| S.No. | Section/Unit |
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| A. | General Biology (Section) |
| | |
| i) | **Biochemistry** |
| | Biomolecules structure and function |
| | Membrane, action potential, transport |
| | Enzyme, kinetics |
| | Metabolism |
| | Photosynthesis, respiration, electron transport chain |
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| ii) | **Microbiology** |
| | Viruses, microbial classification, diversity |
| | Methods in microbiology |
| | Respiration, nitrogen fixation |
| | Host pathogen interaction, disease causing microorganisms, antibiotics mode of action |
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| iii) | **Immunology** |
| | History, Innate, humoral, cell mediated, organs and cells of immunity |
| | Ag, Ab structure, function, antibody diversity generation, secretion |
| | MHC, Autoimmunity, Graft rejection biology, Hypersensitivity reactions |
| | Monoclonal, polyclonal Ab generation, ELISA, RIA |
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| B. | Genetics, Cellular and Molecular Biology (Section) |
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| iv) | **Genetics and Evolutionary Biology** |
| | Structure of genes, chromosomes, mutation, mutagenesis |
| | Replication, transcription, translation (prokaryotic and eukaryotic), operons and operon mutants |
| | Mendelian inheritance, Complementation |
| | Linkage, recombination, chromosome mapping, extrachromosomal inheritance |
| | Microbial genetics, transposons |
| | DNA damage, repair, genetic diseases, inheritance |
| | **Population genetics**<br>[Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation.] |
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| v) | **Cell Biology** |
| | Cell structure, prokaryotic, eukaryotic |
| | Cell cycle, mitosis, meiosis, cell growth, control |

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| | Cell signalling and signal transduction |
| | Cell death and autophagy; Extra-cellular matrix. |
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| **vi)** | **Molecular biology and genetics** |
| | Structure of genes, chromosomes, mutation, mutagenesis |
| | Replication, transcription, translation (prokaryotic and eukaryotic)<br>[Regulation mechanism, non-coding RNA, operons and operon mutants] |
| | DNA damage and repair |
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| **C.** | **Fundamentals of Biological Engineering (Section)** |
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| **vii)** | **Engineering principles applied to biological systems:** |
| | Material and energy balances<br>[for reactive and non-reactive systems; Recycle, bypass and purge processes] |
| | Stoichiometry of growth and product formation<br>[Degree of reduction, electron balance, theoretical oxygen demand] |
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| **viii)** | **Classical thermodynamics and Bioenergetics:** |
| | Thermodynamics and Ligand binding<br>[Laws of thermodynamics; Solution thermodynamics; Phase equilibria, reaction equilibria] |
| | Bioenergetics<br>[Membrane potential; Energetics of metabolic pathways, oxidation and reduction reactions] |
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| **ix)** | **Transport Processes:** |
| | Fluid flow, Mixing in Bioreactors<br>[Newtonian and non-Newtonian fluids, fluid flow - laminar and turbulent, mixing time] |
| | Molecular diffusion and film theory<br>[Oxygen transfer and uptake in bioreactor, kLa and its measurement] |
| | Heat Transfer<br>[Conductive and convective heat transfer, LMTD, overall heat transfer coefficient; Heat exchangers] |
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| **D.** | **Bioprocess Engineering and Process Biotechnology (Section)** |
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| **x)** | **Bioreaction engineering:** |
| | Rate law, Ideal reactors and enzyme immobilization |

