Department of Biotechnology & Bioinformatics, JUIT

MTech Entrance Examination 2026 – Syllabus

Syllabus for M. Tech.-Biotechnology
General Science (30 Marks) 15 × 2
Biostatistics:
Probability, Major of central tendency and dispersion: Mean, Median, Mode, standard deviation, standard error of mean, skewness, kurtosis; Testing of hypothesis: Z-statistics, t-statistics, F-statistics, correlation regression, chi-square test

Physics:
Laws of thermodynamics, Concept of entropy, Applications to compression and expansion processes. Solution thermodynamics - Excess properties of mixtures, Concept of free energy,

Chemistry:
Concept of pH and buffer, Chemical bonding and hybridization, Atomic and molecular structure, Chemical reaction equilibrium, Chemical reaction mechanism (SN1 and SN2), Chemical kinetics (first & second order)

Introductory Mathematics: Calculus review, Ordinary differential equations, Second and higher order differential equations, Linear algebra, Numerical methods

Computer Science:
Introduction to logic (binary, decimal, hexadecimal number conversions), Flow diagram.

Biological Sciences: 70 marks (35 × 2)

Biomolecular structure and function
Covalent structure of Amino acids, proteins, nucleic acids, carbohydrates and lipids.
Forces that stabilise biomolecules: electrostatic and van der waal's interaction, hydrogen bonding. Interactions with solvents, the hydrophobic effect.
Protein Structure: Structural characteristics of alpha-helix, beta-sheet and beta-turn. Ramachandran plot. Protein domains and domain architecture. Quaternary structure of proteins.
Conformation of Nucleic acids: Structural characteristics of A, B and Z-DNA. 3D structure of t-RNA, ribozymes and riboswitches

Methods in Biotechnology
Concepts of precision and accuracy in experimental measurements. Concept of signal-to-noise ratio.

Biochemical Methods: Chromatography: Ion exchange, Gel Filtration and Affinity chromatography. Electrophoresis: Native and SDS-PAGE. Isoelectric focusing. 2D-PAGE and its applications.
UV spectrophotometry. Beer-Lambert's law and its use in the determination of protein/ nucleic acid concentration.
Fundamentals IR spectroscopy and their use in the study of biomolecular conformation.
Centrifugation: Basic concepts of centrifugation. Calculation of g value from RPM. Density gradient centrifugation. Sedimentation velocity and Sedimentation equilibrium. Separation of sub-cellular components and macromolecules using high speed and ultracentrifugation.
Microscopy: Bright field, phase contrast, fluorescence, confocal, and electron microscopy.

Genomics and Proteomics
Introduction to Genomics: Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes.
Genome sequencing: Human genome project-landmarks on chromosomes generated by various mapping methods; DNA sequencing and sequence assembly; Model organisms and other genome projects;
Proteomics: Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and peptide fingerprinting;

Genetics, Phylogeny & Evolution

Chromosomal inheritance: Principles of Mendelian inheritance, codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, linkage and cross-over, sex-linked inheritance, Population Genetics and Hardy-Weinberg equilibrium.
Extrachromosomal inheritance: Maternal inheritance (mitochondria and chloroplast)
Gene concept: Allele, multiple alleles, pseudoalleles.
Genetic analysis: Linkage maps, mapping with molecular markers, tetrad analysis, gene transfer in bacteria: transformation, conjugation, transduction, sex-duction, fine structure analysis of gene.
Mutation: Spontaneous, induced, lethal, conditional, reversion, mutagenic suppression, germinal and somatic mutation, insertion, deletion, duplication, translocation, transposition, ploidy.
DNA finger printing and its applications, DNA bar coding, marker assisted selection and QTL mapping.
Species concept in archaea, bacteria and eukarya.
Phylogenetic analysis and evolutionary relationship among taxa, MLST.

