GATE Syllabus

Biotechnology

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BIOTECHNOLOGY

Subject Code: BT

Course Structure

Sections/Units	Topics
Section A	**Engineering Mathematics**
Section B	**General Biotechnology**
Unit 1	Biochemistry
Unit 2	Microbiology
Unit 3	Cell Biology
Unit 4	Molecular Biology and Genetics
Unit 5	Analytical Techniques
Unit 6	Immunology
Unit 7	Bioinformatics
Section C	**Recombinant DNA Technology**
Section D	**Plant and Animal Biotechnology**
Section E	**Bioprocess Engineering and Process Biotechnology**

Course Syllabus

Section A: Engineering Mathematics

- Linear Algebra:
  - Matrices and determinants
  - Systems of linear equations
  - Eigen values and Eigen vectors
- Calculus:
  - Limit, continuity and differentiability
  - Partial derivatives
  - Maxima and minima
  - Sequences and series

- Test for convergence
- Fourier Series

- Differential Equations:
  - Linear and nonlinear first order ODEs
  - Higher order ODEs with constant coefficients
  - Cauchy's and Euler's equations
  - Laplace transforms
  - PDE-Laplace
  - Heat and wave equations
- 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 of trapezoidal and Simpson's rule
  - Single and multistep methods for differential equations

Section B: General Biotechnology

Unit 1: Biochemistry

- Biomolecules-structure and functions
  - Biological membranes
  - Structure
  - Action potential
  - Transport processes
- Enzymes:
  - Classification
  - Kinetics and mechanism of action
- Basic concepts and designs of metabolism:
  - Carbohydrates
  - Lipids
  - Amino acids
  - Nucleic acids
  - Photosynthesis
  - Respiration
  - Electron transport chain
- Bioenergetics

Unit 2: Microbiology

- Viruses- structure and classification
- Microbial classification and diversity (bacterial, algal and fungal)
- Methods in microbiology
- Microbial growth and nutrition
- Aerobic and anaerobic respiration
- Nitrogen fixation
- Microbial diseases and host-pathogen interaction

Unit 3: Cell Biology

- Prokaryotic and eukaryotic cell structure
- Cell cycle and cell growth control
- Cell-Cell communication
- Cell signaling and signal transduction

Unit 4: Molecular Biology and Genetics

- Molecular structure of genes and chromosomes
- Mutations and mutagenesis
- Nucleic acid replication, transcription, translation and their regulatory mechanisms in prokaryotes and eukaryotes
- Mendelian inheritance
- Gene interaction
- Complementation
- Linkage, recombination and chromosome mapping
- Extra chromosomal inheritance
- Microbial genetics (plasmids, transformation, transduction, conjugation)
- Horizontal gene transfers and Transposable elements
- RNA interference
- DNA damage and repair
- Chromosomal variation
- Molecular basis of genetic diseases

Unit 5: Analytical Techniques

- Principles of microscopy-light, electron, fluorescent and confocal
- Centrifugation- high speed and ultra
- Principles of spectroscopy:
    - UV
    - Visible

- CD
- IR
- FTIR
- Raman
- MS
- NMR

- Principles of chromatography:
  - Ion exchange
  - Gel filtration
  - Hydrophobic interaction
  - Affinity
  - GC
  - HPLC
  - FPLC
- Electrophoresis
- Microarray

Unit 6: Immunology

- History of Immunology
- Innate, humoral and cell mediated immunity
- Antigen
- Antibody structure and function
- Molecular basis of antibody diversity
- Synthesis of antibody and secretion
- Antigen-antibody reaction
- Complement
- Primary and secondary lymphoid organ
- B and T cells and macrophages
- Major histocompatibility complex (MHC)
- Antigen processing and presentation
- Polyclonal and monoclonal antibody
- Regulation of immune response
- Immune tolerance
- Hypersensitivity
- Autoimmunity
- Graft versus host reaction

Unit 7: Bioinformatics

- Major bioinformatics resources and search tools
- Sequence and structure databases

- Sequence analysis:
  - Biomolecular sequence file formats
  - Scoring matrices
  - Sequence alignment
  - Phylogeny
- Data mining and analytical tools for genomic and proteomic studies
- Molecular dynamics and simulations (basic concepts including force fields, protein-protein, protein-nucleic acid, protein-ligand interaction)

Section C: Recombinant DNA Technology

- Restriction and modification enzymes
- Vectors; plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome
- Mammalian and plant expression vectors
- cDNA and genomic DNA library
- Gene isolation, cloning and expression
- 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

Section D: Plant and Animal Biotechnology

- Totipotency
- Regeneration of plants
- Plant growth regulators and elicitors
- Tissue culture and Cell suspension culture system:
  - Methodology
  - Kinetics of growth
  - Nutrient optimization
- Production of secondary metabolites by plant suspension cultures
- Hairy root culture
- Transgenic plants
- Plant products of industrial importance

Animal cell 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 technology
- Stem cell technology
- Animal cloning
- Transgenic animals

Section E: Bioprocess Engineering and Process Biotechnology

- Chemical engineering principles applied to biological system
  - Principle of reactor design
  - Ideal and non-ideal multiphase bioreactors
  - Mass and heat transfer
- Rheology of fermentation fluids, Aeration and agitation
- Media formulation and optimization
- Kinetics of microbial growth, substrate utilization and product formation
- Sterilization of air and media
- Batch, fed-batch and continuous processes
- Various types of microbial and enzyme reactors
- Instrumentation control and optimization
- Unit operations in solid-liquid separation and liquid-liquid extraction
- Process scale-up, economics and feasibility analysis

Engineering principle of bioprocessing

- Upstream production and downstream
- Bioprocess design and development from lab to industrial scale
- Microbial, animal and plant cell culture platforms
- Production of biomass and primary/secondary metabolites
- Biofuels, Bioplastics, industrial enzymes, antibiotics
- Large scale production and purification of recombinant proteins
- Industrial application of chromatographic and membrane based bio-separation methods
- Immobilization of biocatalysts (enzymes and cells) for bioconversion processes
- Bioremediation-Aerobic and anaerobic processes for stabilization of solid/liquid wastes