# BIOTECHNOLOGY

M.S. (Pharm.)

| Semester-I | | |
|---|---|---|
| **Course Code** | **Course Name** | **Credits** |
| BT-520 | Cell Biology | 2 |
| BT-530 | Microbial Genetics | 1 |
| BT-550 | Biochemistry | 2 |
| PT-520 | Microbiology | 1 |
| PT-530 | Biochemical Engineering Fundamentals | 2 |
| MC-511 | Spectral Analysis | 2 |
| NP-510 | Separation Techniques | 1 |
| GE-510 | Biostatistics | 2 |
| GE-511 | Seminar | 1 |
| LG-510 | General Laboratory Experience | 3 |
| **Total Credit** | | **17** |
| **Semester-II** | | |
| **Course Code** | **Course Name** | **Credits** |
| BT-610 | Molecular Biology | 2 |
| BT-620 | Recombinant DNA Technology | 2 |
| BT-630 | Immunology and Immunotechnology | 2 |
| BT-650 | Analysis, Diagnostics and Cell Based Screening | 2 |
| BT-660 | Sequence Analysis | 2 |
| GE-611 | Seminar | 1 |
| LS-610 | General Lab Experience in the Area of Specialization | 2 |
| **Total Credit** | | **13** |
| **Semester-III** [Project (22 weeks)] | | |
| **Course Code** | **Course Name** | **Credits** |
| TH-598 | Synopsis | 5 |
| TH-599 | Presentation | 3 |
| **Total Credit** | | **8** |
| **Semester-IV** | | |
| **Course Code** | **Course Name** | **Credits** |
| TH-698 | Thesis | 9 |
| TH-699 | Defence of Thesis | 3 |
| **Total Credit** | | **12** |

**Grand Total (I to IV semesters): 50**

## SEMESTER-I

**BT-520**
**Cell Biology** (2 credits)

1. **Cell structure and organization:** Cells as a unit of life, prokaryotic and eukaryotic cells, biomembranes, structure and basic functions of various cell organelles i.e. nucleus, ribosomes, ER, golgi, lysosomes, peroxisomes, exosomes, cytoskeleton
2. **Tools and Techniques of Cell Biology:** Histology, staining, fluorescence, confocal microscopy, TEM and SEM, Fluorescent dyes and GFP tagged proteins in visualization, FACS, cell fractionation, cell culture.
3. **Organization of tissues:** Cell-cell and cell-matrix interactions, cell adhesion molecules, components of the extracellular matrix, cellular junctions and role.
4. **Cell cycle:** G1, G2, S and M Phase of the cell cycle. Cell cycle analysis and its applications, programmed cell death apoptosis versus necrosis. Role of telomeres in the cell cycle.
5. **Cell signaling:** Receptor concept, receptor signaling and expression, orphan receptors, extracellular signals and cell functions, hormones, second messengers and hormone actions, growth factor
6. **Transport across membranes:** Osmosis, active and passive transport. Protein transporters ion channels, antiporters, symporters. Applications in the field of medicine.
7. **Cellular movement and Molecular motors:** Types of movement, extravasation, role of cytoskeletal proteins in movement, molecular motors, the movement of cilia and flagella, muscle contraction, myosin and kinesins in the movement of vesicles.
8. **Protein Synthesis and Targeting:** Ribosome and endoplasmic reticulum, Secretory pathway, targeting and sorting of proteins, nuclear localization signal, organelle specific signal sequence, ATP driven translocation, glycosylation, transport of protein, endocytosis, exocytosis, macropinocytosis.
9. **Relevance of Cell Biology:** Stem cells, Tissue engineering, infectious disease.
10. **Cancer:** Tumor cells, cell lines and models, proto-oncogenes and oncognese, oncogenic mutations, loss of cell cycle control, carcinogens.

