.   |  |  | | --- | --- | | **Average Mark** | **Grade** | | >=90 | O | | 80-89 | A | | 70-79 | B | | 60-69 | C | | 50-59 | D | | <50 | F | | CO4 | A | | 12 |
|  |  |  |  |  | |  |
| 22. |  | Develop a function in python to count the number of lowercase alphabets present in a text file “file.txt” | CO6 | A | | 12 |
|  |  |  |  |  | |  |
| 23. | a. | Compare and Contrast between Break and Continue statement. | CO4 | R | | 4 |
|  | b. | Construct a python code to get a list of numbers from user and print all the values in the list till a number greater than 100 is found. If no such number is found, print all the values. | CO3 | A | | 8 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. |  | What are modules in python? How will you import them? Explain the concept by creating and importing a module in python. | CO6 | | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand, write, compile, and run Python programs. |
| CO2 | Analyze Python structures that implement decisions, loops, and store arrays and use these structures in a well designed, OOP program. |
| CO3 | Create Python programs that make use of various modules and packages |
| CO4 | Understand regular expressions and extract required information from file and databases. |
| CO5 | Relate and arrange information from multiple files |
| CO6 | Apply the principles of object-oriented programming and well-documented programs in the Python language, including use of the Bio-python packages in big data analytics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 | 9 | - | - | - | 28 |
| CO2 | 7 | 16 | 15 | - | - | - | 38 |
| CO3 | 6 | - | 8 | - | - | - | 14 |
| CO4 | 4 | - | 12 | - | - | - | 16 |
| CO5 | 1 | - |  | - | - | - | 1 |
| CO6 | 3 | 12 | 12 | - | - | - | 27 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2003** | **Duration** | **3hrs** |
| **Course Name** | **CELL BIOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **QUESTIONS** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | State Fick’s law of diffusion. | | CO2 | U | 1 |
| 2. | Comment on “The Song of the Cell”. | | CO1 | R | 1 |
| 3. | Define Permeability. | | CO2 | U | 1 |
| 4. | Mention any TWO cell organelles to which the proteins synthesized by free ribosomes are transported. | | CO1 | U | 1 |
| 5. | Name TWO actin-bundling proteins. | | CO3 | R | 1 |
| 6. | Define Codon. | | CO1 | U | 1 |
| 7. | Differentiate between BP180 and BP230. | | CO3 | A | 1 |
| 8. | Rate the importance of fluorochromes. | | CO6 | A | 1 |
| 9. | Distinguish between MPF and CdK. | | CO2 | A | 1 |
| 10. | Name the FOUR phases of cell cycle. | | CO2 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the Questions)** | | | | | |
| 11. | Compare and contrast the assembly of actin and intermediate filaments in the cytoplasm of a cell. | | CO3 | A | 3 |
| 12. | List any SIX functions that are regulated by the binding of signal molecules to cell surface receptors. | | CO4 | U | 3 |
| 13. | Illustrate the organization of microtubules in a motile organelle. | | CO3 | U | 3 |
| 14. | Present an overview of cells by grouping them based on their features and functions. | | CO1 | A | 3 |
| 15. | Highlight the tenets of the classical cell theory. | | CO1 | R | 3 |
| 16. | Enumerate any SIX functions of the lysosomes. | | CO1 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Give an illustrated account of the molecular models of plasma membrane and compile its functions. | CO2 | An | 10 |
|  | b. | Categorize membrane phospholipids. | CO2 | R | 2 |
|  |  |  |  |  |  |
| 18. | a. | Explain apoptosis and trace the sequence of events that determine the fate of a cell. | CO2 | An | 5 |
|  | b. | Present an illustrated account of the types of cell surface receptors adding a note on their significance. | CO4 | An | 7 |
|  |  |  |  |  |  |
| 19. | a. | Demonstrate co-translational and post-translational translocation of proteins into endoplasmic reticulum with illustrations. | CO2 | An | 7 |
|  | b. | Write a short note on the structure and significance of the proteins in extracellular matrix. | CO3 | A | 5 |
|  |  |  |  |  |  |
| 20. | a. | Classify ligands giving examples. | CO4 | A | 7 |
|  | b. | Present the unique features of stem cells and evaluate their potential. | CO5 | An | 5 |
|  |  |  |  |  |  |
| 21. | a. | Describe the regulatory system of cell cycle. | CO2 | An | 6 |
|  | b. | Discuss the process of glycosylation in a cell. | CO2 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Relate the structure of a sarcomere to its function with illustrations. | CO3 | A | 6 |
|  | b. | Interpret the role of second messengers in our sensory system. | CO4 | An | 6 |
|  |  |  |  |  |  |
| 23. | a. | Classify cancer cells and demonstrate their power with an illustration. | CO5 | A | 6 |
|  | b. | Comment on any THREE recent and significant discoveries in Cell Physiology that was recognized for Nobel Prize. | CO6 | E | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the breakthrough in stem cell therapy with case studies. | CO6 | E | 6 |
|  | b. | Describe the working principle of fluorescence and confocal microscopy with illustrations. | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | To develop a sound knowledge base in the molecular organization of cell organelles and analyze their functions. |
| CO2 | To outline the process that regulates membrane transport, controls cell cycle and cell death. |
| CO3 | To correlate cell movement to cytoskeleton, and cell-cell and cell-matrix interactions to communication. |
| CO4 | To apply the role of ligands and receptors in cell signaling and signal transduction. |
| CO5 | To categorize the different types of cancer and apply the principles of stem cell therapy. |
| CO6 | To apply the imaging techniques in cell biology and design characterization of cell organelles. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 7 | 2 | 3 |  |  |  | 12 |
| CO2 | 3 | 2 | 1 | 34 |  |  | 40 |
| CO3 | 1 | 3 | 15 |  |  |  | 19 |
| CO4 |  | 3 | 7 | 13 |  |  | 23 |
| CO5 |  |  | 6 | 5 |  |  | 11 |
| CO6 |  |  | 1 | 6 | 12 |  | 19 |
| **Total** | **11** | **10** | **33** | **58** | **12** |  | **124** |



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| **Course Code** | **20BT2005** | **Duration** | **3hrs** |
| **Course Name** | **BASICS OF INDUSTRIAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q.No** | **Questions** | | **CO** | **BL** | **Mark** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Bioreactor wall should be of  a. reactive and corrosive b. non reactive and non corrosive  c. high surface/ volume ratio d. low surface/ volume ratio | | CO1 | U | 1 |
| 2. | The first vitamin to be produced by the fermentation process  a. Vitamin C b. Vitamin B2 c. Vitamin B12 d. Vitamin D2 | | CO2 | R | 1 |
| 3. | The first penicillin isolated by Alexander Fleming, penicillin F is also called  a. n-heptyl penicillin b. 2-pentenyl penicillin c. Benzyl penicillin  d. Phenoxymethyl penicillin | | CO3 | An | 1 |
| 4. | Pharmacologically active principles in plants are  a. Alkaloids b. Thyroxin c. hCG d. both a & b | | CO4 | A | 1 |
| 5. | Which of the following statement is true about the vaccine development process?  a. A vaccine consists of live germ cells  b. Alum can be used as an adjuvant in a vaccine  c.Animal trials are necessary for vaccines before going to the human trial  d. An effective and safe vaccine production can take up to 100 years | | CO5 | U | 1 |
| 6. | Which of the following are true about biodiesel?  a. Eco-friendly b. Non-renewable c. Decreases engine performance  d. Very high lubricity | | CO6 | R | 1 |
| 7. | Which among the following is referred to as an upstream process?  a. Media formulation b. Product purification c. Product recovery  d. Cell lysis | | CO1 | R | 1 |
| 8. | The alcoholic fermentation is predominantly carried out by the organism  a. Lactobacillus b. S. cerevisiae c. Lactobacillus d. E.coli | | CO2 | R | 1 |
| 9. | Which type of metabolites are antibiotics?  a. Primary metabolites b. Secondary metabolites  c. Tertiary metabolites d. Quaternary metabolites | | CO3 | U | 1 |
| 10. | A genetically engineered microorganism which has found extensive use in bioremediation oil spills is a species of  a. Pseudomonas b. Mucuna c. Trichoderma d. Bacillus | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Illustrate the media design-of-experiments for an industrial bioprocess. | | CO1 | U | 3 |
| 12. | *Aspergillus niger* strain used for citric acid production among other fungal strainsand strain improvement made for the industrial production of citric acid. Justify your response. | | CO2 | An | 3 |
| 13. | Illustrate the production of pharmaceutical grade sodium chloride from rock salt. | | CO3 | U | 3 |
| 14. | Explain the process of cheese ripening. | | CO4 | U | 3 |
| 15. | List the applications of biotechnology. | | CO5 | R | 3 |
| 16. | Describe biorefinery. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. | a. | Compare the traditional and modern biotechnology in terms of reactors/process used. | CO1 | An | 6 |
|  | b. | List the basic steps of upstream processing. | CO1 | R | 6 |
| 18. | a. | Report the production of amino acids. | CO2 | U | 6 |
|  | b. | Recognize the steps in the production of Vitamins. | CO2 | U | 6 |
| 19. | a. | Demonstrate the production of Secondary metabolites. | CO3 | A | 6 |
|  | b. | Illustrate the production of Penicillin. | CO3 | A | 6 |
| 20. | a. | Select the suitable steps employed in the production of Xanthan gum. | CO4 | A | 6 |
|  | b. | Write the stages of Lysozymes production. | CO4 | A | 6 |
| 21. | a. | Employ hybridoma technology for the production of Monoclonal antibodies. | CO5 | A | 8 |
|  | b. | Examine the HAT selection. | CO5 | An | 4 |
| 22. | a. | Interpret the method of biofuel generation from biomass. | CO6 | A | 6 |
|  | b. | Schedule the synthetic seeds production. | CO6 | A | 6 |
| 23. | a. | Compare cultural and biochemical characteristics of various groups of microbes for SCP production. | CO6 | An | 6 |
|  | b. | Illustrate the production of bio-preservative – nisin. | CO4 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the production of streptomycin. | CO3 | U | 6 |
|  | b. | Explain the animal products of industrial applications. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Remember the use of microbes for developing industrial products and processes. |
| CO2 | Understand the techniques for genetic improvement of micro-organisms to improve yield of bio products. |
| CO3 | Explain the technical issues related with micro-organisms and production of bio products. |
| CO4 | Analyze industrial market value of these bio-products and relate them with the scope of biotechnology. |
| CO5 | Relate the clinical and biological significance of these bio products for sustainable bioprocess engineering. |
| CO6 | Evaluate the difference in manufacturing commercial bio products and all the ethical issues involved in it. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 0 | 4 | 0 | 6 | 0 | 0 | 17 |
| CO2 | 2 | 12 | 0 | 3 | 0 | 0 | 17 |
| CO3 | 0 | 10 | 12 | 1 | 0 | 0 | 23 |
| CO4 | 0 | 3 | 19 | 0 | 0 | 0 | 22 |
| CO5 | 3 | 1 | 8 | 4 | 0 | 0 | 16 |
| CO6 | 2 | 9 | 12 | 6 | 0 | 0 | 29 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2007** | **Duration** | **3hrs** |
| **Course Name** | **BIO-ANALYTICAL TECHNIQUES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | State the importance of instrumental calibration. | | CO1 | R | 1 |
| 2. | Recall the concept of accuracy. | | CO1 | R | 1 |
| 3. | State Beer Lambert’s law. | | CO2 | R | 1 |
| 4. | List any two applications of conductivity meter. | | CO2 | A | 1 |
| 5. | What is sedimentation coefficient? | | CO3 | R | 1 |
| 6. | Recall isopycnic point. | | CO3 | R | 1 |
| 7. | What is Rf value? | | CO3 | R | 1 |
| 8. | Name the scientist who developed agarose gel electrophoresis. | | CO4 | R | 1 |
| 9. | Define isotope. | | CO6 | R | 1 |
| 10. | What is chemical ionization? | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Outline the types of errors in instrumental methods. | | CO1 | U | 3 |
| 12. | Illustrate any three applications of Flame photometer. | | CO2 | U | 3 |
| 13. | Recall the principle of differential centrifugation. | | CO3 | R | 3 |
| 14. | Name any three stationary phase materials used in Ion exchange chromatography. | | CO3 | R | 3 |
| 15. | Outline the principle of isoelectric focusing. | | CO4 | U | 3 |
| 16. | Name any three methods of detection of radioactive isotopes. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the working principle, instrumentation and applications of pH meter with a neat diagram. | CO1 | E | 12 |
|  |  |  |  |  |  |
| 18. |  | Illustrate the protocols involved in extraction of secondary metabolites of medicinal plants using Soxhlet apparatus. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | State the principle of spectroscopy. | CO2 | R | 2 |
|  | b. | Outline the instrumentation and application of UV-visible spectrophotometer. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 20. | a. | What is sedimentation coefficient? | CO3 | R | 2 |
|  | b. | Illustrate the instrumentation and working principle of analytical ultracentrifugation. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 21. | a. | Write the principle of chromatography. | CO3 | R | 2 |
|  | b. | Explain the process of separation and purification of compounds using HPLC. | CO3 | E | 10 |
|  |  |  |  |  |  |
| 22. | a. | Define electrophoresis. | CO4 | R | 2 |
|  | b. | Illustrate the process of separation and size determination of proteins using SDS-PAGE. | CO4 | U | 10 |
|  |  |  |  |  |  |
| 23. | a. | Explain the working procedure in determination of thermogravimetry analysis. | CO4 | E | 6 |
|  | b. | Illustrate the principle of detection of radioactive isotopes using GM counter with a neat flow diagram. | CO6 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the working principle and instrumentation of Nuclear Magnetic Resonance with a neat diagram. | CO5 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the concepts of calibration and testing. |
| CO2 | Illustrate the different methods of analytical techniques for quantitative analysis. |
| CO3 | Explain importance of centrifugation and chromatography as analytical techniques. |
| CO4 | Demonstrate the gel electrophoresis and thermal analytical techniques. |
| CO5 | Analyze the methods of structural elucidation of different compounds. |
| CO6 | Illustrate importance of radioactive isotopes in modern research. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 |  |  | 12 |  | 29 |
| CO2 | 3 | 13 |  | 1 |  |  | 17 |
| CO3 | 13 | 10 |  |  | 10 |  | 33 |
| CO4 | 3 | 13 |  |  | 6 |  | 22 |
| CO5 | 1 |  |  |  | 12 |  | 13 |
| CO6 | 4 | 6 |  |  |  |  | 10 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2009** | **Duration :** | **3hrs** |
| **Course Name** | **BIOCHEMISTRY** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | Name the enzyme responsible for interconversion of Dihydroxyacetone phosphate and Glyceraldehyde-3-phosphate. | CO1 | R | 1 |
| 2. | Determine the number of ATP synthesized from 1 mole of glucose in aerobic condition during glycolysis and TCA cycle. | CO1 | A | 1 |
| 3. | Identify the amino acid not possessing the property of optical isomerism. | CO2 | R | 1 |
| 4. | Write the example for indole containing aromatic amino acid. | CO2 | A | 1 |
| 5. | Name the protein complex in ETC which uses proton gradient to drive ATP synthesis. | CO3 | R | 1 |
| 6. | State the name of electron carrier which transports the electrons to complex IV from complex III in ETC. | CO3 | R | 1 |
| 7. | Recall the source of C6 in the structure of purine nucleus. | CO4 | R | 1 |
| 8. | Name the source of N3 in the structure of pyrimidine nucleus. | CO4 | R | 1 |
| 9. | Identify the amino acid responsible for Hartnup’s disease. | CO5 | R | 1 |
| 10. | Define saponification number. | CO6 | R | 1 |