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| | [zero and first order kinetics; Ideal reactors - batch, mixed flow and plug flow; Enzyme immobilization, diffusion effects - Thiele modulus, effectiveness factor, Damkoehler number] |
| | Cell growth kinetics<br>[Kinetics of cell growth, substrate utilization and product formation; Structured and unstructured models] |
| | Processes and scale up<br>[Batch, fed-batch and continuous processes; Microbial and enzyme reactors; Optimization and scale up] |
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| **xi)** | **Upstream and Downstream Processing:** |
| | Upstream processing<br>[Media formulation and optimization; Sterilization of air and media; Filtration - membrane filtration, ultrafiltration; Centrifugation - high speed and ultra; Cell disruption] |
| | Downstream processing<br>[Principles of chromatography - ion exchange, gel filtration, hydrophobic interaction, affinity**,** GC, HPLC and FPLC; Extraction, adsorption and drying] |
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| **xii)** | **Instrumentation and Process Control:** |
| | Instrumentation<br>[Pressure, temperature and flow measurement devices; Valves; First order and second order systems] |
| | Process control<br>[Feedback and feed forward control; Types of controllers - proportional, derivative and integral control, tuning of controllers] |
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| **E.** | **Plant, Animal and Microbial Biotechnology (Section)** |
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| **xiii)** | **Plants:** |
| | Regeneration, tissue culture and kinetics of growth<br>[Totipotency; Regeneration of plants; Plant growth regulators and elicitors; Tissue culture and cell suspension culture system - methodology, kinetics of growth and nutrient optimization] |
| | Plant secondary metabolites, artificial seeds and protoplast fusion<br>[Production, Hairy root culture; Plant products of industrial importance; Artificial seeds; Somaclonal variation; Protoplast, protoplast fusion - somatic hybrid and cybrid] |
| | Transgenic plants<br>[direct and indirect methods of gene transfer techniques; Selection marker and reporter gene; Plastid transformation] |
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| **xiv)** | **Animals:** |

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| | Animal cell culture<br>[Culture media composition and growth conditions; Animal cell and tissue preservation; Anchorage and non-anchorage dependent cell culture; Kinetics of cell growth] |
| | Micro & macro carrier culture, hybridoma and stem cell technology<br>[Animal cloning; Transgenic animals; Knock-out and knock-in animals] |
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| **xv)** | **Microbes:** |
| | Food and Industrial microbiology<br>[Production of biomass and primary/secondary metabolites - Biofuels, bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins and metabolites; Clinical, Screening strategies for new products] |
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| **F.** | **Recombinant DNA technology and Other Tools in Biotechnology (Section)** |
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| **xvi)** | **Recombinant DNA technology**: |
| | Enzymes and vectors<br>[Restriction and modification enzymes; Vectors - plasmids, bacteriophage and other viral vectors, cosmids, Ti plasmid, bacterial and yeast artificial chromosomes; Expression vectors] |
| | DNA library, expression, transposons and gene targeting<br>[cDNA and genomic DNA library; Gene isolation and cloning, strategies for production of recombinant proteins] |
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| **xvii)** | **Molecular tools:** |
| | PCR, NA sequencing and blotting<br>[DNA/RNA labelling and sequencing; Southern and northern blotting; In-situ hybridization] |
| | DNA fingerprinting, CRISPR-Cas and biosensors<br>[RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies] |
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| **xviii)** | **Analytical tools:** |
| | Microscopy and spectroscopy<br>[light, electron, fluorescent and confocal microscopy**;** UV, visible, CD, IR, fluorescence, FT-IR, MS, NMR spectroscopy**]** |
| | Electrophoresis, Immunoassays and flow cytometry<br>[Micro-arrays; Enzymatic assays, ELISA, RIA, immunohistochemistry; immunoblotting, Whole genome and ChIP sequencing] |
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| **xix)** | **Computational tools:** |

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| | Search tools, sequence and structure databases<br>[Sequence analysis - sequence file formats, scoring matrices, alignment, phylogeny] |
| | Genomics, proteomics and metabolomics<br>[Gene prediction; Functional annotation; Secondary structure and 3D structure prediction; Knowledge discovery in biochemical databases; Metagenomics; Metabolic engineering and systems biology] |
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| **G.** | **Engineering Mathematics & GA** |
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| **xx)** | **Linear Algebra:** Matrices and determinants; Systems of linear equations; Eigen values and Eigen vectors. |
| | **Calculus:** Limits, continuity and differentiability; Partial derivatives, maxima and minima; Sequences and series; Test for convergence. |
| | **Differential Equations:** Linear and nonlinear first order ODEs, higher order ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms. |
| | **Probability and Statistics:** Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis. |
| | **Numerical Methods:** Solution of linear and nonlinear algebraic equations; Integration by trapezoidal and Simpson's rule; Single step method for differential equations. |