Tissue Culture, Transgenic Technologies and Biotechnology
Totipotency; Tissue culture media; Plant hormones and morphogenesis; embryogenesis; Cell suspension culture; Micropropagation – shoot tip culture, somatic embryos, artificial seeds;

Applications of tissue culture; shoot tip culture; Wide hybridization, Anther culture and dihaploids.
Direct transformation of protoplasts using PEG; electroporation; Transformation by particle bombardment; Chloroplast transformation. Ti plasmid-based transformation; Ti and Ri plasmids, T-DNA genes, borders, Ti plasmid virulence genes and their functions, Monocot transformation, binary vector; Floral dip transformation; Targeted gene delivery and methods of detection
Principles of plant breeding, breeding for self and cross-pollinated crops. Heterosis breeding limitations of conventional breeding

Biochemistry
Biomolecules and their conformation; Enzyme kinetics; Bioenergetics; Metabolism (Glycolysis, TCA and Oxidative phosphorylation); Membrane transport and pumps; Cell cycle and cell growth control; Cell signalling and signal transduction, Basic immunology, Types of immunity, T-cells and B-cells, Antigen-antibody reaction, Antibody structure, T-cell receptors, Complement system, Autoimmunity, Hyper-sensitivity, Hybridoma technology, Vaccines

Microbiology
Prokaryotic and eukaryotic cell structure; Microbial nutrition, growth and control; Microbial metabolism (aerobic and anaerobic respiration, photosynthesis); Microbial genetics (plasmids, transformation, transduction, conjugation); Microbial diversity and characteristic features; Viruses, Host-pathogen interactions, role of microbes in industry

Molecular Biology and Genetics
Cell division, Central dogma of molecular biology, DNA as genetic material, Structure of DNA and RNA, Physical and chemical properties of nucleic acids, DNA super coiling, Basic techniques of molecular Biology, DNA damage and repair, DNA replication, Gene structure in prokaryotes and eukaryotes, DNA transcription and RNA processing, Genetic code and protein synthesis, Gene regulation, Post-translational modifications, Mutations and their role in Evolution, Population genetics, Genetic disorders

Introduction to Bioinformatics
Biological databases, sequence retrieval and analysis (NCBI & BLAST), Sequence alignment (Pairwise and Multiple sequence alignment), Construction of phylogenetic trees, Gene predictions, RNA and protein structure prediction

Major Bioinformatics Resources: Sequence databases, Gene Expression database: GEO, SAGE, 3D Structure Database: PDB, NDB, Knowledge driven Databases & utility, Pattern Sequence: InterPro, Prosite, Pfam, ProDom, Gene Ontology
Database Searches: Keyword-based searches using tools like ENTREZ and SRS Sequence-based searches: BLAST and FASTA
Sequence Analysis, Basic concepts: Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Tandem and Interspersed repeats, repeat finding.

Scoring Matrix, Pairwise sequence alignments, Multiple sequence alignments (MSA), Application in Taxonomy and phylogeny, Comparative genomics.
Structural Biology: 3-D structure visualisation and simulation, Basic concepts in molecular modelling: different types of computer representations of molecules. External coordinates and Internal Coordinates, Molecular Mechanics, Force fields etc.

Recombinant DNA Technology:
Restriction and modification enzymes; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; cDNA and genomic DNA library; Gene isolation; Gene cloning; Expression of cloned gene; Transposons and gene targeting; DNA labeling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD; RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy.

Bioprocess Engineering and Technology: Principles of microbial growth and factors affecting growth, Growth kinetics and substrate utilization in batch, fed-batch and continuous systems, Introduction to bioreactors: batch and fed-batch, plug flow, continuous, enzyme reactors, Sterilization, Mass transfer of oxygen, aeration and agitation, fluid rheology, Fermentation technology (Description of industrial processes: antibiotics, organic acids, alcohol, bioplastics, vitamins, enzymes; biotransformation of steroids, Basics of neutrigenomics – food-gene interactions, Process flow sheet and process economics

Downstream Processing in Biotechnology: Biomass removal and disruption, Precipitation by salts, solvents, Membrane-based purification, Adsorption and chromatography, Extraction (solvent, aqueous two-phase, supercritical), Drying

Bioprocess Plant Design: General design information, Material and energy balance, Process flow sheet, Scale up and scale down issues, Scale up and downstream processes. Selection and specifications of bioprocess equipment, Facility design aspects. Utilities, Process economics,

Basic techniques in biotechnology
Principle and application of microscopy; filtration; centrifugation; spectroscopy (UV/Visible, NMR, IR), Electrophoresis; chromatography (TLC, HPLC, GC, ion exchange, affinity, gel filtration); lyophilization.