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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | Write the importance of oxidative decarboxylation in TCA cycle. | CO1 | A | 3 |
| 12. | Categorize between acidic and basic amino acids. | CO2 | An | 3 |
| 13. | Mention three different sources of phosphorus in energy conservation process. | CO3 | An | 3 |
| 14. | Write the steps involved in ketogenesis. | CO1 | A | 3 |
| 15. | Mention the name of defective enzymes and characteristics/symptoms for Tarui’s disease and Lesch- Nyhan syndrome. | CO5 | An | 3 |
| 16. | Explain the detailed structure of cholesterol. | CO6 | U | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Explain the metabolic pathways for the conversion of glucose into pyruvate and lactate through the process of glycolysis. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. |  | Write a detailed note on Urea cycle. | CO2 | C | 12 |
|  |  |  |  |  |  |
| 19. |  | Discuss the importance of different complexes in ETC for the generation of ATP. | CO3 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | Describe the metabolic pathways in purine biosynthesis. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Enlist the inborn errors mentioning the name of defective enzyme and symptoms of amino acids and nucleotide metabolisms. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Explain the metabolic pathways involved in glycogenesis and glycogenolysis. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Summarize in detail on β-oxidation of fatty acids. | CO6 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss the steps involved in the synthesis of fatty acids. | CO6 | U | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge on the metabolic pathways. |
| CO2 | Summarize the biosynthesis and degradation pathways of amino acids. |
| CO3 | Explain the importance of bioenergetics and energy rich compounds. |
| CO4 | Understand the metabolic reactions of nucleotides. |
| CO5 | Learn the various inborn errors of metabolism. |
| CO6 | Analyze the anabolic and catabolic reactions of lipids. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 12 | 7 | 12 | - | - | 32 |
| CO2 | 1 | - | 1 | 3 | - | 12 | 17 |
| CO3 | 2 | 12 | - | 3 | - | - | 17 |
| CO4 | 2 | 12 | - | - | - | - | 14 |
| CO5 | 13 | - | - | 3 | - | - | 16 |
| CO6 | 1 | 15 | - | - | 12 | - | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2011** | **Duration** | **3hrs** |
| **Course Name** | **MICROBIOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Indicate the importance of agar-agar. | | CO1 | U | 1 |
| 2. | Recall the contributions made by Anton Von Leuwenhoek. | | CO1 | R | 1 |
| 3. | List the examples for a capsulated microorganisms. | | CO2 | R | 1 |
| 4. | Draw the structure of Rhizopus stolonifer. | | CO2 | R | 1 |
| 5. | State the principle of acid fast staining. | | CO3 | U | 1 |
| 6. | Define Binomial Classification. | | CO3 | R | 1 |
| 7. | State the reasons for controlling microorganisms. | | CO4 | U | 1 |
| 8. | List the properties of antimicrobial drug. | | CO4 | R | 1 |
| 9. | Compare autotroph and heterotroph. | | CO5 | U | 1 |
| 10. | Cite the importance of Mycorrhizae in agriculture. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Critically analyze the contributions made by Robert Koch. | | CO1 | An | 3 |
| 12. | Illustrate the multiplication of bacteria with a neat schematic representation. | | CO2 | U | 3 |
| 13. | Appraise the principle of spore staining. | | CO3 | An | 3 |
| 14. | Explain the importance of UV radiation in microbiology laboratory. | | CO4 | U | 3 |
| 15. | Distinguish between chemoorganotrophs and chemolithotrophs. | | CO5 | An | 3 |
| 16. | Illustrate the beneficial role of microorganisms in agriculture. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Trace the events that lead to the discredition of spontaneous generation theory. | CO1 | U | 8 |
|  | b. | Discuss Germ theory of disease with suitable examples. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Explain lytic and lysogeny cycle of bacteriophages with a neat illustrations. | CO2 | U | 8 |
|  | b. | Summarize the biological importance of lichens. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Apply the principle of gram staining to classify bacteria based on their cell wall characteristics. | CO3 | A | 8 |
|  | b. | Articulate the principle of fluorescent microscopy with a neat diagram. | CO3 | A | 4 |
|  |  |  |  |  |  |
| 20. | a. | Describe the principle, working and use of autoclave. | CO4 | U | 8 |
|  | b. | Explain the importance of phenol and alcohol in microbial growth. | CO4 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Classify microorganisms based on nutritional requirements with examples. | CO5 | An | 6 |
|  | b. | Explain how will you obtain a synchronous culture and mention its uses with a neat diagram. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 22. | a. | Discuss the MPN technique for the evaluation of potable water. | CO6 | E | 8 |
|  | b. | Summarize the significance of symbiotic nitrogen fixing bacteria in soil with suitable example. | CO6 | E | 4 |
|  |  |  |  |  |  |
| 23. | a. | Discuss the pathogenicity of Herpse Simplex Virus. | CO6 | U | 6 |
|  | b. | Explain the clinical manifestations of *Candida albicans.* | CO6 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Describe the steps involved in the production of sauerkraut. | CO6 | C | 8 |
|  | b. | Discuss the health benefits of consuming probiotics with suitable examples. | CO6 | C | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the basic knowledge on the development of microbiology. |
| CO2 | Recognize the fundamental concepts pertaining to the structure and functions of microbes. |
| CO3 | Appraise the importance of microscopy, staining techniques and classify the microorganisms. |
| CO4 | Apply appropriate physical and chemical methods to control the growth of microbes. |
| CO5 | Formulate the nutritional requirements for microbial growth and their metabolism. |
| CO6 | Compare and categorize the interactions of microorganisms with humans and animals. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 13 |  | 3 |  |  | 17 |
| CO2 | 2 | 12 |  | 3 |  |  | 17 |
| CO3 | 1 | 1 | 12 | 3 |  |  | 17 |
| CO4 | 1 | 16 |  |  |  |  | 17 |
| CO5 |  | 1 |  | 15 |  |  | 16 |
| CO6 |  | 16 |  |  | 12 | 12 | 40 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2013** | **Duration** | **3hrs** |
| **Course Name** | **FLUID MECHANICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Identify the SI unit of surface tension for a Newtonian fluid. | | CO1 | R | 1 |
| 2. | Define the energy head of a fluid flowing through a pipe | | CO3 | R | 1 |
| 3. | Identify the assumptions made while adopting a venturi meter as flow measuring device. | | CO2 | U | 1 |
| 4. | Choose the position where one would expect higher flow velocity (i) the centre of the pipe, (ii) adjacent to the wall of the pipe | | CO1 | A | 1 |
| 5. | Identify a different kind of minor losses one would expect in a pipe connecting two reservoirs. | | CO4 | R | 1 |
| 6. | Name a simple fluid flow measuring device even used in aircraft fuselage | | CO4 | R | 1 |
| 7. | Head loss due to sudden expansion in a section is 10 cm. Analyze whether the head loss will remain the same if we reverse the flow direction, keeping the discharge rate the same. | | CO5 | An | 1 |
| 8. | Highlight the most significant benefit of using a single-column manometer. | | CO1 | R | 1 |
| 9. | Differentiate weir and notch on their structural aspect | | CO5 | U | 1 |
| 10. | Name a dimensionless number relevant to fluid flow. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Estimate the change in velocity head if the diameter of the pipe is slowly increased from 5 cm to 10 cm. Ignore any energy losses. | | CO1 | E | 3 |
| 12. | A mercury manometer connected to two pipes carrying water is replaced with a different fluid of sp. gravity 5. Estimate new manometric reading, if the original mercury manometric reading had been 10 cm. | | CO2 | E | 3 |
| 13. | Develop the expression of discharge rate through a pipe when a pitot tube is connected as a flow measuring device. | | CO3 | A | 3 |
| 14. | Venturimeter connected to a pipe carrying water (2 m3/s) shows a manometer reading of 10 cm. Calculate the new flow rate, if the manometric reading changes to 20 cm. | | CO3 | E | 3 |
| 15. | Estimate the relative change in major head loss if both the length and diameter of a pipe are doubled while keeping the discharge rate constant | | CO5 | E | 3 |
| 16. | Test that pressure heads and velocity heads are dimensionally equivalent. | | CO6 | An | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | A cylindrical needle of mass 10 g and 5 cm long is resting over a liquid surface with 60° depression of liquid surface (see cross sectional view). Estimate the surface tension of the liquid. | CO1 | E | 6 |
|  | b. | Dynamic viscosity of an oil used to lubricate between a shaft and sleeve is 6 poise. The shaft is of diameter 0.2 m, and rotates at 200 rpm. Calculate the shear stress on the shaft for a sleeve length of 2 cm, and oil film thickness of 2 mm. | CO1 | E | 6 |
|  |  |  |  |  |  |
| 18. |  | The right limb of a simple U-tube mercury manometer is open to atmosphere, while left limb is connected to a pipe carrying oil of specific gravity of 0.7. The center of the pipe is 10 cm below the level of mercury in right limb. If mercury level difference is 20 cm, calculate the pressure of fluid in pipe. | CO1 | E | 12 |
|  |  |  |  |  |  |
| 19. |  | A 30 cm × 15 cm venturimeter is inserted in a pipe carrying oil of sp. gravity 0.9 in upward direction. Calculate the flowrate of oil, if the manometric reading connected to inlet and throat is 30 cm, and their elevation difference is 50 cm. Assume Cd of 0.9. | CO2 | E | 12 |
|  |  |  |  |  |  |
| 20. | a. | The head of water over an orifice of diameter 2 cm is 40 m. Find actual discharge and actual velocity at *vena-contracta*, if C*d* = 0.6 and C*v* = 0.9. | CO2 | E | 6 |
|  | b. | Determine the height of rectangular weir of length of 5 m to be built across a rectangular channel. Maximum depth of water is 4 m upstream of the weir, and discharge is 2000 L/s. Assume C*d* = 0.6. | CO2 | E | 6 |
|  |  |  |  |  |  |
| 21. | a. | Calculate discharge through a pipe of diameter 20 cm, when pressure head difference between two points at 200 m apart are 4 m of water. Assume, Darcey’s friction factor as 0.01. | CO3 | E | 6 |
|  | b. | Determine the difference in elevation between two water surfaces in two tanks connected by a 30 cm diameter 400 m long pipe. The rate of flow is 300 L/s and *f*=0.01. Consider all losses, i.e., friction, entrance, exit loss. | CO3 | E | 6 |
|  |  |  |  |  |  |
| 22. |  | The rate of water flow through a horizontal pipe is 0.25 m3/s. The diameter is suddenly enlarged from 20 cm to 40 cm. Calculate (i) the head loss, and (ii) pressure intensity at larger diameter pipe, if pressure at smaller diameter section is 10 N/cm2. | CO4 | E | 12 |
|  |  |  |  |  |  |
| 23. |  | A syphon of diameter 20 cm connects two reservoirs having difference in elevation of 20 m. Calculate the discharge rate if the length of pipe from upper reservoir to summit is 80 m, and total length is 400 m. Given the summit is 4 m above water level in upper reservoir, and *f*= 0.005. | CO5 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Explain the approach adopted in Rayleigh’s method for dimension analysis and its limitations. | CO6 | An | 6 |
|  | b. | Drag force on a particle is known to be a function of diameter, velocity of the particle, and density viscosity of the fluid. Formulate a dimensionally consistent expression for the same. | CO6 | C | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the nature of fluids, statics and dynamics of fluid flow. |
| CO2 | Summarize the principles for flow in transportation of fluids in the problems related to the process engineering. |
| CO3 | Relate flow through pipe and flow past immersed object. |
| CO4 | Analyze the equations of fluid flow. |
| CO5 | Evaluate principles of fluid flow phenomena in scale up. |
| CO6 | Create empirical relations using dimensional analysis to understand fluid flow phenomena. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 0 | 1 | 0 | 27 | 0 | 30 |
| CO2 | 0 | 1 | 0 | 0 | 27 | 0 | 28 |
| CO3 | 1 | 0 | 3 | 0 | 15 | 0 | 19 |
| CO4 | 2 | 0 | 0 | 0 | 12 | 0 | 14 |
| CO5 | 0 | 1 | 0 | 1 | 15 | 0 | 17 |
| CO6 | 1 | 0 | 0 | 9 | 0 | 6 | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2015** | **Duration** | **3hrs** |
| **Course Name** | **BIOPROCESS PRINCIPLES** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define containment. | | CO1 | R | 1 |
| 2. | State the role of a baffle in a fermentor. | | CO5 | R | 1 |
| 3. | Recall any two examples for chelators. | | CO2 | R | 1 |
| 4. | Appraise the number of experiment to be performed for optimizing carbon, vitamin and nitrogen of 3 concentrations each using classical method. | | CO2 | E | 1 |
| 5. | Relate any two criteria for good medium. | | CO2 | A | 1 |
| 6. | The initial no. of microbes before sterilization is 5x1018. Estimate del factor. | | CO3 | An | 1 |
| 7. | The del factor for heating, overall and cooling was found to be 1.2, 28 and 1.7 respectively. Calculate del holding. | | CO3 | An | 1 |
| 8. | Identify a method by which medium with more amount of heat liable compounds are sterilized. | | CO6 | R | 1 |
| 9. | Assess X90  concept in filtration. | | CO6 | E | 1 |
| 10. | Quote the principle of lyophilization. | | CO4 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | What are risk factors that have to be assessed before applying containment levels? | | CO1 | U | 3 |
| 12. | Classify the sensors based on its applications in process control. | | CO5 | U | 3 |
| 13. | Devise some precautionary measures to increase secondary metabolite production. | | CO2 | C | 3 |
| 14. | The summation of H and L values for dummy variable 1 is 1.5 and 0.7, for dummy variable 2 is 1.5 and 0.3 respectively. Calculate experimental error for 5 actual variables. | | CO2 | E | 3 |
| 15. | 2 litres of medium is taken for sterilization. The Del factor for heating and cooling is 1.12 and 1.3 respectively. The initial no. of microbes before sterilization is 2.7x1016org/ml.Enumerate holding time if k is 2.5 min-1 | | CO3 | E | 3 |
| 16. | Appraise the method of isolating a microbe based on its desired characteristics. | | CO4 | E | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Elaborate on five groups of commercially important fermentation process and add a note on five overlapping stages in the development of fermentation industry. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | With a neat sketch explain in detail about the overview of fermentation process and various parameters to be monitored and controlled during fermentation process. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Illustrate on the process of medium formulation for industrial scale fermentation process. Add a note on the factors influence the oxygen requirement in a fermentation process. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 20. |  | For the following data calculate the difference, average difference, mean square, experimental error and factors showing larger effect.   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | **Trial No.** | **Car** | **Pre** | **Vit** | **Min** | **Ind** | **Dum** | **Nit** | | 1 | 2.1 | 1.5 | 0.7 | 0.1 | 1.2 | 1.1 | 4.1 | | 2 | 1.2 | 1.1 | 1.1 | 0.3 | 0.2 | 0.1 | 3.2 | | 3 | 2.3 | 1.0 | 0.2 | 0.2 | 2.3 | 0.1 | 2.4 | | 4 | 1.4 | 0.6 | 0.5 | 0.5 | 0.4 | 0.5 | 2.6 | | 5 | 1.1 | 0.8 | 0.6 | 0.2 | 1.5 | 0.3 | 2.2 | | 6 | 2.2 | 1.2 | 0.3 | 0.2 | 0.2 | 1.1 | 1.4 | | 7 | 1.3 | 1.1 | 0.5 | 0.3 | 0.4 | 0.2 | 1.5 | | 8 | 1.3 | 1.3 | 1.1 | 0.3 | 0.7 | 0.1 | 1.2 | | CO2 | E | 12 |
|  |  |  |  |  |  |
| 21. |  | A fermentation process requires 7.7 liters batch of complex medium to be steam sterilized at 121 °C. Assuming that the medium before sterilization contains l06 bacterial spores of *Bacillus stearothermophilus* per ml and the probability of non-sterility after sterilization is 1 in 1000, Determine the holding time at 121°C and ▼holding. The time of heating from 100°C to 121°C is 9 min and the time of cooling from 121°C to 100°C is 11 min. Assume that the spore death below 100°C is insignificant. And the value of ▼table=12.549, K= 2.5min-1. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Air is sterilized through a depth filter and is sent at an flow rate of 15 m3/sec for an fermentation process for 8 hours with an linear velocity of 0.47m/s. the value of the rate constant is 2.7 cm-1 Calculate 1. Initial number of microorganism present in air. 2. Radius of the filter 3. Length of the filter 4. Cross sectional area of filter 5. X90 6. Efficiency of filtration. | CO6 | E | 12 |
|  |  |  |  |  |  |
| 23. |  | Interpret and analyze various steps in isolating industrially important microorganisms based on its desired characteristics. | CO4 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain in detail various preservation techniques followed to store isolated industrially important microbes and assess the process of quality control of preserved stock cultures. | CO4 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the process of fermentation and its requirements. |
| CO2 | Remember the process of media formulation and medium optimization for fermentation process. |
| CO3 | Analyze the kinetics of sterilization process. |
| CO4 | Apply knowledge on isolation and storage of industrially important microbes. |
| CO5 | Analyze parameters to control during fermentation process. |
| CO6 | Evaluate the process of sterilization by filtration. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 15 | - | - | - | - | 16 |
| CO2 | 1 | 12 | 1 | - | 16 | 3 | 33 |
| CO3 | - | - | - | 14 | 3 | - | 17 |
| CO4 | 1 | 12 | - | 12 | 3 | - | 28 |
| CO5 | 1 | 15 | - | - | - | - | 16 |
| CO6 | 1 | - | - | - | 13 | - | 14 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2017** | **Duration** | **3hrs** |
| **Course Name** | **MOLECULAR BIOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Specialized transduction is carried out by \_\_\_\_\_\_\_\_\_ phase of Phage.­­­­­ | | CO1 | U | 1 |
| 2. | State whether prokaryotic or eukaryotic genome has nucleosome. | | CO1 | R | 1 |
| 3. | How many types of DNA polymerases are there in E.coli? | | CO2 | R | 1 |
| 4. | Write the nucleotide sequence of Pribnow box. | | CO2 | R | 1 |
| 5. | Cite a common physical agent that causes thymine dimerization. | | CO3 | U | 1 |
| 6. | Name one inhibitor of eukaryotic translation. | | CO3 | R | 1 |
| 7. | Compare origin of replication between prokaryotes and eukaryotes. | | CO4 | U | 1 |
| 8. | Recall and write the site of mRNA transcription in eukaryotic cells. | | CO4 | R | 1 |
| 9. | Cite the organell where the eukaryotic N-glycosylation takes place. | | CO5 | U | 1 |
| 10. | Relate the high glucose condition with lac operon expression. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Analyze the genome organization of prokaryotes. | | CO1 | An | 3 |
| 12. | Relate TFIID, TFIIE and TFIIH with eukaryotic mRNA transcription. | | CO2 | U | 3 |
| 13. | Classify the common mutations that happens during replication. | | CO3 | An | 3 |
| 14. | Illustrate the role of telomerase in eukaryotic replication. | | CO4 | U | 3 |
| 15. | Analyze how the protein is targeted to different sites in prokaryotes. | | CO5 | An | 3 |
| 16. | Justify the universality of genetic code with an example. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Illustrate the genome organization of eukaryotes and comment on H DNA. | CO1 | An | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain the process of prokaryotic replication and its regulation. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Analyze the various mismatch repair systems of prokaryotes. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Compare and contrast the translation initiation between prokaryotes and eukaryotes. | CO4 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Discuss about the post transcriptional processing of mRNA. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Describe the process of transcription in prokaryotes. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 23. |  | Appraise the salient features of genetic code. | CO6 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Illustrate the gene expression regulation of *trp* operon. | CO6 | An | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the fundamental concepts of the prokaryotic and eukaryotic genome organization, its replication and gene expression. |
| CO2 | Understand the process of replication, transcription and translation. |
| CO3 | Recognize common mutations, their natural repair systems and inhibitors of gene expression. |
| CO4 | Distinguish the process of replication, transcription and translation of prokaryotes and eukaryotes. |
| CO5 | Appraise the post-synthesis modifications for transcription and translation. |
| CO6 | Comprehend the role of genetic code, chromatin, operons and cis/trans elements in gene regulation. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 1 |  | 15 |  |  | 17 |
| CO2 | 14 | 15 |  |  |  |  | 29 |
| CO3 | 1 | 1 |  | 15 |  |  | 17 |
| CO4 | 1 | 16 |  |  |  |  | 17 |
| CO5 | 1 | 15 |  |  |  |  | 16 |
| CO6 | 4 | 12 |  |  | 12 |  | 28 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2018** | **Duration** | **3hrs** |
| **Course Name** | **GENETIC ENGINEERING** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **QN** | **Questions** | | **CO** | **B** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Ligase can bind \_\_\_\_\_\_\_\_.   1. Sticky ends of two nucleic acid molecules. 2. Blend ends of two nucleic acid molecules. 3. Both Sticky & Blend ends of two nucleic acid molecules. 4. Blend ends of one nucleic acid molecule with another protein molecule. | | CO1 | U | 1 |
| 2. | When we use pBR322 for cloning we have to select host as   1. *E. coli* with amps & tets 2. *Saccharomyces cerevisiae* with ampr & tetr 3. *E. coli* with amps & tetr 4. *Saccharomyces cerevisiae* with amps & tetr | | CO2 | R | 1 |
| 3. | A molecular technique in which DNA sequences between two oligonucleotide primers can be amplified is known as   1. southern blotting. 2. northern blotting. 3. polymerase chain reaction. 4. DNA replication. | | CO3 | R | 1 |
| 4. | Which of the following refers to transfection   1. Synthesis of mRNA from DNA template. 2. Synthesis of protein based on mRNA sequence. 3. Introduction of foreign gene in to a cell. 4. The process by which a cell become malignant. | | CO4 | A | 1 |
| 5. | A genomic library is a   1. collection of many clones possessing different DNA fragments from the same organisms bound to vectors. 2. book that describes how to isolate DNA from a particular organism. 3. place where the information of the genetic organization of organisms are kept. 4. database where the sequence of an organism's genome is stored. | | CO5 | U | 1 |
| 6. | Which of the following standards are required to evaluate the morality of all human activities?   1. Pathological. 2. Social. 3. Ethical. 4. Psychological. | | CO6 | A | 1 |
| 7. | Exonucleases can   1. Hydrolyzes internal phosphor-di-ester linkages of a nucleic acid molecule. 2. Cleaves the nucleotide molecule at the periphery of a nucleic acid molecule. 3. Hydrolyzes external phosphor-di-ester linkages of a nucleic acid molecule. 4. Cleaves the nucleotide molecule at the interior of a nucleic acid molecule. | | CO1 | U | 1 |
| 8. | Which of the following viruses are used as vectors for transferring genes to animal cells?   1. SV 40 virus. 2. Bovine papilloma virus (BVP). 3. Prions. 4. both a & b are correct. | | CO2 | R | 1 |
| 9. | The Southern blotting technique depends on   1. similarities between the sequences of probe DNA and experimental DNA. 2. similarities between the sequences of probe RNA and experimental RNA. 3. similarities between the sequences of probe protein and experimental protein. 4. the molecular mass of proteins. | | CO3 | U | 1 |
| 10. | In automated DNA sequencing   1. Radio labelled dNTPs are used. 2. Radio labelled ddNTPs are used. 3. fluorescently labelled dNTPs are used. 4. fluorescently labelled ddNTPs are used. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Classify restriction endonucleases. | | CO1 | U | 3 |
| 12. | State the nomenclature and construction of plasmid cloning vector - pBR322. | | CO2 | R | 3 |
| 13. | Illustrate autoradiography. | | CO3 | A | 3 |
| 14. | Examine the preparation of competent cell. | | CO4 | An | 3 |
| 15. | Employ the techniques used for DNA finger printing. | | CO5 | A | 3 |
| 16. | Report the societal issues related with rDNA technology. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. | a. | Examine the role of endonucleases in rDNA technology. | CO1 | An | 7 |
|  | b. | Illustrate homopolymer tailing. | CO1 | A | 5 |
| 18. | a. | Employ cosmid vectors in rDNA technology. | CO2 | A | 7 |
|  | b. | Sketch YAC. | CO2 | A | 5 |
| 19. | a. | Report the mechanism of PCR. | CO3 | U | 6 |
|  | b. | Examine the technique used to analyse and confirm the transformation of rDNA in the host cell. | CO3 | An | 6 |
| 20. | a. | Appraise the chemical method of transformation. | CO4 | An | 7 |
|  | b. | Examine the role of replica plating technique in screening transformed cells. | CO4 | An | 5 |
| 21. | a. | Explain chromosome walking. | CO5 | U | 6 |
|  | b. | Describe the steps involved in the development of genomic library. | CO5 | U | 6 |
| 22. | a. | Discuss the methods to produce transgenic plants. | CO6 | U | 7 |
|  | b. | List the major ethical issues related with genetically modified crops and genetic engineering. | CO6 | R | 5 |
| 23. | a. | Report Expression vectors. | CO2 | U | 6 |
|  | b. | Employ Inverse PCR. | CO3 | A | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Demonstrate RFLP. | CO3 | A | 7 |
|  | b. | Discriminate between pBR322 and pUC18. | CO2 | An | 5 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the basics of genetic engineering. |
| CO2 | Understand the basic tools employed in genetic engineering. |
| CO3 | Relate and evaluate the use of cloning vectors in genetic engineering. |
| CO4 | Comprehend the concept of polymerase chain reaction and its applications. |
| CO5 | Discuss and appraise the strategy and applications of gene cloning. |
| CO6 | Analyze the importance of transgenesis in biotechnological research. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 0 | 5 | 5 | 7 | 0 | 0 | 17 |
| CO2 | 5 | 6 | 12 | 0 | 0 | 0 | 23 |
| CO3 | 1 | 7 | 16 | 6 | 0 | 0 | 30 |
| CO4 | 0 | 0 | 1 | 15 | 0 | 0 | 16 |
| CO5 | 1 | 13 | 3 | 5 | 0 | 0 | 22 |
| CO6 | 5 | 10 | 1 | 0 | 0 | 0 | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2020** | **Duration** | **3hrs** |
| **Course Name** | **BIOPROCESS ENGINEERING** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Recall the SI unit for specific growth rate of a microbial culture | | CO3 | R | 1 |
| 2. | Define steady-state conditions in a chemostat used to grow microbial culture. | | CO5 | R | 1 |
| 3. | Estimate the degree of reduction for a microbial culture with empirical formulae CH2N0.25O0.5. | | CO2 | An | 1 |
| 4. | Indicate if the volumetric oxygen mass transfer coefficient depends on oxygen solubility. | | CO4 | R | 1 |
| 5. | Determine the conditions when the specific growth rate of microbial culture would be maximum in a batch study. | | CO3 | A | 1 |
| 6. | Name one immobilized bioreactor system adopted in bioprocess | | CO6 | R | 1 |
| 7. | Describe the significance of the dilution rate in CSTR operation | | CO5 | U | 1 |
| 8. | Label the appropriate unit for maintenance coefficient in microbial culture | | CO4 | R | 1 |
| 9. | State one limitation in the use of DO probe while measuring kLa in an agitated reactor system | | CO4 | U | 1 |
| 10. | Examine the maximum number of substrates and products that can be mapped using the elemental balance approach, assuming four elements, *i.e.*, C, N, O, H. | | CO3 | A | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | A typical fermentation process starts from an initial biomass and substrate concentration of 0.5 g/l, and 10 g/l, respectively. After 12 h, the biomass concentration increases to 4 g/l, and the substrate concentration drops to 2 g/l. Calculate the apparent growth yield coefficient. If the product yield coefficient is 0.25 g/g, also calculate final product concentration. | | CO3 | A | 3 |
| 12. | Describe the basic methodology involved in the measurement of the volumetric oxygen transfer coefficient using sulphate oxidation technique. Identify the specific advantage of the method. | | CO4 | U | 3 |
| 13. | Explain the isolation method utilizing the selection of desired characteristics | | CO1 | An | 3 |
| 14. | One microorganism is growing in a chemostat fed with 20 g/L of glucose. If μmax is 0.5/h and *k*s equals 15 g/L, estimate the maximum dilution rate permissible before the washout condition. | | CO5 | An | 3 |
| 15. | Explain the utility of fed-batch operation in bioprocess and write the mass balance equation relevant to the system. | | CO5 | An | 3 |
| 16. | Examine the mathematical expression for logistic growth and explain the term referred to as carrying capacity. | | CO2 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No 17 to 23, Q. No 24 is Compulsory)** | | | | | |
| 17. | a. | Examine the different screening methods available for industrially relevant microorganisms. | CO1 | A | 6 |
|  | b. | List the different methods available for the storage of industrially important microorganisms | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. |  | An aerobic culture growing on methanol has the following time profile for biomass (X) and substrate concentration (S). Evaluate maximum specific growth rate, biomass yield on the substrate, and saturation constant.   |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | *t* | 0 | 2 | 4 | 8 | 10 | 12 | 14 | 16 | 18 | | *X* | 0.2 | 0.211 | 0.305 | 0.98 | 1.77 | 3.2 | 5.6 | 6.15 | 6.2 | | *S* | 9.23 | 9.21 | 9.07 | 8.03 | 6.8 | 4.6 | 0.92 | 0.077 | 0 |   Time in hour, biomass and substrate concentrations in (g/L) | CO2 | E | 12 |
|  |  |  |  |  |  |
| 19. | a. | Examine the different alternative expressions for Monod’s growth model. Illustrate the kinetic expressions for substrate consumption, product formation, and assuming maintenance requirements. Explain each relevant term in the kinetics. | CO2 | A | 8 |
|  | b. | Differentiate between apparent yield and true yield coefficients for biomass on a substrate. Explain your view using an appropriate example, if any. | CO2 | An | 4 |
|  |  |  |  |  |  |
| 20. |  | Aerobic degradation of benzoic acid by a mixed culture can be represented by  C6H5COOH + *a* O2 + *b* NH3🡪*c* C5H7NO2 + *d* H2O + *e* CO2  Determine *a*, *b*, *c*, *d*, and *e* if RQ = 0.9  Determine the biomass yield coefficient on the substrate. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 21. | a. | Illustrate the relationship between the specific rate of oxygen consumption by cells and dissolved-oxygen concentration | CO4 | A | 4 |
|  | b. | Establish the mathematical relationship to measure *k*L*a* under the unsteady-state dynamic method. | CO4 | A | 8 |
|  |  |  |  |  |  |
| 22. |  | A bacterial culture grows in a 5 L bioreactor and the growth kinetics is established as  where S is substrate concentration in g/L; μ, specific growth rate (/h), *μ*max is 2/h, *k*s = 12 g/L. The feed flow rate is 0.5 L/h, feed substrate concentration (S0) is 50 g/L, and biomass yield coefficient (YX/S) is 0.6.  Calculate substrate and cell concentration in the reactor under steady-state conditions. Also, calculate the biomass productivity of the system. | CO5 | An | 12 |
|  |  |  |  |  |  |
| 23. | a. | Appraise the empirical relationships between volumetric oxygen transfer and power consumption in a bioreactor system. Also, examine the relationship between the power number and Reynolds number based on the viscous and turbulent flow regime. | CO4 | An | 8 |
|  | b. | Examine the relationship between agitation speed and volume when scaling up a reactor while maintaining the same power input per unit volume, in the turbulent region. | CO4 | A | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Summarize the different enzyme immobilization techniques adopted in the packed-bed reaction system | CO6 | E | 6 |
|  | b. | Explain the mass transfer process of a substrate from the bulk fluid  to surface of biocatalyst using the “effectiveness” factor | CO6 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand various methods of isolation and preservation of Industrially important microbes. |
| CO2 | Remember principles of stoichiometry and concepts of bioreactor engineering. |
| CO3 | Understand kinetic models of growth and product formation. |
| CO4 | Apply methods to calculate volumetric mass transfer coefficients in bioreactors. |
| CO5 | Analyze various bioreactors for fermentation process. |
| CO6 | Evaluate application of various reactors in fermentation processes. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 0 | 6 | 6 | 3 | 0 | 0 | 15 |
| CO2 | 0 | 0 | 11 | 5 | 12 | 0 | 28 |
| CO3 | 1 | 0 | 17 | 0 | 0 | 0 | 18 |
| CO4 | 2 | 4 | 16 | 8 | 0 | 0 | 30 |
| CO5 | 1 | 1 | 0 | 18 | 0 | 0 | 20 |
| CO6 | 1 | 0 | 0 | 6 | 6 | 0 | 13 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2021** | **Duration** | **3hrs** |
| **Course Name** | **ENZYME ENGINEERING AND TECHNOLOGY** | **Max. Marks** | **100** |

**Note:** Students **may use Cartesian graph paper** for solving numerical problems

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Name the protein part of the enzyme. | | CO1 | R | 1 |
| 2. | Infer the best model that describes the interaction between active site and substrate. | | CO1 | U | 1 |
| 3. | Identify the difference between coenzymes and prosthetic group. | | CO3 | U | 1 |
| 4. | In a reaction mixture containing 20 µmol of starch and amylase enzyme, it took 5 minutes for the complete conversion of starch. The protein content of the mixture was 5mg. Determine the specific activity. | | CO4 | A | 1 |
| 5. | Determine the Km of enzyme if the initial velocity is reduced to half of the maximum velocity. | | CO4 | A | 1 |
| 6. | Name any two direct methods for observing the progress of enzyme reaction | | CO5 | R | 1 |
| 7. | Identify the type of inhibition observed with inhibitor that can bind only to the enzyme substrate complex. | | CO6 | A | 1 |
| 8. | Recall an enzyme used in the antiblood clotting. | | CO2 | R | 1 |
| 9. | Name the immobilization technique that may be accomplished with membrane. | | CO3 | U | 1 |
| 10. | List out the enzymes used in the fruit juice industry. | | CO2 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Illustrate the interaction between an enzyme and its substrate, according to the induced-fit model. | | CO1 | An | 3 |
| 12. | In the conversion of starch to maltose in the presence of amylase under standard conditions, KM = 4.0 x 10-4 M. When S=120 µM, initial rate of reaction was found to be 75.0 μmol/(mL\*s). Calculate turnover number for amylase under these conditions. | | CO6 | An | 3 |
| 13. | Draw and label an immobilized enzyme fluidized bed reactor. | | CO3 | U | 3 |
| 14. | Construct a Lineweaver Burk plot for competitive and uncompetitive inhibition. | | CO3 | U | 3 |
| 15. | For an enzyme catalyzed reaction, Vmax is 2.1 g/(Lmin) and K2 is 28 min-1. Calculate the initial Enzyme concentration E0. | | CO5 | A | 3 |
| 16. | Assess the importance of nanobiocatalyst in bioprocessing. | | CO2 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Elaborate a detailed note on the Enzyme Commission’s system of classification of enzymes with examples. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | The kinetics of an enzyme catalyzed reaction were analyzed in the absence and presence of inhibitor A. Determine,   1. MM parameters for no inhibition using LB plot 2. Type of inhibition 3. Inhibitor constant A  |  |  |  | | --- | --- | --- | | **S (mM)** | **V (mM/Lmin)** | | | **I=0** | **IA=1.26mM** | | 0.25 | 1.02 | 0.73 | | 0.33 | 1.39 | 0.87 | | 0.4 | 1.67 | 1.09 | | 0.5 | 1.89 | 1.3 | | 0.6 | 2.08 | 1.41 | | 0.75 | 2.44 | 1.82 | | 1.0 | 2.5 | 2.71 | | CO4 | A | 12 |
|  |  |  |  |  |  |
| 19. |  | The following results were obtained for an enzyme- catalyzed reaction.  Estimate Km and Vmax by Lineweaver-Burk plot and Hanes woolf plot   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Substrate concentration (mmol L-1) | 5.0 | 6.67 | 10.0 | 20.0 | 40.0 | | Initial velocity (µmol L-1 min-1) | 147 | 182 | 233 | 323 | 400 | | CO6 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Derive the expression for competitive and noncompetitive inhibition reactions and explain it with the help of a Line-weaver Burk plot. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 21. |  | Discuss in detail on various steps involved in purification of an intracellular enzyme. | CO 5 | C | 12 |
|  |  |  |  |  |  |
| 22. |  | Elaborate construction and working of potentiometric and piezoelectric biosensors with a neat sketch. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain in detail on various physical and chemical methods of enzyme immobilization with its advantages and disadvantages. Add a note on packed bed bioreactor with a neat sketch. | CO3 | U | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Examine the application of various enzymes in food and pharmaceutical industries with examples. | CO 2 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand enzymes and enzymatic reactions. |
| CO2 | Relate the application of enzymes in various industries. |
| CO3 | Apply enzymes in free and immobilized form for various reaction. |
| CO4 | Analyze the enzyme kinetics. |
| CO5 | Evaluate the processing and purification of enzymes. |
| CO6 | Hypothesize model for enzyme kinetics and inhibition types. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 13 | 1 |  | 3 |  |  | 17 |
| CO2 | 2 | 12 | 3 | 12 |  |  | 29 |
| CO3 |  | 20 |  |  |  |  | 20 |
| CO4 |  |  | 14 | 12 |  |  | 26 |
| CO5 | 1 |  | 3 |  |  | 12 | 16 |
| CO6 |  |  | 1 | 15 |  |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2025** | **Duration** | **3hrs** |
| **Course Name** | **IMMUNOLOGY** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Expand PAMPs and PRR with two examples in each. | | CO1 | U | 1 |
| 2. | List granulocytes and agranulocytes. | | CO1 | A | 1 |
| 3. | Distinguish serum and plasma in just one sentence. | | CO1 | A | 1 |
| 4. | List any two ROS utilized by the immune system. | | CO2 | R | 1 |
| 5. | The immunoglobulin that can cross the placenta is \_\_\_\_\_\_\_\_. | | CO3 | U | 1 |
| 6. | \_\_\_\_\_\_\_\_\_\_ enables IgA to pass through membranes and be secreted. | | CO3 | R | 1 |
| 7. | HIV causes \_\_\_\_\_\_\_\_\_\_\_. | | CO4 | An | 1 |
| 8. | List two polymeric immunoglobulins. | | CO5 | R | 1 |
| 9. | Expand ELISA. | | CO5 | E | 1 |
| 10. | Kohler and Milstein were awarded the Nobel prize for \_\_\_\_\_\_\_\_ technology. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Brief upon commensals/normal flora now known as microbiota. | | CO1 | An | 3 |
| 12. | Outline the design of the functioning of the immune system. | | CO2 | U | 3 |
| 13. | Discuss neutralization, opsonization and complement activation. | | CO3 | R | 3 |
| 14. | Differentiate Affinity & Avidity. | | CO4 | U | 3 |
| 15. | Distinguish between epitope and paratope and mention the molecular interactions between them. | | CO5 | E | 3 |
| 16. | Explain hypersensitivity and at least two medications used to treat it. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Describe in detail the structure and function of primary lymphoid organs. | CO1 | R | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain Heamatopoisis with a neat diagram. | CO2 | U | 12 |
|  |  |  |  |  |  |
| 19. |  | Dissect and describe the structure of Immunoglobulin. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Explain in detail the MHC-I processing and presentation. | CO4 | E | 12 |
|  |  |  |  |  |  |
| 21. |  | Elaborate on the classical pathway of complement activation. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Elucidate the types, properties and the role of cytokines in regulating the immune system. | CO5 | U | 12 |
|  |  |  |  |  |  |
| 23. | a. | Elucidate extravasation. | CO6 | E | 6 |
|  | b. | Distinguish between T-dependent and T-independent B-cell activation. | CO6 | E | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Discuss the different types of vaccines against COVID-19. | CO6 | An | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Learn the history and development and controversies of the field of immunology. |
| CO2 | Recognizes the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system. |
| CO3 | Identify the cells of the immune system and their functions. |
| CO4 | Understand the functioning of the innate and adaptive immune system. |
| CO5 | Interpret the cellular & molecular interactions, physiology and the pathology of the immune system. |
| CO6 | Infer of the applications of immunology in diagnosis and treatment of diseases. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 12 | 1 | 2 | 3 | - | - | 18 |
| CO2 | 1 | 15 | - | - | - | - | 16 |
| CO3 | 4 | 1 | 12 | - | - | - | 17 |
| CO4 | - | 3 | - | 1 | 12 | - | 16 |
| CO5 | 13 | 12 | - | - | 4 | - | 29 |
| CO6 | 1 | 3 | - | 12 | 12 | - | 28 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code:** | **20BT2029** | **Duration :** | **3hrs** |
| **Course Name:** | **BIOCHEMICAL THERMODYNAMICS** | **Max. Marks :** | **100** |

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| **Q. No.** | **Questions** | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | |
| 1. | Compare between intensive and extensive property of a system. | CO1 | U | 1 |
| 2. | Choose the correct option;  Characteristic gas constant of a gas is equal to- (a) Cv - Cp, (b) Cp /Cv,  (c) Cp - Cv, (d) Cv/Cp. | CO1 | An | 1 |
| 3. | Define Triple point in a thermodynamic system. | CO2 | R | 1 |
| 4. | Pick the correct one;  In an adiabatic process 10 J of work is done on a system. The correct assessment on the system would be- (a) Internal energy increases 10 J,  (a) Heat lost is 10 J, (c) Enthalpy change is 10 J, (d) Temperature rises by 10 K. | CO2 | U | 1 |
| 5. | Define isothermal compressibility with its numerical expression. | CO3 | R | 1 |
| 6. | Determine the total mole fraction of components present in the liquid phase of a solution. | CO3 | U | 1 |
| 7. | Enumerate the change in entropy for a system in an adiabatic process. | CO4 | U | 1 |
| 8. | Identify the correct one;  Gibbs free energy change in an isothermal process can be equivalent to- (a), PdV (b) VdP, (c) TdS, (d) SdT. | CO4 | An | 1 |
| 9. | Determine the degree of freedom for an ethanol-water VLE system. | CO5 | E | 1 |
| 10. | For an azeotropic system which of the following is correct.  a) x1 + y1 = 1  b) x1 = y1  c) x1 = y2  d) x1 = x2 | CO5 | U | 1 |

|  |  |  |  |  |
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| **PART – B (6 X 3 = 18 MARKS)** | | | | |
| 11. | A gas is enclosed by a movable piston in a cylinder. The gas expands from an initial volume of 5 m3 as a result of 210 kJ of work done on the system by an external source. The pressure of the system remains constant at 560 kPa. Estimate the net work done by the system in J. | CO1 | E | 3 |
| 12. | Determine the change in entropy in kJ/K when 80 g of argon is heated from 300 k to 500 k at constant volume. Assume the specific heat at constant volume is 0.3122 kJ/Kg-K. The molecular weight of argon is 40 g/mol. | CO2 | An | 3 |
| 13. | The molar volume of an organic liquid at 300 k and 1 bar is 0.1 m3/kmol and its coefficient of expansion is 1.25×10-3 k-1. Determine change in volume with respect to the change in temperature at constant pressure in m3/kmol.K. | CO3 | An | 3 |
| 14. | A binary mixture consists of 60 mole% ethylene and 40 mole% propylene. At 423 k, the vapour pressures of ethylene and propylene are 15.2 atm and 9.8 atm, respectively. Find the total pressure in atm and mole fraction of ethylene in the vapour phase at equilibrium. | CO4 | E | 3 |
| 15. | Liquid A and B form an azeotrope containing 46.1 mole% A at 101.3 kPa and 345 k. At 345 k, the vapour pressure of A is 84.8 kPa and that of B is 78.2 kPa. Determine the activity coefficients for both of A and B. | CO5 | An | 3 |
| 16. | A gas mixture containing 2 moles of N2, 7 mol of H2 and 1 mol of NH3 initially, undergoing reaction; N2+3H2 →2NH3. After some time ε = 0.5. Evaluate the estimated mole fraction of NH3 in the mixture. | CO6 | E | 3 |

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| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.no 17 to 23)** | | | | |
| 17. | 1 Kg of water is vapourized in a container at the constant temperature of 373 K and constant pressure of 101325 N/m2. The specific volume of liquid and vapour at these conditions are 1.04×10-3 m3/kg and 1.673 m3/kg, respectively. The amount of heat added to the water is 2257 KJ. Calculate the change in internal energy in kJ and enthalpy in kJ. | CO1 | E | 12 |
|  |  |  |  |  |
| 18. | H2 gas at 100 ⸰C and 300 atm pressure occupies a volume of 0.1191 dm3 mol-1. The area under the curve is observed as 4.92 atm dm3 mol-1, when the values of α are plotted vs pressure. Determine the deviation from the ideal behavior (α) in dm3 mol-1 and find the fugacity in atm and its fugacity coefficient. | CO2 | E | 12 |
|  |  |  |  |  |
| 19. | Explain different phase change processes for a pure system. | CO2 | An | 12 |
|  |  |  |  |  |
| 20. | Liquid A and B form an azeotrope containing 46.1 mole percent A at 101.3 kPa and 345 K. At 345 K, the vapour pressure of A is 84.8 kPa and that of B is 78.2 kPa. Calculate the van Laar constants (A and B). | CO3 | E | 12 |
|  |  |  |  |  |
| 21. | 2 mol of an ideal gas was initially at 293 K and 15 atm. The expansion of gas takes place adiabatically when the external pressure is reversed to 5 atm. Determine the final temperature in ⸰C and volume in L. Calculate the work done in L-atm during the process, given that Cp= 8.58 Cal/mol/degree. Consider the value of R as 2 Cal/degree-mol. | CO4 | E | 12 |
|  |  |  |  |  |
| 22. | Establish the relationship between Gibbs free energy and fugacity in a thermodynamic system. | CO5 | C | 12 |
|  |  |  |  |  |
| 23. | Derive the expressions for virial coefficients B` and C` from the derivation of virial equation. | CO4 | C | 12 |
| **COMPULSORY QUESTION** | | | | |
| 24. | For a system, in which the following reaction occurs,  CH4+H2O = CO+3H2;  Assume that initially, 2 mol CH4,1 mol H2O, 1 mol CO and 4 mol H2 were present. Determine expressions for mole fraction yi as a function of ε for the chemical species CH4, H2O, CO and H2. | CO6 | E | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Recognize relevant thermodynamic properties of ideal and real fluids. |
| CO2 | Explain concept of entropy, enthalpy, partial molar property, fugacity, activity of thermodynamic system. |
| CO3 | Solve mathematical problem involving volumetric, thermodynamic properties of real fluids. |
| CO4 | Infer dependency of biochemical reaction equilibrium on pressure and temperature. |
| CO5 | Design solution of VLE problem with real fluid for improved recovery in bioprocess system. |
| CO6 | Create problems dealing with multi-phase biochemical systems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | 1 | - | 1 | 15 | - | 17 |
| CO2 | 1 | 1 | - | 15 | 12 | - | 29 |
| CO3 | 1 | 1 | - | 3 | 12 | - | 17 |
| CO4 | - | 1 | - | 1 | 15 | 12 | 29 |
| CO5 | - | 1 | - | 3 | 1 | 12 | 17 |
| CO6 | - | - | - | - | 15 | - | 15 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2032** | **Duration** | **3hrs** |
| **Course Name** | **INDUSTRIAL SAFETY AND HAZARD ANALYSIS** | **Max. Marks** | **100** |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | What are all the major hazards in Bioprocess industries? | | CO1 | U | 1 |
| 2. | Name few personal protective equipment that should be used by the workers in Industries. | | CO5 | R | 1 |
| 3. | Write any one safety methods need to be used while handling acidic solvents. | | CO2 | An | 1 |
| 4. | What is the level of safety that must be maintained in viral vaccine production Industries? | | CO4 | A | 1 |
| 5. | What parameters determine a material is hazardous? | | CO3 | R | 1 |
| 6. | How the technical persons are trained to handle the hazardous material? | | CO2 | U | 1 |
| 7. | What is the purpose of Risk assesment? | | CO1 | An | 1 |
| 8. | How will you develop a Risk mitigation plane? | | CO4 | R | 1 |
| 9. | Draw the symbol used to denote the Biohazard. | | CO4 | U | 1 |
| 10. | Name few Bioprocess based Industries in India. | | CO5 | An | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | What are Extreme operating conditions in Industries? | | CO1 | R | 3 |
| 12. | How will you promote the Industrial safety? | | CO2 | R | 3 |
| 13. | What are the guidelines/operability studies needed for handling the hazardous materials? | | CO3 | R | 3 |
| 14. | Quantitative risk assessment- an essential tool in safety management explain. | | CO4 | U | 3 |
| 15. | How can we eliminate or substitute hazardous biological organisms. | | CO4 | R | 3 |
| 16. | Explain the Process Safety in Bioprocess Manufacturing Facilities. | | CO5 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain the needs of safety in Industries. | CO2 | R | 6 |
|  | b. | What are the major toxicants and chemicals? | CO1 | U | 6 |
|  |  |  |  |  |  |
| 18. | a. | How the safety procedures are implemented? | CO2 | An | 6 |
|  | b. | How the accidents are identified and explain the ways in which these can be prevented? | CO1 | An | 6 |
|  |  |  |  |  |  |
| 19. | a. | How will you process the hazardous checklist? | CO2 | R | 6 |
|  | b. | What are the ways in which the hazardous can be identified? | CO2 | U | 6 |
|  |  |  |  |  |  |
| 20. | a. | Explain Event trees, fault trees. | CO2 | R | 6 |
|  | b. | What are all the Risk associated with Radiation exposure? | CO3 | R | 6 |
|  |  |  |  |  |  |
| 21. | a. | Explain the Administrative control on Hazard management. | CO4 | R | 6 |
|  | b. | How the Engineering control need to be maintained in Hazard control? | CO4 | R | 6 |
|  |  |  |  |  |  |
| 22. | a. | How will you identify the Bioprocess Hazard? | CO4 | A | 6 |
|  | b. | Write the essential features of Bioprocessing Safety Management Practices. | CO5 | An | 6 |
|  |  |  |  |  |  |
| 23. | a. | What are all the factors are used as a Key Considerations for Assessing Risk to Manage Bioprocess Safety? | CO5 | R | 6 |
|  | b. | What are all the Effects of Emerging Technology on Bioprocessing Risk Management? | CO4 | An | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Narrate the Bioprocessing Safety Management Practices followed in the Bioprocess industries | CO5 | U | 6 |
|  | b. | How the Layer of protection analysis are consider as an effective risk management technique? | CO4 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand plant safety in selection and layout of process plants and the usage of safety codes. |
| CO2 | Distinguish different types of hazards. |
| CO3 | Relate the occupational diseases. |
| CO4 | Analyze the bio medical and engineering response to health hazards. |
| CO5 | Evaluate the effective process control and instrumentation met. |
| CO6 | Create awareness the usage of safety measures. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 3 | 7 | - | 7 | - | - | 17 |
| CO2 | 21 | 7 | - | 7 | - | - | 35 |
| CO3 | 10 | - | - | - | - | - | 10 |
| CO4 | 16 | 4 | 7 | 12 | - | - | 39 |
| CO5 | 10 | 6 | - | 7 | - | - | 23 |
| CO6 | - | - | - | - | - | - | - |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2033** | **Duration** | **3hrs** |
| **Course Name** | **ENVIRONMENTAL POLLUTION CONTROL ENGINEERING** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Define eutrophication. | | CO1 | R | 1 |
| 2. | What do you mean by the term “sewer”? | | CO1 | R | 1 |
| 3. | Name the microbe which is used for degrading oil spills in the soil. | | CO3 | R | 1 |
| 4. | Define gene technology. | | CO3 | R | 1 |
| 5. | Represent the members of central board in EPA. | | CO2 | U | 1 |
| 6. | Recall the incident after which the EPA was introduced in our country | | CO3 | R | 1 |
| 7. | Assess the role of DLC. | | CO2 | E | 1 |
| 8. | Indicate 3R’s in pollution control. | | CO6 | U | 1 |
| 9. | Cite an example for industrial symbiosis. | | CO4 | U | 1 |
| 10. | List out baseline situation in EIA. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | List out main role of CPCB. | | CO2 | R | 3 |
| 12. | What is trade effluent? Give example. | | CO1 | U | 3 |
| 13. | Indicate any two environmental laboratories. | | CO4 | U | 3 |
| 14. | Summarize the steps to arrive at a finding in EIA. | | CO6 | U | 3 |
| 15. | Appraise the role of Environmental audit. | | CO3 | E | 3 |
| 16. | Summarize on incineration. | | CO5 | E | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Express any three social issues related to pollution in detail. Also add a note on the effects of various pollution on environment and suggest some solutions for the issues you are discussing. | CO1 | C | 12 |
|  |  |  |  |  |  |
| 18. |  | Explain in detail on air prevention and control of pollution act. | CO2 | R | 12 |
|  |  |  |  |  |  |
| 19. |  | Examine and express a detailed note on stages in environmental impact assessment, impact factors and areas of consideration, measurement of environmental impact, organization and methodologies with a neat flowsheet. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 20. |  | Illustrate a detailed note on the process of conducting environmental audits with its classification. | CO6 | U | 12 |
|  |  |  |  |  |  |
| 21. |  | Elaborate a detailed note on the process of clean technology in various industries and examine the methods material reuse to achieve waste reduction. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 22. |  | Illustrate a detailed note on cleanup with a case study add a note on management of e-waste. | CO4 | A | 12 |
|  |  |  |  |  |  |
| 23. |  | Elaborate on the manufacture, handling and storage of hazardous and genetically engineered organisms rules and appraise the nature of various committees and assess their roles and responsibilities in detail. | CO6 | E | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain in detail the stages in handling, management and transport of biomedical waste. | CO5 | An | 12 |

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|  | **COURSE OUTCOMES** |
| CO1 | Understand basics of environmental pollution. |
| CO2 | Remember Pollution control acts and regulations. |
| CO3 | Apply bio safety principles in pollution control. |
| CO4 | Evaluate cleaner technology on pollution control. |
| CO5 | Evaluate various approaches for biomedical waste treatment and disposal. |
| CO6 | Analyze various biosafety measures. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 3 | - | - | - | 12 | 17 |
| CO2 | 15 | 1 | - | - | 1 | - | 17 |
| CO3 | 3 | - | 12 | - | 3 | - | 18 |
| CO4 | - | 4 | 12 | 12 | - | - | 28 |
| CO5 | - | - | - | 12 | 3 | - | 15 |
| CO6 | 1 | 16 | - | - | 12 | - | 29 |
|  | | | | | | | **124** |



|  |  |  |  |
| --- | --- | --- | --- |
| **Course Code** | **20BT2039** | **Duration** | **3hrs** |
| **Course Name** | **CANCER BIOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Recall the tumor suppressor which directs damaged DNA for repair. | | CO1 | R | 1 |
| 2. | Define carcinogen. | | CO1 | U | 1 |
| 3. | Analyze etiologic factors and cite a non-ionizing radiation causing cancer. | | CO2 | An | 1 |
| 4. | Choose the HPV onco-protein that binds p53: E6 or E7? | | CO2 | R | 1 |
| 5. | What is the process of formation of new blood vessels in cancer site? | | CO3 | R | 1 |
| 6. | Name any one oncogene. | | CO3 | R | 1 |
| 7. | Infer on the main role of VEGF in cancer. | | CO4 | U | 1 |
| 8. | Mention any one lab test used to detect tumor marker protein in blood. | | CO6 | R | 1 |
| 9. | Which type of therapy uses tyrosine kinase inhibitors as drugs? | | CO5 | U | 1 |
| 10. | Brachytherapy uses which of the following?: a. Internal radiation as unsealed source, b. Internal radiation as sealed source. | | CO6 | An | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Distinguish cancer tumor from benign tumor. | | CO1 | An | 3 |
| 12. | Construct a modified cell cycle of a cancer cell. | | CO4 | A | 3 |
| 13. | Categorize the carcinogens based on their action. | | CO2 | An | 3 |
| 14. | Classify the tumor suppressors. | | CO3 | R | 3 |
| 15. | Infer on TNM staging used for cancer reporting. | | CO6 | U | 3 |
| 16. | Understand the MAPK pathway and indicate the signal targets for therapy. | | CO5 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Illustrate the hallmarks of cancer cell and cancer metabolism. | CO1 | U | 8 |
|  | b. | Infer on the ultimate causes of cancer death. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Explain how the various physical agents causes cancer. | CO2 | U | 8 |
|  | b. | Infer on the epigenetics of cancer. | CO2 | U | 4 |
|  |  |  |  |  |  |
| 19. | a. | Analyze the role of various growth factors in cancer development. | CO3 | An | 8 |
|  | b. | Differentiate proto-oncogene and oncogene. | CO3 | An | 4 |
|  |  |  |  |  |  |
| 20. | a. | Comprehend on ‘seed and soil’ hypothesis for metastasis and illustrate the metastatic cascade with neat diagram. | CO5 | U | 8 |
|  | b. | Illustrate the molecular mechanism of cancer angiogenesis. | CO5 | U | 4 |
|  |  |  |  |  |  |
| 21. | a. | Write the types of tumor markers with suitable examples. | CO5 | R | 8 |
|  | b. | Write about the early detection of cervical cancer by screening. | CO5 | R | 4 |
|  |  |  |  |  |  |
| 22. | a. | Compare and contrast any 4 cancer imaging techniques. | CO6 | R | 8 |
|  | b. | Write the different ways by which biopsy can be taken for detection. | CO6 | R | 4 |
|  |  |  |  |  |  |
| 23. | a. | Classify the chemotherapeutic agents with their mechanism of action. | CO6 | E | 8 |
|  | b. | Differentiate neoadjuvant and adjuvant therapies with an example. | CO6 | E | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Analyze the available radiotherapy methods, their merits and demerits. | CO6 | An | 8 |
|  | b. | Analyze the current status and challenges of gene therapy. | CO6 | An | 4 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Remember the epidemiology of cancer and principles of carcinogenesis. |
| CO2 | Outline the different forms of cancer and the principles of their development. |
| CO3 | Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell. |
| CO4 | Relate the cell biology with the regulatory imbalance in carcinogenesis, detection and therapy. |
| CO5 | Recognize the molecular mechanism of cancer spread, its markers and therapy. |
| CO6 | Evaluate the current strategies of cancer diagnosis, prevention and treatment to develop new drugs. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 13 |  | 3 |  |  | 17 |
| CO2 | 1 | 12 |  | 4 |  |  | 17 |
| CO3 | 5 |  |  | 12 |  |  | 17 |
| CO4 |  | 1 | 3 |  |  |  | 4 |
| CO5 | 12 | 16 |  |  |  |  | 28 |
| CO6 | 13 | 3 |  | 13 | 12 |  | 41 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2042** | **Duration** | **3hrs** |
| **Course Name** | **PLANT AND ANIMAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define somatic embryo. | | CO1 | R | 1 |
| 2. | Name the first media used in plant tissue culture. | | CO1 | R | 1 |
| 3. | Name the significance of particle bombardment method of gene transfer in plants. | | CO2 | R | 1 |
| 4. | List the disadvantage of PEG mediated gene transfer in plants. | | CO2 | A | 1 |
| 5. | What are herbicides? | | CO2 | R | 1 |
| 6. | What is the disadvantage of conventional plant breeding? | | CO3 | R | 1 |
| 7. | What is transgene silencing? | | CO3 | R | 1 |
| 8. | Name any one product produced through plant cell culture. | | CO4 | R | 1 |
| 9. | Recall how many essential amino acids are present in animal cell culture media. | | CO5 | R | 1 |
| 10. | Name the central government department which issues ethical guidelines for animal biotechnology. | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Outline the stages of hardening of tissue culture plants. | | CO1 | U | 3 |
| 12. | Illustrate the method of gene transfer using microinjection. | | CO2 | U | 3 |
| 13. | Recall the gene transfer techniques in development of insect resistance in plants. | | CO3 | R | 3 |
| 14. | List the reporter genes used in plant genetic transfer. | | CO3 | R | 3 |
| 15. | Outline the important factors for contamination in cell line. | | CO4 | U | 3 |
| 16. | Summarize the ethical issues in animal biotechnology. | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. |  | Explain the nutritional composition of MS media used in plant tissue culture. | CO1 | E | 12 |
|  |  |  |  |  |  |
| 18. |  | Illustrate the steps involved in establishment of cell suspension culture for in vitro drug production in plants. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 19. | a. | Recall the basic features of Ti plasmid of *Agrobacterium tumefaciens.* | CO2 | R | 2 |
|  | b. | Outline the process of gene transfer in plants using Gene gun method with neat diagram. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 20. | a. | Name one disease resistant transgenic plant. | CO3 | R | 2 |
|  | b. | Illustrate the steps involved in development of disease resistant transgenic plant. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 21. | a. | How many copies of chloroplast genome is present in one cell? | CO3 | R | 2 |
|  | b. | Explain the method of chloroplast transformation in the modern scenario. | CO3 | E | 10 |
|  |  |  |  |  |  |
| 22. | a. | What is plant selectable marker? | CO3 | R | 2 |
|  | b. | Illustrate the steps involved in genome editing technology CRISPR/CAS towards crop improvement. | CO3 | U | 10 |
|  |  |  |  |  |  |
| 23. | a. | Explain the media used in animal cell culture and its method of sterilization. | CO4 | E | 6 |
|  | b. | Outline the strategies on scale up of cell culture for product development in animal cell culture in the modern research. | CO5 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Explain the various steps involved in the process of In vitro fertilization. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge in plant biotechnology and its applications. |
| CO2 | Gain the knowledge about to increase the production in agriculture products. |
| CO3 | Prepare them to work in the agriculture industries. |
| CO4 | Demonstrate *In vitro* fertilization and the manipulation of embryo done for genetic screening will  provide wider understating among the students and create awareness. |
| CO5 | Development of transgenic animals for breed development for enhanced milk production. |
| CO6 | Adapt appropriate ethical guidelines in animal biotechnology. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 2 | 15 |  |  | 12 |  | 29 |
| CO2 | 4 | 13 |  | 1 |  |  | 18 |
| CO3 | 14 | 20 |  |  | 10 |  | 44 |
| CO4 | 1 | 3 |  |  | 6 |  | 10 |
| CO5 | 1 | 6 |  |  |  |  | 7 |
| CO6 | 4 |  |  |  | 12 |  | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2045** | **Duration** | **3hrs** |
| **Course Name** | **AGRICULTURAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Cite the importance of Apomixis. | | CO1 | U | 1 |
| 2. | Define Rhizogenesis. | | CO1 | R | 1 |
| 3. | Recall the difference between interspecific and intergeneric hybridization. | | CO2 | R | 1 |
| 4. | List the objectives of population improvement programme. | | CO2 | R | 1 |
| 5. | Recognize the importance of Isoschizomers in genetic engineering. | | CO3 | U | 1 |
| 6. | An extra-chromosomal segment of circular DNA of a bacterium is used to carry the gene of interest into the host cell. What is the name given to it? | | CO3 | R | 1 |
| 7. | Define Biome and Ecosystems. | | CO4 | U | 1 |
| 8. | **State the difference between endemic and exotic species.** | | CO4 | R | 1 |
| 9. | Explain bioprospecting with examples. | | CO5 | U | 1 |
| 10. | Relate the terms Contig and Scaffold in sequencing. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Illustrate the significance of homozygous lines in plant breeding. | | CO1 | An | 3 |
| 12. | Explain the main features of interspecific hybridization. | | CO2 | U | 3 |
| 13. | Examine the functions of DNA polymerase in plant. | | CO3 | An | 3 |
| 14. | Summarize the objectives of Red Data Book. | | CO4 | U | 3 |
| 15. | Compare invention and inventive step in a patent. | | CO5 | An | 3 |
| 16. | Explain the role of genomics in crop improvement. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. | a. | Discuss the significance of plant breeding in crop development. | CO1 | U | 8 |
|  | b. | Summarize the challenges associated in plant breeding with regard to climate change. | CO1 | U | 4 |
|  |  |  |  |  |  |
| 18. | a. | Explain the genetic basis of heterosis and their significance in plant breeding. | CO2 | U | 8 |
|  | b. | Critically analyze the nutritional requirement of *in vitro* cultures. | CO2 | An | 4 |
|  |  |  |  |  |  |
| 19. | a. | Analyze the mechanism and function of DNA ligase with a neat illustration. | CO3 | An | 6 |
|  | b. | Compare the functions of Alkaline phosphatase and Polynucleotide kinase. | CO3 | An | 6 |
|  |  |  |  |  |  |
| 20. | a. | Articulate the principles of conservation biology with strategies leading to successful studies. | CO4 | A | 8 |
|  | b. | Examine the importance of biodiversity hotspots. | CO4 | A | 4 |
|  |  |  |  |  |  |
| 21. | a. | Explain the reasons why the patent on Basmati should not have gone to an American Company. | CO5 | An | 8 |
|  | b. | Assess the basic principles underlying the plant variety protection laws in India. | CO5 | An | 4 |
|  |  |  |  |  |  |
| 22. | a. | Examine the different methods of breeding self-pollinated crops. | CO2 | A | 8 |
|  | b. | Illustrate the different factors that controls cellular totipotency. | CO2 | A | 4 |
|  |  |  |  |  |  |
| 23. | a. | Explain the various steps involved in somatic hybridization. | CO2 | U | 6 |
|  | b. | Describe methods employed for protoplast isolation and fusion. | CO2 | U | 6 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Summarize the genome project on *Arabidopsis thaliana* genome. | CO6 | U | 6 |
|  | b. | Discuss the importance of biological databases with suitable examples. | CO6 | U | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge on plant breeding. |
| CO2 | Outline the principles of plant breeding and its techniques. |
| CO3 | Demonstrate various tools involved in genetic engineering. |
| CO4 | Illustrate the different strategies for biodiversity conservation. |
| CO5 | Acquire knowledge on IPR and its importance in patent rights. |
| CO6 | Demonstrate different tools of plant genome analysis. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 1 | 13 |  | 3 |  |  | 17 |
| CO2 | 2 | 23 | 12 | 4 |  |  | 41 |
| CO3 | 1 | 1 |  | 15 |  |  | 17 |
| CO4 | 1 | 4 | 12 |  |  |  | 17 |
| CO5 |  | 1 |  | 15 |  |  | 16 |
| CO6 |  | 16 |  |  |  |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2057** | **Duration** | **3hrs** |
| **Course Name** | **BIOETHICS, IPR AND BIOSAFETY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | What do you know about biosafety? | | CO1 | U | 1 |
| 2. | Define biosafety cabinet. | | CO1 | An | 1 |
| 3. | Define GMO. | | CO2 | R | 1 |
| 4. | Give the expansion for GATT and WTO. | | CO2 | R | 1 |
| 5. | What are TRIPS obligations? | | CO3 | U | 1 |
| 6. | What do you mean by copy right? | | CO3 | R | 1 |
| 7. | What is a Patent? | | CO4 | R | 1 |
| 8. | What rights does a patent provide? | | CO4 | An | 1 |
| 9. | Mention the possible approaches in Eugenics | | CO5 | A | 1 |
| 10. | Define biopiracy. | | CO5 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Elaborate on the biosafety issues in biotechnology | | CO1 | U | 3 |
| 12. | Define GMO and LMO and discuss their environmental impact. | | CO2 | A | 3 |
| 13. | Explain WIPO Treaties. | | CO3 | R | 3 |
| 14. | What are the general requirements of patent law? | | CO4 | R | 3 |
| 15. | Write a note on environmental impacts of using GMOs. | | CO5 | An | 3 |
| 16. | What is organ transplantation? Which organs can be transplanted? | | CO6 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No. 17 to 23, Q.No. 24 is Compulsory)** | | | | | |
| 17. | a. | Explain 'Biosafety guidelines' and recommended 'Biosafety levels' for infectious agents. | CO1 | E | 7 |
|  | b. | What is the purpose of Containment? Explain their types. | CO1 | U | 5 |
|  |  |  |  |  |  |
| 18. | a. | Explain the role of institutional biosafety committee. | CO2 | R | 4 |
|  | b. | Give an overview of national regulations and relevant international agreements of Cartagena protocol. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 19. | a. | Discuss the following:   1. Madrid Agreement b) Hague Agreement | CO3 | R | 6 |
|  | b. | Narrate about the Indian Patent Act 1970 and recent amendments. | CO3 | A | 6 |
|  |  |  |  |  |  |
| 20. | a. | Discuss in brief: a) Patentable subjects b) Patent licensing | CO4 | An | 6 |
|  | b. | Distinguish between the traditional knowledge and patents in the biotechnological research and development for the inventions. | CO4 | E | 6 |
|  |  |  |  |  |  |
| 21. | a. | Explain the ethical implications of:   1. GM Crops b) human cloning c) designer babies | CO5 | R | 6 |
|  | b. | Write a note on ethical implications of Human Genome Project. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 22. | a. | What is bioethics? Explain in detail. | CO6 | R | 5 |
|  | b. | Mention the major barriers in xenotransplantation and explain its ethics | CO6 | An | 7 |
|  |  |  |  |  |  |
| 23. | a. | Discuss the measures to regulate and prohibit the use of biological weapons. | CO5 | A | 5 |
|  | b. | Discuss legal protection of Biotechnological inventions with suitable examples. | CO3 | E | 7 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Elaborate on the process of patent filing procedure. | CO4 | R | 5 |
|  | b. | Critically comment on the ethical, social and legal aspects of gene therapy, germ line and adult stem cell research. | CO5 | An | 7 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | What is the meaning of copy right? |
| CO2 | Understand the various biosafety regulations in transgenics. |
| CO3 | Illustrate IPR and patent procedures. |
| CO4 | Comprehend on various techniques of genome, stem cells and organ research in humans. |
| CO5 | Aware of modern rDNA research and its ethical procedures. |
| CO6 | Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 9 |  | 1 | 7 |  | 17 |
| CO2 | 6 | 8 | 3 |  |  |  | 17 |
| CO3 | 10 | 1 | 6 |  | 7 |  | 24 |
| CO4 | 9 |  |  | 7 | 6 |  | 22 |
| CO5 | 7 | 6 | 6 | 10 |  |  | 29 |
| CO6 | 5 |  | 3 | 7 |  |  | 15 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2059** | **Duration** | **3hrs** |
| **Course Name** | **IoT IN BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | \_\_\_\_\_\_\_\_\_ was the co-founder of the Auto-ID Center at the Massachusetts Institute of Technology, explained the potential of IoT. | | | CO1 | U | 1 |
| 2. | \_\_\_\_\_\_\_\_\_ is a network space where billions of intelligent embedded devices will connect with larger computing systems, and to each other, without human intervention. | | | CO1 | R | 1 |
| 3. | Sensors provide tens of thousands of data per second and that which processes the data at edge and minimizes the volume of data that needs to be forwarded to cloud is the \_\_\_\_\_\_\_\_\_\_. | | | CO2 | R | 1 |
| 4. | Define transducer. | | | CO2 | R | 1 |
| 5. | Define VRI Technology. | | | CO3 | R | 1 |
| 6. | Relate the ZigBee system with the Bluetooth. | | | CO3 | U | 1 |
| 7. | \_\_\_\_\_\_\_\_\_\_\_ is a 2D barcode that can store various binary data, including alphanumeric and special characters and it can also store images, signatures and fingerprints. | | | CO4 | U | 1 |
| 8. | Define VPN. | | | CO4 | R | 1 |
| 9. | \_\_\_\_\_\_\_\_\_\_\_ is a measurement representing the oscillation rate of electromagnetic radiation spectrum, or electromagnetic radio waves, from frequencies ranging from 300 Gigahertz (GHz) to as low as 9 kilohertz (kHz). | | | CO5 | U | 1 |
| 10. | Paraphrase network integrity in IoT. | | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Interpret the significance of Projects by EU on IOT before 2010. | | | CO1 | An | 3 |
| 12. | Show the significance of a Digital Sensor with an apt example. | | | CO2 | U | 3 |
| 13. | Criticize constructively the use of LoRa WAN as a WSN protocol. | | | CO3 | An | 3 |
| 14. | Identify the 2D Barcode depicted here and state their use. | | | CO4 | U | 3 |
| 15. | Justify that “Bayer Global” is an Internationally Operating Company. | | | CO5 | E | 3 |
| 16. | Relate the ground rules of IoT configuration management. | | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | |  | Explain the six overlaps of the Internet of Things with other fields of Research. | CO1 | U | 12 |
|  | |  |  |  |  |  |
| 18. | | a. | Interpret the significance of communication platforms as vital components of IoT. | CO2 | A | 06 |
|  | | b. | Categorize the various devices & equipment and products used by end users and their uses in modern day technology. | CO2 | An | 06 |
|  | |  |  |  |  |  |
| 19. | |  | Summarize the types of Sensors in Agriculture. | CO3 | U | 12 |
|  | |  |  |  |  |  |
| 20. | |  | Classify the concept of Smart Robotic Warehouse Management System for Industry 4.0 using an example. | CO4 | An | 12 |
|  | |  |  |  |  |  |
| 21. | | a. | Appraise the IoT-ization of the Healthcare leader, Bayer Inc. | CO5 | E | 10 |
|  | | b. | Report the services rendered in SYNBIO Technologies Ltd. | CO5 | A | 02 |
|  | |  |  |  |  |  |
| 22. | |  | Analyze the implications of some commonly used WSN protocols. | CO3 | An | 12 |
|  | |  |  |  |  |  |
| 23. | |  | Assess the various ways you can protect your digital footprint. | CO4 | A | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | |  | Appraise the extent of ease extended by Automation in laboratories because of IoT. | CO6 | E | 12 |

CO – COURSE OUTCOME BL – BLOOMS’ TAXONOMY

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand the history and basic concepts of IOT. |
| **CO2** | Identify the various components of IOT. |
| **CO3** | Use IoT for different biotechnological applications. |
| **CO4** | Categorize IoT to different pharmaceutical applications. |
| **CO5** | Justify significance of IoT in research and development. |
| **CO6** | Plan IoT with future trends in biotechnology. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| **CO / P** | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| **CO1** | 01 | 13 | - | 03 | - | - | 17 |
| **CO2** | 02 | 03 | 06 | 06 | - | - | 17 |
| **CO3** | 01 | 13 | - | 15 | - | - | 29 |
| **CO4** | 01 | 04 | 12 | 12 | - | - | 29 |
| **CO5** | - | 01 | 02 | - | 13 | - | 16 |
| **CO6** | - | 04 | - | - | 12 | - | 16 |
|  | | | | | | | **124** |



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| **Course Code** | **20BT2061** | **Duration** | **3hrs** |
| **Course Name** | **BIOLOGY FOR ENGINEERS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | | |
| 1. | Define evolution. | | | CO1 | R | 1 |
| 2. | Describe condition on earth at the time of origin of life. | | | CO1 | U | 1 |
| 3. | Recall the role of endoplasmic reticulum. | | | CO2 | R | 1 |
| 4. | State cytokinesis. | | | CO2 | R | 1 |
| 5. | List the components of phospholipids. | | | CO3 | R | 1 |
| 6. | Differentiate Nucleotide and Nucleoside. | | | CO3 | U | 1 |
| 7. | Explain indicator media. | | | CO4 | U | 1 |
| 8. | Describe the chromosomal theory of inheritance. | | | CO5 | U | 1 |
| 9. | Recall the role of histones. | | | CO6 | R | 1 |
| 10. | Define transcription. | | | CO6 | R | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | | |
| 11. | Explain evidence of evolution. | | | CO1 | U | 3 |
| 12. | Discuss macro and micro nutrients. | | | CO2 | U | 3 |
| 13. | Explain Transferases and Isomerases. | | | CO3 | U | 3 |
| 14. | Define the principle of fermentation. | | | CO4 | R | 3 |
| 15. | State gene interaction and its types. | | | CO5 | R | 3 |
| 16. | Recall the properties of genetic code. | | | CO6 | R | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | | |
| 17. | |  | Explain theory of biogenesis with three supported experiments. | CO1 | U | 12 |
|  | |  |  |  |  |  |
| 18. | |  | Describe Darwinism. | CO1 | R | 12 |
|  | |  |  |  |  |  |
| 19. | |  | Discuss meiosis with illustration. | CO2 | U | 12 |
|  | |  |  |  |  |  |
| 20. | |  | Define circulatory and digestive system. | CO2 | R | 12 |
|  | |  |  |  |  |  |
| 21. | | a. | Describe the chemical properties of lipids. | CO3 | R | 6 |
|  | | b. | Classify the biomolecules- protein. | CO3 | U | 6 |
|  | |  |  |  |  |  |
| 22. | |  | Explain microbial growth curve. | CO4 | U | 12 |
|  | |  |  |  |  |  |
| 23. | |  | Recall Mendel’s Theory of Genetics. | CO5 | R | 12 |
| **COMPULSORY QUESTION** | | | | | | |
| 24. | |  | Describe central dogma of life. | CO6 | U | 12 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Define Life and Life forms. |
| CO2 | Recognize the importance of Human health, disease, and Comorbidities. |
| CO3 | Analyze biomolecules and enzymes in biological processes. |
| CO4 | Appraise the Significance of entrepreneurship and industry. |
| CO5 | Design a sustainable idea that is a trend for drug resistance. |
| CO6 | Evaluate ethics and honors for research in Biology. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 13 | 16 |  |  |  |  | 29 |
| CO2 | 14 | 15 |  |  |  |  | 29 |
| CO3 | 7 | 10 |  |  |  |  | 17 |
| CO4 | 3 | 13 |  |  |  |  | 16 |
| CO5 | 15 | 1 |  |  |  |  | 16 |
| CO6 | 5 | 12 |  |  |  |  | 17 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2068** | **Duration** | **3hrs** |
| **Course Name** | **PRINCIPLES OF PLANT BIOTECHNOLOGY AND APPLICATIONS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)** | | | | | |
| 1. | Name the father of plant tissue culture. | | CO1 | R | 1 |
| 2. | Define somatic embryo. | | CO1 | R | 1 |
| 3. | Recall electroporation. | | CO2 | R | 1 |
| 4. | Infer the role of protoplast in genetic transformation. | | CO2 | U | 1 |
| 5. | Recall the size of Ri plasmid. | | CO3 | R | 1 |
| 6. | List the nod genes involved in Nitrogen fixation in legumes. | | CO3 | R | 1 |
| 7. | Cite one example for elictors. | | CO4 | U | 1 |
| 8. | Define permeabilization. | | CO4 | R | 1 |
| 9. | Recall one method of germplasm conservation. | | CO5 | R | 1 |
| 10. | Identify the significance of illumination in plant bioreactors. | | CO6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)** | | | | | |
| 11. | Relate the role of auxins in organogenesis. | | CO1 | An | 3 |
| 12. | Interpret PEG mediated gene transfer. | | CO2 | A | 3 |
| 13. | Name any two gene banks for plant genome. | | CO3 | R | 3 |
| 14. | List the application of immobilization technique in plant cell drug production. | | CO4 | R | 3 |
| 15. | Interpret systemic acquired resistance (SAR) in plants. | | CO5 | A | 3 |
| 16. | Identify the optimal growth stage for secondary metabolite production in plant cell suspension culture. | | CO6 | U | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q.No 17 to 23, Q.No 24 is Compulsory)** | | | | | |
| 17. |  | Explain the nutritional composition of MS media and the role of hormones in organogenesis with suitable examples. | CO1 | U | 12 |
|  |  |  |  |  |  |
| 18. |  | Illustrate the protocol to develop transgenic crop using *Agrobacterium* mediated gene transfer technique with diagram. | CO2 | An | 12 |
|  |  |  |  |  |  |
| 19. |  | Analyze the molecular mechanism of nitrogen fixation in legumes with its advantages. | CO3 | An | 12 |
|  |  |  |  |  |  |
| 20. |  | Evaluate the process of *in vitro* production of secondary metabolite Vincristine using plant cell suspension culture. | CO4 | E | 12 |
|  |  |  |  |  |  |
| 21. |  | Describe the various genetic resources and methods in marker assisted selection for breeding plants. | CO5 | R | 12 |
|  |  |  |  |  |  |
| 22. |  | Summarize the process adapted in cultivar release and commercial seed production in India. | CO5 | E | 12 |
|  |  |  |  |  |  |
| 23. |  | Explain the steps involved in hardening and acclimatization of tissue cultured banana plants for commercial purpose | CO1 | A | 12 |
| **COMPULSORY QUESTION** | | | | | |
| 24. |  | Elaborate on the different types of bioreactors used for *in vitro* production of pharmaceutical compound Taxol. | CO6 | E | 12 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Summarize cell and tissue culture techniques. |
| CO2 | Illustrate the knowledge on plant genetic engineering tools. |
| CO3 | Enumerate the different vectors used in plant transformation. |
| CO4 | Employ different methods of in vitro drug production techniques. |
| CO5 | Examine the principles of plant breeding and protection. |
| CO6 | Assess the different bioreactors and its applications in plant biotechnology. |

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| **Assessment Pattern as per Bloom’s Level** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 2 | 12 |  | 15 |  |  | 29 |
| CO2 | 1 | 1 | 3 | 12 |  |  | 17 |
| CO3 | 5 |  |  | 12 |  |  | 17 |
| CO4 | 4 | 1 |  |  | 12 |  | 17 |
| CO5 | 13 |  | 3 |  | 12 |  | 28 |
| CO6 |  | 4 |  |  | 12 |  | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT2069** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCES IN ANIMAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (10 X 1 = 10 MARKS)**  **(Answer all the questions)** | | | | | |
| 1. | Define transformed cell line. | | CO 1 | R | 1 |
| 2. | Recite on karyotyping. | | CO 2 | R | 1 |
| 3. | Give examples of any two natural biomaterial used in tissue engineering. | | CO 3 | U | 1 |
| 4. | Interpret on scaffold. | | CO 3 | A | 1 |
| 5. | Name the antifungal compounds produced by *L. casei* AST18 in milk fermentation | | CO 5 | C | 1 |
| 6. | List any two genetically modified organism used in post ingestion  forage quality in rumen. | | CO 5 | R | 1 |
| 7. | Identify the techniques used for assisted hatching in IVF. | | CO 4 | U | 1 |
| 8. | Recall the hormones used for superovulation in animals. | | CO 5 | R | 1 |
| 9. | Write about gene knock out in transgenic animals. | | CO 5 | C | 1 |
| 10. | Indicate any one ethical issue associated with transgenic animals | | CO 6 | U | 1 |
| **PART – B (6 X 3 = 18 MARKS)**  **(Answer all the questions)** | | | | | |
| 11. | Appraise on Isoenzymes. | | CO1 | An | 3 |
| 12. | State the importance of cell banks with examples. | | CO2 | R | 3 |
| 13. | Explain the process involved in skin tissue engineering. | | CO3 | U | 3 |
| 14. | Write about the raw materials used for the preparation of animal feed. | | CO 6 | A | 3 |
| 15. | Illustrate on micromanipulation technology. | | CO 4 | An | 3 |
| 16. | Interpret on marker assisted selection in transgenic animals. | | CO 5 | A | 3 |
| **PART – C (6 X 12 = 72 MARKS)**  **(Answer any five Questions from Q. No. 17 to 23, Q. No. 24 is Compulsory)** | | | | | |
| 17. | a. | Analyze the process involved in chromosome banding for cell line characterization. | CO1 | An | 6 |
|  | b. | Describe in detail about chromosome paining involved in karyotyping. | CO1 | U | 6 |
| 18. | a. | Discuss the pathogenesis cycle of rabies infection in animals. | CO2 | U | 4 |
|  | b. | Interpret on the production of anti-rabies vaccine. | CO2 | A | 8 |
| 19. | a. | Differentiate between 2D and 3D cell culture. | CO3 | An | 4 |
|  | b. | Summarize the protocol for initiation and cultivation of tumor  spheroids in spinner flasks with illustrations. | CO3 | E | 8 |
| 20. | a. | State the properties of lactic acid bacteria in milk fermentation. | CO5 | R | 4 |
|  | b. | Assess the role of lactic acid bacteria in fermented milk products with examples. | CO5 | E | 8 |
| 21. |  | Criticize on sexing of X and Y bearing sperms from semen samples of animals. | CO4 | An | 12 |
| 22. | a. | Infer on the methods involved *In vitro* fertilization in animals | CO4 | C | 6 |
|  | b. | Express the process of artificial insemination. | CO4 | C | 6 |
| 23. | a. | Articulate the use of artificial intelligence in animal monitoring with examples. | CO6 | A | 8 |
|  | b. | Discover the importance of ethical issues in animal biotechnology. | CO6 | A | 4 |
| **COMPULSORY QUESTION** | | | | | |
| 24. | a. | Summarize the homologous recombination method in the development of transgenic animals. | CO5 | E | 6 |
|  | b. | Explain in detail on Cre/lox P system for gene knock out in animals. | CO5 | An | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Demonstrate the cell culture techniques for maintenance of cell lines. |
| CO2 | Recognize the importance of scaling up of cell culture for development of cell culture products. |
| CO3 | Interpret the applications of tissue engineering and 3D cell culture techniques. |
| CO4 | Relate the need of genetic screening for *In vitro* fertilization. |
| CO5 | Apply the knowledge of livestock improvement using transgenesis. |
| CO6 | Assess the scope, applications and ethical issues in animal biotechnology. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 1 | 6 | - | 9 | - | - | 16 |
| CO2 | 4 | 4 | 8 | - | - | - | 16 |
| CO3 | - | 4 | 1 | 4 | 8 | - | 17 |
| CO4 | - | 1 | - | 15 | - | 12 | 28 |
| CO5 | 6 | - | 3 | 6 | 14 | 2 | 31 |
| CO6 | - | 1 | 15 | - | - | - | 16 |
|  | | | | | | | **124** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3002** | **Duration** | **3hrs** |
| **Course Name** | **GENETIC ENGINEERING AND RECOMBINANT PRODUCTS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | List out the rDNA drug products approved for market in India and describe their significance. | CO6 | R | 8 |
|  | b. | Describe the production process of insulin using rDNA technology. | CO6 | R | 8 |
|  |  |  |  |  |  |
| 2. | a. | Appraise the role of rDNA technology in food processing, preservation and nutraceutical productions. | CO4 | An | 16 |
|  |  |  |  |  |  |
| 3. | a. | Compare and contrast the properties of cloning and expression vectors. | CO2 | U | 8 |
|  | b. | Discuss about the application of shuttle vectors in industrial productions. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 4. | a. | Evaluate the expression vectors used for bacteria, yeast, mammalian and plant cells. | CO2 | E | 16 |
|  |  |  |  |  |  |
| 5. | a. | Compare the Sanger’s method of DNA sequencing and pyrosequencing. | CO2 | U | 8 |
|  | b. | Distinguish the RT-PCR and qPCR with product analysis. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 6. | a. | Recognize the significance of cDNA library, its construction steps and their screening based on gene expression. | CO1 | R | 16 |
|  |  |  |  |  |  |
| 7. | a. | Discuss about the various therapeutic and diagnostic enzymes along with their industrial production scenario. | CO6 | U | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Illustrate the techniques used for the production of therapeutic antibodies and vaccines in plants. | CO6 | An | 10 |
|  | b. | Appraise the development of genetically enhanced animals with suitable examples. | CO5 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the basic concepts in Genetic engineering. |
| CO2 | Recognize the usage of the tools of genetic engineering. |
| CO3 | Choose the techniques employed in genetic manipulation of microbes. |
| CO4 | Analyze the techniques employed in the genetic manipulation plants for crop improvement |
| CO5 | Illustrate the techniques employed in the genetic manipulation animals for commercial purposes. |
| CO6 | Discuss the genetic manipulation techniques employed in the production of therapeutics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 |  |  |  |  |  | 16 |
| CO2 |  | 32 |  |  | 16 |  | 48 |
| CO3 |  |  |  |  |  |  | - |
| CO4 |  |  |  | 16 |  |  | 16 |
| CO5 |  |  |  | 10 |  |  | 10 |
| CO6 | 16 | 16 |  | 10 |  |  | 42 |
|  | | | | | | | **132** |



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| **Course Code** | **20BT3002** | **Duration** | **3hrs** |
| **Course Name** | **GENETIC ENGINEERING AND RECOMBINANT PRODUCTS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Recall the impact of rDNA technology in agriculture with examples. | CO4 | R | 8 |
|  | b. | State the various risks associated with rDNA products in agriculture field. | CO4 | R | 8 |
|  |  |  |  |  |  |
| 2. |  | Analyze the role of rDNA technology in various industrial productions. | CO3 | An | 16 |
|  |  |  |  |  |  |
| 3. | a. | Classify the vectors and give one example for each. | CO2 | U | 8 |
|  | b. | Compare the pUC and pET series of expression vectors that are commonly used for E.coli expression system. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 4. |  | Evaluate the advantages, disadvantages and screening methods of pBR and pUC series of cloning vectors. | CO2 | E | 16 |
|  |  |  |  |  |  |
| 5. | a. | Compare and contrast the reverse transcriptase PCR and qPCR. | CO2 | U | 8 |
|  | b. | Illustrate the steps of pyrosequencing method and its application in NGS. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 6. | a. | Enumerate on the steps followed in the construction of genomic library using cloning vector. | CO1 | R | 8 |
|  | b. | Describe the hybridization techniques used for screening genomic library. | CO1 | R | 8 |
|  |  |  |  |  |  |
| 7. | a. | Summarize the applications of various recombinant enzymes used for therapeutic and industrial purposes. | CO6 | U | 8 |
|  | b. | Infer on the use of ZFN and TALEN as gene editing tools. | CO6 | U | 8 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Analyze the methods of producing improved crop varieties by recombinant technology. | CO4 | An | 10 |
|  | b. | Criticize on the genetic manipulations of animals for commercial use. | CO5 | An | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Understand the basic concepts in Genetic engineering. |
| CO2 | Recognize the usage of the tools of genetic engineering. |
| CO3 | Choose the techniques employed in genetic manipulation of microbes. |
| CO4 | Analyze the techniques employed in the genetic manipulation plants for crop improvement |
| CO5 | Illustrate the techniques employed in the genetic manipulation animals for commercial purposes. |
| CO6 | Discuss the genetic manipulation techniques employed in the production of therapeutics. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 |  |  |  |  |  | 16 |
| CO2 |  | 32 |  |  | 16 |  | 48 |
| CO3 |  |  | 16 |  |  |  | 16 |
| CO4 | 16 |  |  | 10 |  |  | 26 |
| CO5 |  |  |  | 10 |  |  | 10 |
| CO6 |  | 16 |  |  |  |  | 16 |
|  | | | | | | | **132** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3003** | **Duration** | **3hrs** |
| **Course Name** | **BIOPROCESS MODELLING AND SIMULATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Appraise the importance of bioprocess modelling in unraveling the mechanism working in microscopic level. | CO1 | An | 6 |
|  | b. | Formulate the strategies to complete a process modelling project, indicating the requirement of tools, algorithm, and data pertinent to it. | CO1 | C | 10 |
|  |  |  |  |  |  |
| 2. | a. | Develop the system of differential equations for a microbial bioprocess, utilizing a single substrate for growth and product formation. Assume the product is inhibitory to microbial growth. | CO2 | An | 10 |
|  | b. | Distinguish between structured/unstructured, segregated/unsegregated models adopted in bioprocess. | CO2 | E | 6 |
|  |  |  |  |  |  |
| 3. | a. | Explain the steps involved in solving a system of differential equations using numerical integration with Euler’s method. | CO3 | An | 10 |
|  | b. | Infer the problems associated with 1st order numerical approach. Appraise the use of Runge-Kutta method or any alternative strategies for a better integration accuracy. | CO3 | An | 6 |
|  |  |  |  |  |  |
| 4. | a. | Examine the utility of cross validation approach in modelling. Determine the steps involved in the *k-*fold cross validation with schematics, if necessary. | CO4 | A | 10 |
|  | b. | For a given sets of model parameters, the following modelled values are projected against the experimental one.  Expt. X (g/L) 1 2 3 4  Model X (g/L) 1.5 2.5 3.25 4.75  Compute the SSE and R2 for the given data set. | CO4 | A | 6 |
|  |  |  |  |  |  |
| 5. | a. | Discuss the parameter identifiability problem in modelling. How can we improve the confidence in parameter estimation? | CO5 | U | 10 |
|  | b. | Interpret the terms involved in logistic growth models. Identify the limitations of using a logistic growth kinetics. | CO5 | U | 6 |
|  |  |  |  |  |  |
| 6. | a. | Develop a simplified process model that can capture the microbiological dynamics involved in the anaerobic digestion of substrate(s). | CO6 | C | 10 |
|  | b. | Microorganism is growing on urea, and producing NH3 and CO2 (getting exchanged to atmosphere) in growth associated manner. Infer the number of state variables, and their expressions to be mapped considering pH change in media. | CO6 | C | 6 |
|  |  |  |  |  |  |
| 7. | a. | Explain the substrate utilization parameters, i.e., yield coefficients, maintenance for a bioprocess. Analyse if you can make reasonable guess of those values from your dataset. | CO1 | An | 10 |
|  | b. | Appraise the utility of lumped variables such as DIC, DIN in process modelling. | CO1 | An | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | *Cupriavidus necator* can accumulate biopolymer inside the cell under low nitrogen condition. Polymer accumulation also negatively impact the cell growth. Formulate a bioprocess model taking up these constrains into consideration. | CO6 | C | 14 |
|  | b. | Assume microbial growth requires both nitrogen and carbon as substrate. However, the nitrogen availability is always very high in medium. Propose a simple growth kinetics based on this information. | CO6 | C | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Recognize the different stages and their inter-relationship in bioprocess modelling. |
| CO2 | Relate modelling, simulation and parameter estimation. |
| CO3 | Develop bioprocess system models from experimental data using Matlab tool. |
| CO4 | Examine the suitability of developed models in a quantitative manner. |
| CO5 | Interpret the bioprocess modelling outcome for refinement of model structure. |
| CO6 | Formulate simplification strategies and simulate bioprocess models with relevant examples. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 0 | 0 | 0 | 22 | 0 | 10 | 32 |
| CO2 | 0 | 0 | 0 | 10 | 6 | 0 | 16 |
| CO3 | 0 | 0 | 0 | 16 | 0 | 0 | 16 |
| CO4 | 0 | 0 | 16 | 0 | 0 | 0 | 16 |
| CO5 | 0 | 16 | 0 | 0 | 0 | 0 | 16 |
| CO6 | 0 | 0 | 0 | 0 | 0 | 36 | 36 |
|  | | | | | | | **132** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3009** | **Duration** | **3hrs** |
| **Course Name** | **MICROBIAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Articulate different methods employed for strain improvement of industrially important microorganisms with appropriate examples. | CO1 | A | 10 |
|  | b. | Examine the techniques involved in screening of industrially important enzyme synthesizing microorganisms. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Articulate the working principle of MALDI instrument and their applications in biotechnology. | CO2 | A | 10 |
|  | b. | Explain the objectives of metagenomics and metatranscriptomics. Add a note on their diversified applications. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Appraise the production of any one important recombinant viral vaccine against animal diseases using rDNA technology. | CO3 | An | 10 |
|  | b. | With the help of suitable examples, demonstrate how microorganisms transform antibiotics and alkaloids. | CO3 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Discuss the importance of biofertilizers and bioinsecticides in agriculture with suitable case study. | CO4 | An | 8 |
|  | b. | Quorum sensing causes some pathogens to express virulence factors that promote infection of gram positive and gram negative bacteria-Critically discuss with suitable examples. | CO4 | An | 12 |
|  |  |  |  |  |  |
| 5. | a. | Examine the production of mycotoxins and their impact on human health. Add a note on their types. | CO5 | A | 10 |
|  | b. | Discuss food preservation by means of food additives and irradiation methods. | CO5 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Describe the working principle of 2D gel electrophoresis and their applications in biological sciences. | CO2 | U | 12 |
|  | b. | Describe the methods to construct phylogenetic tree to understand the evolutionary process of microorganisms. | CO2 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Appraise various mechanisms that contribute to Multi Drug Resistant (MDR) bacteria with examples. Comment on the various approaches undertaken to control the menace of MDR. | CO4 | An | 10 |
|  | b. | Discuss about food borne intoxications caused by *Listeria monocytogenes*. | CO5 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the production process of penicillin acylase using suitable microorganism with their industrial applications. | CO6 | C | 10 |
|  | b. | Illustrate the production of industrially important antibiotics and the methods to enhance their yield. | CO6 | A | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Microbial fuel cells are considered as source of sustainable energy- Discuss with suitable examples. | CO6 | U | 10 |
|  | b. | Appraise the production of prebiotics and probiotics using suitable microbial strain with their health benefits. | CO6 | E | 10 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Gain knowledge about recent advances in microbial biotechnology. |
| CO2 | Apply the concept of genomics and proteomics in biotechnology with regard to microorganisms. |
| CO3 | Acquire practical exposure to recombinant DNA technology in microbes to enhance animal health and production. |
| CO4 | Demonstrate and evaluate the interactions between microbes, hosts and environment. |
| CO5 | Give an account of important microbial/enzymatic industrial processes in food and fuel industry. |
| CO6 | Critically analyze any microbial products from an economics/market point of view. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | - | 20 | - | - | - | 20 |
| CO2 | - | 30 | 10 | - | - | - | 40 |
| CO3 | - | 10 | - | 10 | - | - | 20 |
| CO4 | - | - | - | 30 | - | - | 30 |
| CO5 | - | 20 | 10 | - | - | - | 30 |
| CO6 | - | 10 | 10 | - | 10 | 10 | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3010** | **Duration** | **3hrs** |
| **Course Name** | **AGRICULTURE AND FOOD BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Examine the plant genetic transformation technique used by Potrykus in development of Golden rice with a neat diagram. | CO1 | A | 10 |
|  | b. | Evaluate the method of in vitro propagation of horticulture crops and its significance with a suitable example. | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | “Microorganisms play an important role in nutrient cycle” Illustrate the statement with suitable examples. | CO2 | An | 10 |
|  | b. | Evaluate the current scenario of biocontrol agents as an alternative method for climate smart agriculture. | CO2 | E | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the different steps involved in fermentation process development of microbes used in agriculture. | CO3 | A | 15 |
|  | b. | Analyze the safety assessment of foods derived from genetically modified microorganisms. | CO3 | An | 5 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Illustrate the industrial production of single cell protein and its significance as human food supplement. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 5. | a. | Summarize the food safety regulations of processed food in India. | CO5 | E | 15 |
|  | b. | Discuss on recent trends in food processing. | CO5 | U | 5 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Illustrate the importance of national food processing policy and the scope of food processing in India. | CO6 | A | 20 |
|  |  |  |  |  |  |
| 7. | a. | Appraise the different food packages and containers used in food industries. | CO5 | E | 12 |
|  | b. | Articulate the status of implementation of food packing regulations in India. | CO5 | A | 8 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Describe the current status, policy and prospects of external trade of agricultural products in India with suitable examples. | CO6 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Explain the various factors of food spoilage and its prevention as per food safety and standard authority of India. | CO6 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge on basics of biotechnology in Agriculture. |
| CO2 | Outline the applications of microbes in Agriculture. |
| CO3 | Understand the concept of industrial Biotechnology processes. |
| CO4 | Relate the technological applications in food processing. |
| CO5 | Evaluate the advances in Food processing and Packaging. |
| CO6 | Analyze Marketing and Export of Food Products. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  |  | 10 |  |  |  | 10 |
| CO2 |  |  |  | 10 | 10 |  | 20 |
| CO3 |  |  | 15 | 5 | 10 |  | 30 |
| CO4 |  |  | 20 |  |  |  | 20 |
| CO5 |  | 5 | 8 |  | 27 |  | 40 |
| CO6 |  | 20 | 20 | 20 |  |  | 60 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3012** | **Duration** | **3hrs** |
| **Course Name** | **BIOETHICS AND BIOSAFETY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Illustrate the biosafety guidelines for handling and disposal of hazardous substances in rDNA research with suitable examples. | CO1 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Discuss the good laboratory practices to be adapted in genetic engineering laboratory. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 3. | a. | Summarize the steps involved in filing of PCT application and grading of patent. | CO3 | U | 10 |
|  | b. | Debate on traditional knowledge and geographical indications in relation to IPR in India. | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Illustrate the role of IPR in the current scenario of rDNA research in Biotechnology. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain the various biosafety assessment procedures of use of genetically modified microorganisms and their release in environment with relevant case studies. | CO5 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Justify the use of stem cells as an alternate for animal research biotechnology. | CO4 | E | 20 |
|  |  |  |  |  |  |
| 7. |  | Explain the patentability and ethics in organ culture in modern day research with relevant examples. | CO4 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Discuss on ethical implication of GM crops and GMO with suitable examples. | CO6 | U | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Analyze the rDNA guidelines of department of biotechnology for animals and plants. | CO6 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall different rDNA technology of transgenic in animals, humans and plants. |
| CO2 | Understand the various biosafety regulations in transgenics. |
| CO3 | Illustrate IPR and patent procedures. |
| CO4 | Comprehend on various techniques of genome, stem cells and organ research in humans. |
| CO5 | Aware of modern rDNA research and its ethical procedures. |
| CO6 | Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  |  |  | 20 |  |  | 20 |
| CO2 |  | 20 |  |  |  |  | 20 |
| CO3 |  | 10 |  | 20 | 10 |  | 40 |
| CO4 |  |  | 20 |  | 20 |  | 40 |
| CO5 |  |  | 20 |  |  |  | 20 |
| CO6 |  | 20 |  | 20 |  |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3014** | **Duration** | **3hrs** |
| **Course Name** | **IMMUNOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain the types of immunity. | CO1 | U | 10 |
|  | b. | Discuss the characteristics and functions of primary and secondary lymphoid organs citing a suitable example. | CO1 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Describe the history of Immunology highlighting the important discoveries. | CO1 | R | 20 |
|  |  |  |  |  |  |
| 3. | a. | Illustrate and explain the Granulocytes and Agranulocytes. | CO2 | A | 10 |
|  | b. | Describe in detail the process of antigen processing and presentation. | CO2 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Write a detailed account on T-Cell activation and the cellular immune response. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 5. | a. | Describe the various Antigen Antibody reactions. | CO3 | An | 10 |
|  | b. | Explain the Complement system in detail. | CO3 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Distinguish between Tolerance and Autoimmunity. | CO4 | A | 20 |
|  |  |  |  |  |  |
| 7. |  | Write a detailed account on Phage display libraries. | CO5 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Describe PCR based technology for Antibody generation. | CO6 | R | 10 |
|  | b. | Discuss about flow cytometry and immunoelectron microscopy. | CO6 | An | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Evaluate the process of Hemagglutination. | CO6 | E | 10 |
|  | b. | Explain the production and applications of monoclonal antibodies. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Account for the structure and function of the immune system both at the molecular and cellular level. |
| CO2 | Account for polyclonal, monoclonal and humanized antibodies and production of these. |
| CO3 | Describe immunization/vaccination, immunological disease and immunotherapy. |
| CO4 | Plan, carry out and present achieved results of immunological serum analyses by means of different immunotechniques. |
| CO5 | Discuss immunological techniques and on the instrumentation involved. |
| CO6 | Implement various immnotechniques in immunology related applications. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 30 | 10 | - | - | - | - | 40 |
| CO2 | - | 20 | 10 | - | 10 | - | 40 |
| CO3 | 10 | - | - | 10 | - | - | 20 |
| CO4 | - | - | 20 | - | - | - | 20 |
| CO5 | - | 20 | - | - | - | - | 20 |
| CO6 | 10 | 10 | - | 10 | 10 | - | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3019** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED ANIMAL BIOTECHNOLOGY & TISSUE CULTURE** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define artificial insemination and the steps involved in it. | CO1 | R | 10 |
|  | b. | Explain the embryo transfer technique mentioning its advantages. | CO1 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | What are scaffolds? Define the other characteristics that can be controlled and measured in scaffold fabrication. | CO6 | R | 10 |
|  | b. | Explain the biomaterials and their application in tissue engineering | CO6 | An | 10 |
|  |  |  |  |  |  |
| 3. |  | Elaborate on the genetic characteristics and markers of livestock breeds. | CO4 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Describe *in-situ* and *ex-situ* preservation of germplasm. | CO2 | U | 10 |
|  | b. | Explain the gene knockout technology. | CO2 | R | 10 |
|  |  |  |  |  |  |
| 5. |  | Define transgenic animal technology and its applications. | CO3 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain *in-vitro* testing of drugs using animal cell culture. | CO5 | A | 10 |
|  | b. | Elaborate on cell line preservation and its applications. | CO5 | U | 10 |
|  |  |  |  |  |  |
| 7. |  | What are therapeutic proteins? Discuss the application in the expression of therapeutic proteins. | CO4 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Define 3D culture with examples and its protocol for different cell types. | CO6 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Discuss the Ethical, social, and moral issues related to the cloning of transgenic animals. | CO3 | E | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Define concepts in Animal Biotechnology. |
| CO2 | Describe the importance of Cryopreservation of embryos and embryo sexing in animals. |
| CO3 | Relate and evaluate the genetic defects in animal embryos through molecular diagnosis. |
| CO4 | Experiment the technology used for animal breeding. |
| CO5 | Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials. |
| CO6 | Design the strategies for livestock improvement through transgenesis with ethical concern. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | - | 10 | - | - | - | 20 |
| CO2 | 10 | 10 | - | - | - | - | 20 |
| CO3 | 20 | - | - | - | 20 | - | 40 |
| CO4 | 20 | 20 | - | - | - | - | 40 |
| CO5 | - | 10 | 10 | - | - | - | 20 |
| CO6 | 20 | 10 | - | 10 | - | - | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3021** | **Duration** | **3hrs** |
| **Course Name** | **DRUG DESIGN AND DISCOVERY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Explain signal transduction pathways for G-protein coupled receptors. | CO2 | U | 6 |
|  | b. | Explain the dose response curve, toxicity curves and therapeutic ratios. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 2. | a. | Recall the overview of drug development and pathway. | CO1 | R | 3 |
|  | b. | Describe the phase and stages of drug development. | CO1 | R | 13 |
|  |  |  |  |  |  |
| 3. |  | Describe the various inter and intramolecular interactions involved in drug actions with an example. | CO3 | U | 16 |
|  |  |  |  |  |  |
| 4. | a. | Explain in detail about the carcinogenicity and reproductive toxicity testing involved in the preclinical testing of new drugs. | CO6 | U | 8 |
|  | b. | Describe Good clinical practices (GCP) and its guidelines involved in clinical trial testing of new drugs | CO6 | R | 8 |
|  |  |  |  |  |  |
| 5. | a. | Examine the various stages involved in FDA’s new drug approval process. | CO4 | R | 8 |
|  | b. | Enumerate the philosophy of cGMP and its relevance to globalized pharmaceutical industry. | CO5 | R | 8 |
|  |  |  |  |  |  |
| 6. | a. | Infer the regulatory procedure of World Trade Organizations in clinical trials | CO5 | U | 12 |
|  | b. | Give one example to explain the Patent Cooperation Treaty (PCT) | CO5 | U | 4 |
|  |  |  |  |  |  |
| 7. | a. | Pharmacodynamics refers to the relationship between drug concentration at the site of action and the resulting effect-Discuss. | CO1 | U | 10 |
|  | b. | Illustrate about chronic toxicity studies. | CO6 | U | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Appraise the importance of prediction and analysis of ADME properties in drug design. | CO1 | An | 10 |
|  | b. | Explain the following: (i) Combinatorial chemistry (ii) High throughput screening. | CO3 | R | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the process of drug discovery and development. |
| CO2 | Discuss the challenges faced in each step of the drug discovery process. |
| CO3 | Classify the computational methods used in drug discovery. |
| CO4 | Organize information into a clear report. |
| CO5 | Demonstrate their ability to work in teams and communicate scientific information effectively. |
| CO6 | Construct, review and evaluate preclinical and clinical pharmaceutical studies. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 16 | 10 | - | 10 | - | - | 36 |
| CO2 | - | 16 | - | - | - | - | 16 |
| CO3 | 10 | 16 | - | - | - | - | 26 |
| CO4 | 8 | - | - | - | - | - | 8 |
| CO5 | 8 | 16 | - | - | - | - | 24 |
| CO6 | 8 | 14 | - | - | - | - | 22 |
|  | | | | | | | **132** |



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| **Course Code** | **20BT3021** | **Duration** | **3hrs** |
| **Course Name** | **DRUG DESIGN AND DISCOVERY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Describe the various dosage forms of drug. | CO1 | U | 10 |
|  | b. | Explain Lipinski’s rule and list the factors that affect drug distribution. | CO1 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Explain signal transduction pathways for G-protein coupled receptors. | CO2 | U | 10 |
|  | b. | Explain the dose response curve, toxicity curves and therapeutic ratios. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. |  | Classify the different forms of IPR and its implications in drug discovery and development. | CO4 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain various routes of administration with their advantages and disadvantages. Add a note on novel drug delivery system. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 5. | a. | Examine the various stages involved in FDA’s new drug approval process. | CO1 | A | 10 |
|  | b. | Analyze the philosophy of cGMP and its relevance to globalized pharmaceutical industry. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Discuss in detail the categories and systems involved US FDA regulatory agency. | CO4 | U | 10 |
|  | b. | Describe the regulatory action of Central Drugs Standard Control Organization – CDSCO. | CO5 | R | 10 |
|  |  |  |  |  |  |
| 7. |  | Discuss the role of World Intellectual Property organization (WIPO) in intellectual property with one example. | CO5 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Examine the various steps involved in carrying out a clinical trial. | CO6 | R | 10 |
|  | b. | Describe the current principles of Good Clinical Practices guidelines. | CO6 | U | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Describe the CADD and its current scenario in drug discovery on the basis of structure and ligand. | CO3 | R | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the process of drug discovery and development. |
| CO2 | Discuss the challenges faced in each step of the drug discovery process. |
| CO3 | Classify the computational methods used in drug discovery. |
| CO4 | Organize information into a clear report. |
| CO5 | Demonstrate their ability to work in teams and communicate scientific information effectively. |
| CO6 | Construct, review and evaluate preclinical and clinical pharmaceutical studies. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 10 | 10 | 10 |  |  |  | 30 |
| CO2 |  | 40 |  |  |  |  | 40 |
| CO3 |  | 20 |  |  |  |  | 20 |
| CO4 |  | 30 |  |  |  |  | 30 |
| CO5 | 10 | 20 |  | 10 |  |  | 40 |
| CO6 | 10 | 10 |  |  |  |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3026** | **Duration** | **3hrs** |
| **Course Name** | **STEM CELL THERAPEUTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Assess the different classes of cell cultures and their applications. | CO1 | E | 10 |
|  | b. | Infer the significance of Cell morphology and Cryopreservation in storage of cell lines. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 2. |  | Illustrate the importance of Stem Cell Niche which supplies multiple cell lineages to generate functional organs with a labelled diagram. | CO2 | A | 16 |
|  |  |  |  |  |  |
| 3. | a. | Categorize the various growth factors involved in stem cell therapy. | CO3 | An | 8 |
|  | b. | Relate the application of Embryonic stem cells in regenerative medicine. | CO3 | A | 8 |
|  |  |  |  |  |  |
| 4. |  | Classify the derivation and differentiation of Pluripotent stem cells. | CO4 | An | 16 |
|  |  |  |  |  |  |
| 5. | a. | Establish the revolutionary advances of stem cells in Cancer research. | CO5 | A | 8 |
|  | b. | Debate the ethical implications on the concepts of *Organ-on-Chip* and *Body-on-Chip.* | CO5 | An | 8 |
|  |  |  |  |  |  |
| 6. | a. | Discuss the deeper concerns in stem cell technology with respect to ageing, longevity, and Immortality. | CO6 | U | 10 |
|  | b. | Explain the therapeutic application of induced Pluripotent stem cells. | CO6 | A | 6 |
|  |  |  |  |  |  |
| 7. |  | Justify the trend *‘from mechanisms to therapeutic opportunities’* with respect to cellular senescence in ageing. | CO2 | E | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. |  | Appraise the ethical issues of Stem cell therapeutics and its nuances in societal implications. | CO6 | E | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| **CO1** | Understand the basic concepts in culturing animal and mammalian cells. |
| **CO2** | Understand the aspects of cellular ageing. |
| **CO3** | Understand the types of Stem cells, their development and function. |
| **CO4** | Learn the various methods to isolate and culture Stem cells. |
| **CO5** | Learn the various therapeutic applications of stem cells. |
| **CO6** | Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| **CO1** | - | 06 | - | - | 10 | - | 16 |
| **CO2** | - | - | 16 | - | 16 | - | 32 |
| **CO3** | - | - | 08 | 08 | - | - | 16 |
| **CO4** | - | - | - | 16 | - | - | 16 |
| **CO5** | - | - | 08 | 08 | - | - | 16 |
| **CO6** | - | 10 | 06 | - | 20 | - | 36 |
|  | | | | | | | **132** |



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| **Course Code** | **20BT3031** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED ENVIRONMENTAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (5 X 16 = 80 MARKS)**  **(Answer any five from the following)** | | | | | |
| 1. | a. | Classify the major causes of air pollution leads to global warming and green house gas effects. | CO1 | An | 8 |
|  | b. | Describe the role of microorganisms in biogeochemical cycle with suitable examples. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 2. | a. | Articulate different approaches for strain improvement in environmental management. | CO2 | A | 8 |
|  | b. | Lichens – A Pollution Indicator. Justify the importance. | CO2 | An | 8 |
|  |  |  |  |  |  |
| 3. | a. | Illustrate the process flow of waste water treatment. | CO3 | U | 4 |
|  | b. | Define eutrophication. Write the important to remove inorganic nitrogen and phosphate from wastewater with suitable treatment process. | CO3 | A | 12 |
|  |  |  |  |  |  |
| 4. |  | Summarize the methods to eliminate the gaseous and volatile organic contaminants using pollution controlling devices. | CO4 | E | 16 |
|  |  |  |  |  |  |
| 5. |  | Explain the recalcitrant compound degradation pattern and how the hydrocarbon products are degraded? | CO5 | A | 16 |
|  |  |  |  |  |  |
| 6. | a. | Anticipate the production process of biodegradable plastics using biopolymers. | CO6 | C | 8 |
|  | b. | Explain the stages of fermentation process in bioethanol production. | CO6 | A | 8 |
|  |  |  |  |  |  |
| 7. |  | Appraise the structural and catabolic diversity approach for the identification of metagenomes in environmental niche for bioremediation. | CO5 | E | 16 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Question)** | | | | | |
| 8. | a. | Comment on Quorum sensing. Explain the role of Quorum sensing in environmental monitoring. | CO4 | A | 14 |
|  | b. | Write the uses of xylanase in paper production. | CO6 | C | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Create an awareness of professional responsibility towards protecting the environment. |
| CO2 | Learn environmental issues involved engineering and resources projects. |
| CO3 | Study the natural and engineered bio-treatment methods to remediate the pollutants. |
| CO4 | Develop treatment methods and create awareness about opportunities in environmental management. |
| CO5 | Future challenges for bioremediation and biodegradation process. |
| CO6 | Investigate the opportunities for incorporating environmental quality into products, processes and projects. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | - | 8 | - | 8 | - | - | 16 |
| CO2 | - | - | 8 | 8 | - | - | 16 |
| CO3 | - | 4 | 12 | - | - | - | 16 |
| CO4 | - | - | 14 | - | 16 | - | 30 |
| CO5 | - | - | 16 | - | 16 | - | 32 |
| CO6 | - | - | 8 | - | - | 14 | 22 |
|  | | | | | | | **132** |



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| **Course Code** | **20BT3031** | **Duration** | **3hrs** |
| **Course Name** | **ADVANCED ENVIRONMENTAL BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define pollution. Classify the major causes of air pollution that leads to global warming and green house gas effects. | CO1 | An | 10 |
|  | b. | Describe the role of microorganisms in biogeochemical cycle with suitable examples. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Articulate different approaches for strain improvement in environmental management. | CO2 | A | 10 |
|  | b. | Analyze the role of pollution indicators in air quality monitoring. | CO2 | An | 10 |
|  |  |  |  |  |  |
| 3. | a. | Define eutrophication. Write the importance to remove inorganic nitrogen and phosphate from wastewater with suitable treatment process. | CO3 | A | 12 |
|  | b. | Name the pollutants from leather and dye industrial effluents and their impacts in environment. | CO3 | R | 8 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Summarize the methods to eliminate the gaseous and volatile organic contaminants using pollution controlling devices. | CO4 | E | 16 |
|  | b. | List the harmful effects due to disposal of industrial wastes without adequate treatment. | CO4 | R | 4 |
|  |  |  |  |  |  |
| 5. | a. | Explain the recalcitrant compound degradation pattern and how the hydrocarbon products are degraded? | CO5 | A | 14 |
|  | b. | Summarize the treatment methods of waste water by lagoons. | CO3 | A | 6 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Anticipate the production process of biodegradable plastics using biopolymers. | CO6 | C | 10 |
|  | b. | Explain the stages of fermentation process in bioethanol production. | CO6 | A | 10 |
|  |  |  |  |  |  |
| 7. | a. | Appraise the structural and catabolic diversity approach for the identification of metagenomes in environmental niche for bioremediation. | CO5 | E | 16 |
|  | b. | Draw the flow diagram of biodiesel production. | CO6 | E | 4 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Define bioleaching. Illustrate bioleaching process with suitable examples. | CO4 | A | 14 |
|  | b. | Write a note on Vermicomposting. | CO6 | A | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Comment on Quorum sensing. Explain the role of Quorum sensing in environmental monitoring. | CO4 | A | 14 |
|  | b. | Write the uses of xylanase in paper production. | CO6 | C | 6 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Create an awareness of professional responsibility towards protecting the environment. |
| CO2 | Learn environmental issues involved engineering and resources projects. |
| CO3 | Study the natural and engineered bio-treatment methods to remediate the pollutants. |
| CO4 | Develop treatment methods and create awareness about opportunities in environmental management. |
| CO5 | Future challenges for bioremediation and biodegradation process. |
| CO6 | Investigate the opportunities for incorporating environmental quality into products, processes and projects. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 10 |  | 10 |  |  | 20 |
| CO2 |  |  | 10 | 10 |  |  | 20 |
| CO3 | 8 |  | 18 |  |  |  | 26 |
| CO4 | 4 |  | 28 |  | 16 |  | 48 |
| CO5 |  |  | 14 |  | 16 |  | 30 |
| CO6 |  |  | 16 |  | 4 | 16 | 36 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3051** | **Duration** | **3hrs** |
| **Course Name** | **BIOCHEMISTRY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Sketch the formation of pyruvate from glucose with suitable reactions. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Summarize on the classification of carbohydrates with examples. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 3. |  | Explain the biosynthesis of urea cycle. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Enumerate on classification and properties of fatty acids. | CO4 | R | 20 |
|  |  |  |  |  |  |
| 5. |  | Illustrate the double helical structure of DNA with a suitable diagram. | CO5 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Describe the conformation levels of protein with examples. | CO1 | U | 20 |
|  |  |  |  |  |  |
| 7. |  | Discuss the sources, functions and deficiency diseases of vitamin B1, B2  and B6. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Classify fat soluble vitamins with suitable structures and examples. | CO3 | AN | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Classify macro minerals, sources, biochemical functions and deficiency diseases. | CO6 | AN | 20 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins. |
| CO2 | Assess the significance of nucleic acid structure, properties and functions. |
| CO3 | To impart knowledge on the significance of Vitamins and mineral functions. |
| CO4 | Integrate the metabolic pathways of synthesis and degradation of biomolecules. |
| CO5 | Justify the clinical and biological significance of biomolecules. |
| CO6 | Classify the biomolecules and understand their specific roles in biological system. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 20 | 20 |  |  |  | 40 |
| CO2 |  | 20 |  |  |  |  | 20 |
| CO3 |  | 20 | 20 | 20 |  |  | 60 |
| CO4 | 20 |  |  |  |  |  | 20 |
| CO5 |  |  | 20 |  |  |  | 20 |
| CO6 |  |  |  | 20 |  |  | 20 |
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| **Course Code** | **20BT3052** | **Duration** | **3hrs** |
| **Course Name** | **PLANT SECONDARY METABOLITES AND PHARMACEUTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Narrate the types of plant secondary metabolites and their specific functions. | CO1 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Describe the biosynthesis of alkaloids with examples. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 3. |  | Classify the process of detection of microbial pathogens in plants using chemical defense mechanism with examples. | CO3 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Analyze the concepts of compartmentalization in a cell and the process of metabolic channeling in plants with suitable examples. | CO4 | An | 20 |
|  |  |  |  |  |  |
| 5. |  | Discuss the production of pharmaceutically important secondary metabolites – Taxol. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Outline the biosynthesis of plant terpenoids. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 7. |  | Illustrate various subclasses of flavonoids with suitable examples and list their functions. | CO1 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Evaluate the type of excipients used in formulation of a pharmaceutical dosage forms | CO6 | E | 20 |
| **PART – B (1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Describe the steps involved in formulation, production and evaluation of gelatin capsules. | CO6 | R | 20 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Enumerate major plant secondary metabolites and its uses. |
| CO2 | Illustrate the biosynthesis and regulation of plant secondary metabolites. |
| CO3 | Infer the different methods of production of secondary metabolites. |
| CO4 | Interpret the biochemical pathways for improved secondary metabolite production. |
| CO5 | Enumerate the pharmaceutical procedures for preformulation studies. |
| CO6 | Examine the development of formulation and dosage forms. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 20 |  | 20 |  |  | 40 |
| CO2 |  | 40 |  |  |  |  | 40 |
| CO3 |  |  | 20 |  |  |  | 20 |
| CO4 |  |  |  | 20 |  |  | 20 |
| CO5 |  |  |  | 20 |  |  | 20 |
| CO6 | 20 |  |  |  | 20 |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3053** | **Duration** | **3hrs** |
| **Course Name** | **MOLECULAR BIOLOGY AND CELL SIGNALLING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Discuss the enzymes that interact with DNA. | CO1 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Elaborate on DNA damage and repair. | CO2 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | Explain with examples the various types of polymerases and their function. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Assess the steps employed in initiation, elongation and termination of transcription in prokaryotes. | CO3 | E | 20 |
|  |  |  |  |  |  |
| 5. |  | Explain lac operon. | CO4 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | What is Apoptosis? Explain the various pathways involved in Apoptosis. | CO4 | R | 20 |
|  |  |  |  |  |  |
| 7. |  | Illustrate how G-proteins activate cAMP dependent protein kinase and highlight its functions with a neat sketch. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Write a detailed note on siRNA. | CO6 | E | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Define Autophagy. Explain the mechanism of Autophagy. | CO6 | An | 20 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Exhibit a knowledge base in DNA replication, transcription, translation and Cell signaling. |
| CO2 | Summarize the process of gene expression and its regulation in prokaryotes and eukaryotes. |
| CO3 | Experiment with model organisms in gene expression studies and cancer research. |
| CO4 | Compare and contrast the different molecular processes in gene expression, signalling processes and cancer mechanism. |
| CO5 | Engage in review of scientific literature in the areas of biomedical sciences. |
| CO6 | Critique and professionally present primary literature articles in the general biomedical sciences field |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | - | - | - | - | - | 20 |
| CO2 | - | - | - | 20 | - | - | 20 |
| CO3 | - | 20 | - | - | 20 | - | 40 |
| CO4 | 20 | - | - | 20 | - | - | 40 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | - | - | - | 20 | 20 | - | 40 |
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| **Course Code** | **20BT3054** | **Duration** | **3hrs** |
| **Course Name** | **MICROBIOLOGY AND MOLECULAR GENETICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Explain illumina NGS method of sequencing. Add a note on their application. | CO1 | U | 12 |
|  | b. | Appraise the role of Denaturing Gradient Gel Electrophoresis (DGGE), Single Stranded Conformation Polymorphism (SSCP) in identification of microorganisms. | CO1 | E | 8 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Examine the importance of phenol, alcohol, and detergents in control of microbial growth. | CO2 | An | 10 |
|  | b. | Illustrate the working principle of lyophilization and their application in preservation of industrially important microorganisms with appropriate examples. | CO2 | A | 10 |
|  |  |  |  |  |  |
| 3. | a. | Discuss the causative agent, symptomology and pathogenicity of *Mycobacterium tuberculosis*. | CO3 | An | 10 |
|  | b. | Describe the role of human gut microbiome in health and diseases. | CO3 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain genetic fine structure analysis of r11 locus and its outcome. | CO4 | An | 10 |
|  | b. | Explain the following experiments with suitable diagram: (a) Interrupted and Uninterrupted mating (b) Transformation. | CO4 | U | 10 |
|  |  |  |  |  |  |
| 5. | a. | Discuss transposons in drosophila with suitable illustrations. | CO5 | U | 10 |
|  | b. | Illustrate the impact of retro transposons on human evolution with examples. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain the *In situ* and *Ex situ* bioremediation with their advantages and disadvantages | CO3 | U | 12 |
|  | b. | Outline the stepwise development of root nodule in leguminous plants on infection by *Rhizobium* *sp*. | CO3 | U | 8 |
|  |  |  |  |  |  |
| 7. | a. | Examine the life cycle, mode of transmission and clinical features of malaria. | CO3 | An | 12 |
|  | b. | Discuss how energy is produced during anaerobic processes. | CO2 | An | 8 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the mechanism of Ultraviolet Radiation induced DNA damage. | CO6 | U | 6 |
|  | b. | Explain the mode of action of mutagens: (i) Hydroxylamine  (ii) Nitrous acid. | CO6 | U | 8 |
|  | c. | List any three beneficial and harmful effects of mutation with examples. | CO6 | R | 6 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Appraise the molecular basis of mutation and origin of spontaneous mutations using Fluctuation test. | CO6 | E | 10 |
|  | b. | Develop a suitable protocol for the isolation of mutants using a suitable chemical mutagenic agent. | CO6 | C | 10 |

CO – COURSE OUTCOME BL – BLOOMS’ LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Analyze the classification, diversity, and ubiquity of major categories of microorganisms. |
| CO2 | Demonstrate the structural, physiological differences of microorganisms and their growth control. |
| CO3 | Evaluate the interactions between microbes, hosts and environment. |
| CO4 | Acquire knowledge on prokaryotic, eukaryotic genome organization and the process of replication. |
| CO5 | Interpret the epigenetic effects on transposons in genes of interest. |
| CO6 | Describe the causes and consequences of mutations on microbial evolution and the generation of diversity. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 |  | 12 |  |  | 8 |  | 20 |
| CO2 |  |  | 10 | 18 |  |  | 28 |
| CO3 |  | 30 |  | 22 |  |  | 52 |
| CO4 |  | 10 |  | 10 |  |  | 20 |
| CO5 |  | 10 |  | 10 |  |  | 20 |
| CO6 | 6 | 14 |  |  | 10 | 10 | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3055** | **Duration** | **3hrs** |
| **Course Name** | **ANIMAL BIOTECHNOLOGY AND IMMUNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Describe the process of artificial insemination and *in vitro* fertilization in animals. | CO1 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Explain the process of embryo splitting in animals. | CO1 | An | 10 |
|  | b. | Interpret on cryopreservation of sperms, ova and embryos. | CO1 | An | 10 |
| 3. | a. | Describe in situ and ex situ germplasm preservation with examples. | CO2 | R | 10 |
|  | b. | Enumerate on antifertility animal vaccines. | CO2 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Articulate the in utero testing for genetic defects and discuss on pregnancy diagnostic kits. | CO3 | A | 20 |
| 5. |  | Analyze how meat adulteration is detected using DNA based methods with suitable examples. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Explain the principle and applications of the following with illustrations.   1. Immuno electrophoresis 2. Flow cytometry and cell sorting | CO4 | An | 20 |
| 7. |  | Describe the process and purification techniques in the isolation of antibodies. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Appraise the protocols involved in the production of monoclonal antibodies through hybridoma technology. | CO6 | E | 10 |
|  | b. | Explain plant as expression systems with examples. | CO6 | U | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain the mechanism of immunological recognition of tumors. | CO5 | U | 10 |
|  | b. | Discuss on the mechanism of immunosuppression. | CO5 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Explain the role of cryopreservation of embryos and embryo sexing. |
| CO2 | Describe the basic concepts in animal biotechnology and its importance in livestock improvement. |
| CO3 | Relate and identify the genetic defects in animal embryos through molecular techniques. |
| CO4 | Identify the cellular and molecular basis of immune responsiveness through antigen and antibody interactions. |
| CO5 | Describe the roles of the immune system in both maintaining health and contributing to disease. |
| CO6 | Demonstrate a capacity for problem-solving about immune responsiveness. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 20 |  | 20 |  |  | 40 |
| CO2 | 20 |  |  |  |  |  | 20 |
| CO3 |  | 20 | 20 |  |  |  | 40 |
| CO4 |  |  |  | 20 |  |  | 20 |
| CO5 |  | 20 |  | 20 |  |  | 40 |
| CO6 |  | 10 |  |  | 10 |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3056** | **Duration** | **3hrs** |
| **Course Name** | **RESEARCH METHODOLOGY AND APPLIED STATISTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Formulate a strategy to perform a “literature review” valuable to the research design. Highlight the *importance* of literature review in the same context. | CO1 | C | 10 |
|  | b. | Discuss the stages/steps involved in executing scientific research. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | The abstract of an article is a very important structural component of a research article. Explain the significance and propose strategies to make it more valuable and informative. | CO2 | A | 10 |
|  | b. | Illustrate the purpose of the “Methodology” section in a scientific article. Appraise on technical details to be provided in the same and restrictions, if any. | CO2 | U | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain the differences between falsification, fabrication, and plagiarism which are the primary concerns in research misconduct. | CO3 | An | 10 |
|  | b. | Assess the different forms of authorship issues that may arise in scientific publication. Determine the role of authors/researchers to avoid such practices. | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Determine the strategies one should take to choose the right journal for their research work. Explain how would the “Authors instruction” be useful to authors in preparing the manuscript | CO4 | An | 10 |
|  | b. | Explain the different forms of authorship issues that may arise due to a breach of publication ethics. Determine the involvements required from individuals to be credible for “Authorship” | CO4 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Estimate the probability that the sum of numbers from two rolls in a fair dice is (i) exactly eight (ii) more than eight. | CO5 | E | 5 |
|  | b. | Differentiate between the probability mass function and probability density function with appropriate examples. | CO5 | U | 5 |
|  | c. | Suppose the systolic blood pressure is normally distributed with a mean of 120 and a standard deviation of 20 mm Hg. Estimate the proportion of individuals who would have SBP in the range 100<SBP<140. | CO5 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Suppose total carbohydrate intake in 12- to 14-year-old boys is normally distributed, with a mean of 124 g and a standard deviation of 20 g. Estimate percentage of boys in this age range have carbohydrate  intake above 140 g (ii) below 90 g | CO6 | E | 10 |
|  | b. | Microbial susceptibility test is conducted in nine replicates and the readings are (in mm): 27.5, 24.6, 28.0, 26.4, 24.2, 27.2, 28.4, 25.6, and 27.6. Provide a point and interval estimate (95% CI) for the mean zone diameter. Hint: Use *t*-statistics in the calculation. | CO6 | E | 10 |
|  |  |  |  |  |  |
| 7. | a. | Cholesterol levels in middle age women in the United States are approximately normally distributed with a mean of 190 mg/dL. On the other hand, blood tests performed on 100 female Asian immigrants had a mean of 181.52 mg/dL with a standard deviation of 40 mg/dL. Test the hypothesis that blood sugar in immigrants is lower than that of native US citizens at a significance level α of 0.10. | CO2 | An | 10 |
|  | b. | The mean serum-creatinine level measured in 12 patients 24 hours after they received a newly proposed antibiotic was 1.2 mg/dL. If the mean and standard deviation of serum creatinine in the general population are 1.0 and 0.4 mg/dL, respectively, then, using a significance level of .05, test whether the mean serum-creatinine level in this group is different  from that of the general population. | CO2 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Sample of eight individuals who work in company “A” and have a mean systolic blood pressure (SBP) of 132 mm Hg and a sample standard deviation of 15 mm Hg. A sample of 21 workers in the same age group who works for company “B” has a mean SBP of 127 mm Hg and a sample standard deviation of 18 mm Hg. Validate the hypothesis that the mean SBP of the two groups is essentially the same. | CO4 | An | 10 |
|  | b. | A study performed in ethnic groups for high-density lipoprotein (HDL) cholesterol (mg/dL) as below:   |  |  |  | | --- | --- | --- | |  | Asian | American | | Mean | 51 | 55 | | SD | 16.8 | 17 | | n | 1000 | 2000 |   Provide a 95% CI for the difference between the means, assuming normal distribution as the sample size is very high. | CO4 | E | 10 |
| **PART – B (1 X 20 = 20 MARKS)**  **(Compulsory Questions)** | | | | | |
| 9. | a. | Explain the logic behind fitting a regression line using the least squares error approach. Justify the use of regression coefficient as a measure of the fitness of the same. | CO6 | An | 8 |
|  | b | A linear regression of for following data set is presented as *y*=4.34*x*+4.8. Estimate the regression coefficient using the least square approach.   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | *x* | 1 | 2 | 2 | 3 | 4 | 5 | 6 | | *y* | 8 | 14 | 14 | 18 | 24 | 26 | 30 | | CO6 | E | 12 |

CO – COURSE OUTCOME BL – BLOOMS LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Design their experiment keeping in mind the appropriate statistical test to be adopted in support of research hypothesis. |
| CO2 | Understand key steps to transform a wobbly idea into a convincing research proposal report -connecting the small objectives to big-picture. |
| CO3 | Perform hypothesis testing based on parametric and non-parametric approach in statistical package, office tools. |
| CO4 | Analyze the need of literature, experimental data, and supporting information in realm of research publication. |
| CO5 | Practice good-research and publication ethics. |
| CO6 | Understand the need of statistical analysis pertinent to their experimental data. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 0 | 10 | 0 | 0 | 0 | 10 | 20 |
| CO2 | 0 | 10 | 10 | 20 | 0 | 0 | 40 |
| CO3 | 0 | 0 | 0 | 10 | 10 | 0 | 20 |
| CO4 | 0 | 0 | 10 | 20 | 10 | 0 | 40 |
| CO5 | 0 | 5 | 0 | 0 | 15 | 0 | 20 |
| CO6 | 0 | 0 | 0 | 8 | 32 | 0 | 40 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3057** | **Duration** | **3hrs** |
| **Course Name** | **BIOPROCESS AND DOWNSTREAM PROCESSING** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Describe the various parameters to be monitored and controlled in fermentation processes with a neat sketch of a bioreactor. | CO1 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Compare a simple from a complex media and a detailed explanation on media requirements for fermentation. | CO2 | A | 10 |
|  | b. | Examine the steps ensured for the fabrication of a commercial media in industrial fermentation process. | CO2 | A | 10 |
|  |  |  |  |  |  |
| 3. | a. | Describe the various methods used for the isolation of industrially important microorganisms. | CO3 | U | 10 |
|  | b. | Sketch the methods employed to maintain the shelf life of industrially important microorganisms. | CO3 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Analyze on the methods involved in the separation of cells from the bioreactor post fermentation. | CO5 | An | 20 |
|  |  |  |  |  |  |
| 5. | a. | Categorize the methods used in quantification of biomass concentration. | CO4 | An | 10 |
|  | b. | Articulate the growth pattern and kinetics employed in batch culture. | CO4 | A | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Classify the microbial products and demonstrate the kinetic patterns of growth and product formation in batch fermentations. | CO4 | A | 10 |
|  | b. | Describe the environmental factors that affect microbial growth performance. | CO4 | U | 10 |
|  |  |  |  |  |  |
| 7. |  | Illustrate the industrial production of an antibiotic along with its downstream process operation. | CO6 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Infer how an mRNA product can be isolated. Also highlight its downstream approach. | CO5 | U | 10 |
|  | b. | Illustrate the principle of electrostatic interaction used for the separation of biomolecules. | CO5 | A |  |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Discuss on the principle and theory behind lyophilization and drying with suitable diagrams. | CO5 | U | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the process of fermentation and its requirements. |
| CO2 | Recall the media formulation, medium optimization and sterilization process. |
| CO3 | Illustrate the importance of microbial screening and preservation in bioprocessing. |
| CO4 | Discuss the cell growth and product formation. |
| CO5 | Apply knowledge on various unit operations in downstream processing. |
| CO6 | Analyze industrial product development in fermentation process. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 |  | 20 |  |  |  |  | 20 |
| CO2 |  |  | 20 |  |  |  | 20 |
| CO3 |  | 10 | 10 |  |  |  | 20 |
| CO4 |  | 10 | 20 |  |  |  | 40 |
| CO5 |  | 30 | 10 | 10 |  |  | 60 |
| CO6 |  |  | 20 | 20 |  |  | 20 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3058** | **Duration** | **3hrs** |
| **Course Name** | **MOLECULAR MEDICINE AND DIAGNOSTICS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Interpret the issues pertaining to current applications and future developments of Nanomedicine. | CO1 | A | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Examine the necessity to understand the types of infectious diseases for molecular medicine. | CO2 | A | 20 |
|  |  |  |  |  |  |
| 3. | a. | Articulate the role of biobanks in health surveys like HUNT with suitable illustration. | CO3 | A | 10 |
|  | b. | Assess the role of Research Ethics Committees and consent for biobanking. | CO3 | E | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Distinguish the disease and their types with reference to the etiology and pathogenesis for diagnostics. | CO4 | E | 20 |
|  |  |  |  |  |  |
| 5. | a. | Explain the diagnosis and prenatal screening of Cystic Fibrosis. | CO5 | An | 10 |
|  | b. | Survey the significance of PCR diagnosis for Tuberculosis. | CO5 | An | 10 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Appraise the identification of genes, variants and mapping genomes. | CO1 | An | 20 |
|  |  |  |  |  |  |
| 7. |  | Debate the diseases caused by an abnormality in an individual's DNA with respect to Genetic inheritance. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Deduce the significance of both the classes of Major Histocompatibility Complex (MHC) in the immune system. | CO6 | An | 10 |
|  | b. | Differentiate between Monoclonal and Polyclonal Antibodies. | CO6 | An | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Classify the different bone and blood disorders as a means to study genetic basis of diseases and immunodiagnostics. | CO6 | An | 10 |
|  | b**.** | Determine the principles and techniques of Immunohistochemistry as a tool for Immunodiagnostics. | CO6 | A | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| **CO1** | Recognize molecular mechanisms in development of disease. |
| **CO2** | Predict the use of molecular genetic methods in the detection, identification and quantification of different microorganisms. |
| **CO3** | Apply the principles of molecular diagnostics and advantages/limitations of its applications. |
| **CO4** | Develop technological integration of chemistry, physics and molecular biology for use in  bioanalysis relevant for biomedical research and diagnostics. |
| **CO5** | Design advanced study in the theoretical and practical aspects of the genetic basis and diagnosis of disease from both human and pathogen perspectives. |
| **CO6** | Appraise the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| **CO1** | - | - | 20 | 20 | - | - | 40 |
| **CO2** | - | - | 20 | - | - | - | 20 |
| **CO3** | - | - | 10 | - | 10 | - | 20 |
| **CO4** | - | - | - | - | 20 | - | 20 |
| **CO5** | - | - | - | 40 | - | - | 40 |
| **CO6** | - | - | 10 | 30 | - | - | 40 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3063** | **Duration** | **3hrs** |
| **Course Name** | **PHARMACEUTICAL TECHNOLOGY AND CLINICAL TRIAL** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Write short notes on biopharmaceuticals. | CO1 | R | 5 |
|  | b. | Define drug and outline the history of drug discovery and application. | CO1 | U | 15 |
|  |  | (OR) |  |  |  |
| 2. | a. | Schematically explain a ADME properties of drugs and pharmacological effects of oral dosage forms. | CO1 | U | 10 |
|  | b. | Explain in detail the drug metabolism phase testing and analysis. | CO2 | R | 10 |
|  |  |  |  |  |  |
| 3. | a. | Explain briefly the pharmacodynamic properties of oral drug and physiological role in human body. | CO2 | R | 10 |
|  | b. | Define drug incompatibility? Write a note on parenteral dosage and toxicity. | CO2 | U | 10 |
|  |  | (OR) |  |  |  |
| 4. | a. | Enumerate the ideal characteristics of antibiotics and classifications. | CO3 | U | 10 |
|  | b. | Describe the manufacturing process of penicillin drug. | CO3 | A | 10 |
|  |  |  |  |  |  |
| 5. | a. | Explain briefly about recent advances in the manufacture of drugs using  r-DNA technology. | CO4 | A | 10 |
|  | b. | Describe the techniques used for solid dosage analysis and testing methods in pharmaceutical industries. | CO4 | R | 10 |
|  |  | (OR) |  |  |  |
| 6. | a. | Write a detail note on Biomaterials and their applications in Controlled and sustained delivery of drugs | CO4 | U | 10 |
|  | b. | Explain natural and synthetic materials used for mediated drug delivery. | CO3 | R | 10 |
|  |  |  |  |  |  |
| 7. | a. | Explain the various types, applications and advantages of tablet coating. | CO5 | A | 10 |
|  | b. | Write about tablets under the following heads.   1. dry granulation b) wet granulation | CO5 | U | 10 |
|  |  | (OR) |  |  |  |
| 8. | a. | Define clinical trial. | CO6 | R | 3 |
|  | b. | Explain briefly about various clinical trial phases used to define pharmacological activity on new drug discovery. | CO6 | U | 17 |
| **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Define gelatin. Briefly explain the manufacturing of hard gelatin capsule formulation. | CO4 | R | 10 |
|  | b. | Explain capsule quality testing methods and analysis. | CO4 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Distinguish to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education. |
| CO2 | Contrast students with a solid foundation in pharmacology, scientific and engineering fundamentals required to solve biopharmaceutical related problems. |
| CO3 | U students with good scientific and technical knowledge so as to comprehend novel products and solutions for the health care issues. |
| CO4 | Articulate in scientific & professional ethics on biological product manufacturing process. |
| CO5 | Discover scientific methods and SOPs in clinical trials and fundamentals in new drug discovery process. |
| CO6 | Develop academic environment aware of excellence in new drug discovery and patenting professional career. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **R** | **U** | **A** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | 10 |  |  |  |  | 30 |
| CO2 | 10 | 20 |  |  |  |  | 30 |
| CO3 | 10 | 10 | 10 |  |  |  | 30 |
| CO4 | 20 | 20 | 10 |  |  |  | 50 |
| CO5 |  | 10 | 10 |  |  |  | 20 |
| CO6 | 3 | 17 |  |  |  |  | 20 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3063** | **Duration** | **3hrs** |
| **Course Name** | **PHARMACEUTICAL TECHNOLOGY AND CLINICAL TRIAL** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define Pharmaceutical technology and their application in human health. | CO1 | R | 3 |
|  | b. | Define drug and outline the history of drug discovery and application. | CO1 | R | 17 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Schematically explain ADME properties of drugs and pharmacological effects of oral dosage forms. | CO1 | R | 12 |
|  | b. | Summarize the important unit process applied on the drugs manufacturing technology. | CO1 | U | 8 |
|  |  |  |  |  |  |
| 3. | a. | Elaborate the routes of drug administration in human body with example. | CO2 | R | 10 |
|  | b. | Interpret how drug has been activated on the human physiological system to express the pharmacological action. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the criteria for manufacturing good quality soft gelatin formulation. | CO3 | R | 12 |
|  | b. | Describe in brief the physiochemical test for evaluation of soft gelatin capsule. | CO3 | R | 8 |
|  |  |  |  |  |  |
| 5. | a. | Illustrate the chemical technology behind the hard gelatin capsule manufacturing. | CO4 | R | 10 |
|  | b. | Contrast the different methodology to manufacture the soft gelatin capsule. | CO4 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain the analytical methods and tests for various drugs and pharmaceutical formulations. | CO5 | U | 10 |
|  | b. | Briefly describe the standard of hygiene and good manufacturing practice implies on pharmaceutical industries. | CO5 | R | 10 |
|  |  |  |  |  |  |
| 7. | a. | Interpret the sustainable materials used for sustained and controlled delivery of drugs. | CO5 | R | 10 |
|  | b. | Define biomaterials. Explain the role of therapeutic proteins and liposome polymer as a carrier of drug to reach the target receptor. | CO6 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Classify the importance of each human clinical trial phase on the new drug discovery and IPR assessment. | CO6 | U | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain the various types, applications and advantages of tablet coating and testing. | CO4 | R | 10 |
|  | b. | Infer the protocol for manufacturing tablets under the following heads of i. Dry granulation ii. wet granulation. | CO4 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Distinguish to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education. |
| CO2 | Contrast students with a solid foundation in pharmacology, scientific and engineering fundamentals required to solve biopharmaceutical related problems. |
| CO3 | Understand students with good scientific and technical knowledge so as to comprehend novel products and solutions for the health care issues. |
| CO4 | Articulate in scientific & professional ethics on biological product manufacturing process. |
| CO5 | Discover scientific methods and SOPs in clinical trials and fundamentals in new drug discovery process. |
| CO6 | Develop academic environment aware of excellence in new drug discovery and patenting professional career. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 32 | 8 |  |  |  |  | 40 |
| CO2 | 10 | 10 |  |  |  |  | 20 |
| CO3 | 20 |  |  |  |  |  | 20 |
| CO4 | 20 | 20 |  |  |  |  | 40 |
| CO5 | 20 | 10 |  |  |  |  | 30 |
| CO6 | 10 | 20 |  |  |  |  | 30 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3064** | **Duration** | **3hrs** |
| **Course Name** | **BIOINFORMATICS AND BASICS OF R PROGRAMMING** | **Max. Marks** | **100** |

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| --- | --- | --- | --- | --- | --- |
| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A(4 X 20= 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define Bioinformatics. | CO1 | R | 3 |
|  | b. | Write down the format used in nucleic acid data bases submission or reading any information. | CO2 | U | 17 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Explain in detail the genomic sequence format and different open-source biomolecular databases. | CO1 | R | 20 |
|  |  |  |  |  |  |
| 3. | a. | Define multiple sequence alignment and mention the algorithms involved in it. | CO2 | U | 10 |
|  | b. | Write short note on the nomenclature system used in Bioinformatics work. | CO2 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | You have a scoring scheme where  A match gives you +8  a mismatch gives you −5  opening a gap costs you−3  Illustrate the best Local alignment for the same two DNA sequences.  Sequence A: CTTAGAACTAT  Sequence B: CGGAGGTCATAC | CO3 | E | 20 |
|  |  |  |  |  |  |
| 5. | a. | Write a complete note on Computational molecular structure prediction. | CO3 | R | 10 |
|  | b. | What is modelling? Describe the different methods used for molecular modelling. | CO4 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Briefly describe the pharmacophore QSAR modelling. | CO4 | U | 10 |
|  | b. | Explain various advantage and disadvantage of QSAR model. | CO4 | R | 10 |
|  |  |  |  |  |  |
| 7. | a. | Explain the data import in R language. Explain the concept and syntax used in operators, vectors and factors. | CO5 | U | 10 |
|  | b. | Define R packages. **Explain the** R packages for Bioinformatics applications. | CO5 | R | 10 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the installation and configuration procedure and studio environment in R programming with applications. | CO5 | R | 10 |
|  | b. | Briefly describe the manual installation and configuration of a package, loading package to library. | CO6 | U | 10 |
| **PART – B(1 X 20= 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Briefly describe the importance and application of Bigdata analytics in bioinformatics. | CO6 | U | 10 |
|  | b. | Define data mining, briefly describe the various data mining process followed in healthcare and chemical data. | CO6 | U | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
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|  | **COURSE OUTCOMES** |
| CO1 | Familiarized with various biological database and software tools. |
| CO2 | Predict the structure and functions of biomolecules. |
| CO3 | Apprehend the knowledge on ligand and structure-based drug design. |
| CO4 | Enable to write, compile, and run R programs. |
| CO5 | Analyze data from different interfaces. |
| CO6 | Develop R script for various biological problems. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 23 | - | - | - | - | - | 23 |
| CO2 | 27 | 10 | - | - |  |  | 37 |
| CO3 | 10 | - | - | - | 20 | - | 30 |
| CO4 | 10 | 20 | - | - |  |  | 30 |
| CO5 | 20 | 10 | - | - | - | - | 30 |
| CO6 | - | 30 | - | - | - | - | 30 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3065** | **Duration** | **3hrs** |
| **Course Name** | **NGS DATA ANALYSIS** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Discuss ordinary, directory, device files and parent child relationship in UNIX file system. | CO1 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Recall the architecture of UNIX OS and file handling with common commands. | CO1 | R | 20 |
|  |  |  |  |  |  |
| 3. | a. | Describe the procedure involved in pyrosequencing. | CO2 | U | 10 |
|  | b. | Discuss the method involved in SOLiD Sequencing and its applications. | CO2 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Enumerate the functioning of miRNA and siRNA in suppressing  target mRNA activity with suitable examples. | CO3 | An | 20 |
|  |  |  |  |  |  |
| 5. | a. | Appraise on genomic variation in discovery by whole genome sequencing. | CO4 | An | 10 |
|  | b. | Discuss NGS Quality control and read mapping approaches. | CO5 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Explain ensembel genome browser and genome annotation. | CO6 | U | 10 |
|  | b. | Recall bioinformatics tools and its role in analysis and interpretation of genome sequence. | CO5 | An | 10 |
|  |  |  |  |  |  |
| 7. |  | Elucidate on epigenomics data analysis using *De Novo* genome assembly from NGS reads. | CO5 | E | 20 |
|  |  | **(OR)** |  |  |  |
| 8. | a. | Explain the flow chart for the major steps involved in metagenome analysis. | CO5 | An | 10 |
|  | b. | Sketch the importance of 16SrRNA and its role in metagenomics. | CO6 | A | 10 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Describe in detail about RNA sequencing analysis with suitable examples. | CO6 | U | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Summarize the applications of the different NGS technologies, including the weakness and  strengths of the approaches. |
| CO2 | Demonstrate the steps involved in a general NGS data analysis. |
| CO3 | Record key theoretical concepts of alignment and de novo assembly. |
| CO4 | Synthesize and formulate a project and relevant question within the field. |
| CO5 | Illustrate the basics of NGS data analysis. |
| CO6 | Infer analytical and reflective skills in analyzing results from individual steps and the final. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | 20 |  |  |  |  | 40 |
| CO2 |  | 20 |  |  |  |  | 20 |
| CO3 |  |  |  | 20 |  |  | 20 |
| CO4 |  |  |  | 10 |  |  | 10 |
| CO5 |  | 10 |  | 20 | 20 |  | 50 |
| CO6 |  | 30 | 10 |  |  |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3066** | **Duration** | **3hrs** |
| **Course Name** | **ALGAE BIOTECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Report different isolation techniques of microalgae. | CO1 | A | 14 |
|  | b. | Explain growth curve for a microalgal species. | CO1 | U | 6 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Compare between the methods followed for micropipette washing and centrifuge washing with streak plate techniques. | CO1 | An | 14 |
|  | b. | Differentiate between the compositions for BG-11 and BB medium. | CO1 | U | 6 |
|  |  |  |  |  |  |
| 3. | a. | Elaborate on various microalgal harvesting techniques for value-added production. | CO2 | R | 14 |
|  | b. | Discuss the importance of light intensity, aeration and temperature in microalgal culture maintenance. | CO2 | U | 6 |
|  |  | **(OR)** |  |  |  |
| 4. | a. | Explain the bioadsorption of heavy metals by microalgae. | CO3 | U | 14 |
|  | b. | Report on the algal bioremediation of industrial dyes. | CO3 | C | 6 |
|  |  |  |  |  |  |
| 5. | a. | Discuss the technological advancement in the production of biodiesel from microalgae. | CO3 | U | 14 |
|  | b. | Write the application of cyanobacteria as biofertilizer. | CO3 | C | 6 |
|  |  | **(OR)** |  |  |  |
| 6. | a. | Define biomarker and write the importance of any two biomarkers in oxidative stress of microalgae. | CO4 | U | 14 |
|  | b. | Infer the surface characteristics of microalgal species using SEM analysis with a neat sketch of various magnifications. | CO4 | C | 6 |
|  |  |  |  |  |  |
| 7. |  | Develop the technical interventions for various microalgae based commercial products. | CO5 | C | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Summarize the basic understanding on production of microalgal based single cell protein. | CO5 | E | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Write a detailed note on extraction of DNA from microalgae. | CO6 | C | 10 |
|  | b. | Write a detailed note on extraction of chlorophyll from microalgae. | CO6 | C | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Understand the importance of algae and their culture techniques. |
| CO2 | Summarize the value added products of algae. |
| CO3 | Outline the application of algae in Industry and environment. |
| CO4 | Elaborate the cell characteristics of microalgae. |
| CO5 | Investigate different products from algal sources through technological interventions. |
| CO6 | Infer algal characterization using molecular tools. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | - | 12 | 14 | 14 | - | - | 40 |
| CO2 | 14 | 6 | - | - | - | - | 20 |
| CO3 | - | 28 | - | - | - | 12 | 40 |
| CO4 | - | 14 | - | - | - | 6 | 20 |
| CO5 | - | - | - | - | 20 | 20 | 40 |
| CO6 | - | - | - | - | - | 20 |  |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3069** | **Duration** | **3hrs** |
| **Course Name** | **HUMAN ANATOMY, PHYSIOLOGY AND HEALTH EDUCATION** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. | a. | Define the term physiology and describe the physiological aspects of passive membrane transport process. | CO1 | R | 10 |
|  | b. | Explain in detail about the structural and functional characteristics of epithelial tissue. | CO1 | U | 10 |
|  |  | **(OR)** |  |  |  |
| 2. | a. | Define active transport and discuss in detail about uniport, antiport and symport process. | CO2 | U | 10 |
|  | b. | Summarize the physiological aspects of muscle contraction. | CO2 | E | 10 |
|  |  |  |  |  |  |
| 3. |  | Describe in detail about the composition and functions of blood and body fluids. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Discuss the types, causes and symptoms associated with Anemia. | CO4 | U | 20 |
|  |  |  |  |  |  |
| 5. |  | Categorize the regulation of blood pressure, pulse and disorders of heart. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Enumerate the significance of Monocyte-macrophage system. | CO3 | R | 20 |
|  |  |  |  |  |  |
| 7. |  | Criticize the structure and physiological functions of artery, veins and capillaries. | CO5 | E | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Explain the causative agent, mode of transmission and prevention of Tuberculosis. | CO6 | E | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. | a. | Explain the causative agent, mode of transmission and prevention of Chicken pox. | CO6 | U | 10 |
|  | b. | Interpret the pathogenicity of diphtheria toxins and its prevention. | CO6 | A | 10 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Recall the anatomical terminology to identify and describe locations of major organs of each system covered. |
| CO2 | Explain interrelationships among molecular, cellular, tissue and organ functions in each system. |
| CO3 | Summaries the interdependency and interactions of the systems |
| CO4 | Enumerate contributions of organs and systems to the maintenance of homeostasis. |
| CO5 | Describe the physiological role of CVS system on human body. |
| CO6 | Infer to aware of excellence in health education and first aid and to describe modern technology and tools used to study for excellent education carrier and well beings. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 10 | 10 |  |  |  |  | 20 |
| CO2 |  | 10 |  |  | 10 |  | 20 |
| CO3 | 20 | 20 |  |  |  |  | 40 |
| CO4 |  | 20 |  |  |  |  | 20 |
| CO5 |  |  |  | 20 | 20 |  | 40 |
| CO6 |  | 10 | 10 |  | 20 |  | 40 |
|  | | | | | | | **180** |



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| **Course Code** | **20BT3070** | **Duration** | **3hrs** |
| **Course Name** | **VACCINE TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Give a detailed account on the history of vaccination. | CO1 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Analyze the Epidemiology and Pathophysiology of Tetanus. What is the outcome of the vaccination for Tetanus? | CO2 | An | 20 |
|  |  |  |  |  |  |
| 3. |  | Indicate the steps significant to vaccine designing in exogenous and endogenous pathway of antigen processing. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Explain the various types of vaccines. | CO3 | E | 20 |
|  |  |  |  |  |  |
| 5. |  | Discuss Adjuvants, their types and function. | CO4 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Discuss attenuation and inactivation and the various modes and chemicals used. | CO4 | R | 20 |
|  |  |  |  |  |  |
| 7. |  | Elaborate on the various routes of immunization along with their advantages and disadvantages. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Discuss storage and handling of vaccines. Write a note on the assessment of vaccine safety. | CO6 | E | 20 |
| **COMPULSORY QUESTION** | | | | | |
| 9. |  | Analyze the different types of vaccines available against the SARS-CoV-2 virus. | CO6 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

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|  | **COURSE OUTCOMES** |
| CO1 | Describe the role of immune cells and their mechanism and concept of vaccination. |
| CO2 | Categorize the different types of vaccines available for diseases. |
| CO3 | Understand the modern strategies and routes of immunization. |
| CO4 | Apply the concept of vaccine technology for development of vaccines. |
| CO5 | Evaluate various delivery methods suitable for vaccines. |
| CO6 | Relate the quality control and regulatory guidelines involved in vaccine production. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| CO / P | **Remember** | **Understand** | **Apply** | **Analyze** | **Evaluate** | **Create** | **Total** |
| CO1 | 20 | - | - | - | - | - | 20 |
| CO2 | - | - | - | 20 | - | - | 20 |
| CO3 | - | 20 | - | - | 20 | - | 40 |
| CO4 | 20 | - | - | 20 | - | - | 40 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | - | - | - | 20 | 20 | - | 40 |
|  | | | | | | | **180** |



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| --- | --- | --- | --- |
| **Course Code** | **20BT3070** | **Duration** | **3hrs** |
| **Course Name** | **VACCINE TECHNOLOGY** | **Max. Marks** | **100** |

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| **Q. No.** | **Questions** | | **CO** | **BL** | **Marks** |
| **PART – A (4 X 20 = 80 MARKS)**  **(Answer all the Questions)** | | | | | |
| 1. |  | Give a detailed account on the history of vaccination. | CO1 | R | 20 |
|  |  | **(OR)** |  |  |  |
| 2. |  | Discuss the Epidemiology and Pathophysiology of Diphtheria. | CO2 | U | 20 |
|  |  |  |  |  |  |
| 3. |  | Describe antigen processing and presentation and indicate the steps which are significant to vaccine designing. | CO3 | U | 20 |
|  |  | **(OR)** |  |  |  |
| 4. |  | Describe the types of vaccines. | CO3 | E | 20 |
|  |  |  |  |  |  |
| 5. |  | Discuss Adjuvants, their types and function. | CO4 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 6. |  | Discuss attenuation and inactivation and the various modes and chemicals used. | CO4 | R | 20 |
|  |  |  |  |  |  |
| 7. |  | Elaborate on the various modes of vaccine delivery stating their advantages and disadvantages. | CO5 | An | 20 |
|  |  | **(OR)** |  |  |  |
| 8. |  | Discuss storage and handling of vaccines. Write a note on the assessment of vaccine safety. | CO6 | E | 20 |
| **PART – B (1 X 20 = 20 MARKS)**  **COMPULSORY QUESTION** | | | | | |
| 9. |  | Analyze the different types of vaccines for COVID-19. | CO6 | An | 20 |

**CO** – COURSE OUTCOME **BL** – BLOOM’S LEVEL

|  |  |
| --- | --- |
|  | **COURSE OUTCOMES** |
| CO1 | Describe the role of immune cells and their mechanism and concept of vaccination. |
| CO2 | Categorize the different types of vaccines available for diseases. |
| CO3 | Understand the modern strategies and routes of immunization. |
| CO4 | Apply the concept of vaccine technology for development of vaccines. |
| CO5 | Evaluate various delivery methods suitable for vaccines. |
| CO6 | Relate the quality control and regulatory guidelines involved in vaccine production. |

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| **Assessment Pattern as per Bloom’s Taxonomy** | | | | | | | |
| **CO / P** | **R** | **U** | **A** | **An** | **E** | **C** | **Total** |
| CO1 | 20 | - | - | - | - | - | 20 |
| CO2 | - | 20 | - | - | - | - | 20 |
| CO3 | - | 20 | - | - | 20 | - | 40 |
| CO4 | 20 | - | - | 20 | - | - | 40 |
| CO5 | - | - | - | 20 | - | - | 20 |
| CO6 | - | - | - | 20 | 20 | - | 40 |
|  | | | | | | | **180** |