### *Recommended books:*


1. Molecular Cell Biology by Harvey Lodish
2. Molecular Biology of the Cell by Bruce Alberts
3. Principles of Biochemistry: Lehgninger
4. Biochemistry by L Stryer
5. Lehninger Principles of Biochemistry, Fourth Edition, 2007, D. L. Nelson and M. M. Cox W. H. Freeman and Company
6. Biochemistry, Third Edition, 2004, D. Voet and J. G. Voet John Willey and Sons
7. Kuby – Immunology, Sixth Edition, 2007, T. J. Kindt et.al. W. H. Freeman and Company 8. Immunology, Seventh Edition, 2006, David Male et.al ASM Press

**BT-530**
**Microbial Genetics** (1 credit)

1. **Classical genetics:** 'Transforming factor', Hershey and Chase's experiment, Replica plating, Types and selection of mutants
2. **Mechanisms of genetic exchange:** Transformation, Genetic mapping using transformation.
3. **Mechanisms of genetic exchange:** Transduction (generalized, specialized), Genetic mapping using transduction, Triple cross experiments, Cis-trans complementation
4. **Mechanisms of genetic exchange:** Conjugation (Hfr strains; Interrupted mating, time-of entry mapping), Lederberg-Tatum experiment, Resistance plasmids.
5. **Transposition:** Mechanism and models. Insertion sequences. Composite transposons. Transposon-generated in vitro mutagenesis.
6. **Gene regulation in prokaryotes:** Principles of regulation in E. coli, Differences between prokaryotes and eukaryotes. Regulation of transcription and processing (lac operon, tryptophan operon, etc.); Translational control, feedback inhibition. Blue-white screening. Different models and mechanisms of transcriptional attenuation.
7. **Gene regulatory proteins:** Different types of motifs. Structures of repressors. Mechanism of lac repressor. Concept of 'immunity'
8. **Viruses:** Structure, classification, genome, replication and growth, purification, quantification. Mechanism of infection by retroviruses. HAART. Life cycle of viruses: Lytic and Lysogenic phage. Detail of lambda genome.
9. **Other infectious agents:** Koch's postulates Viroids, satellites, prions. Replication species barrier.
10. **Yeast:** Model organism, Importance as a genetic tool. Mating type switch. Types 2of yeast vectors. Important genes. Red-white screening.
11. **Applications of yeast genetics:** Two-hybrid system, Yeast artificial chromosomes. In vivo recombination

## *Recommended books:*


1. Microbiology (4/e) by Lansing Prescott, John Harley and Donald Klein, McGraw hill.
2. Lewin's Genes X by Jocelyn E. Krebs. Elliott S. Goldstein and Stephen T. Kilpatrick.Jones and Bartlett.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (4/e) by Bernard R. Glick, Jack J. Pasternak and Cherly L. Patten, ASM press.
4. Relevant research and review papers.
5. Gene Cloning and DNA Analysis, Fourth Edition, T. A. Brown, Blackwell Science.
6. Principles of Gene Manipulation, Sixth Edition, 2004, S. B. Primrose et.al. Blackwell Science, Atul Prakashan.
7. Pharmaceutical Statistics: Practical and Clinical Applications, Fourth Edition, 2004, Sanford Bolton
8. Biometry, Third Edition, 1995, Robert R. Sokal and F. James Rohlf .
9. Introduction to the Practice of Statistics, Fifth Edition, 2004 David S. Moore and George P. McCabe

10. Experimental Design in Biotechnology, 1989, Perry D. Haaland 11. Probability Statistics and Queueing Theory, 2005, P. Kandasamy, K. Thilagavathi and K. Gunavathi

**BT-550**
**Biochemistry** (2 credits)

1. **Biomolecules:** Carbohydrates, Lipids, chemistry and classification, structures of biomolecules, biochemical properties, pharmaceutical importance
2. **Protein and Nucleic acids:** Structure (primary, secondary, tertiary and quaternary), properties, pharmaceutical importance.
3. **Enzymes:** Classification, mode of action (activation, specificity), enzyme kinetics, enzyme inhibitors and regulators, allosteric enzymes, isoenzymes, multienzyme system, pharmaceutical importance.
4. **Coenzymes and cofactors:** Coenzymes, classification of vitamins, role and mechanism of action of some important coenzyme (NAD+/NADP+, FAD, lipoic acid, tetrahydrofolate, B12- coenzyme), role of cofactors with specific examples
5. **Biochemical energetics Part I:** free energy, concept of standard free energy, laws of thermodynamics, exergonic and endergonic reactions.
6. **Biochemical energetics Part II:** energy rich compounds, coupling of reaction, biological oxidation-reduction.
7. **Carbohydrate metabolism:** Glycolysis, gluconeogenesis, pentose phosphate pathways (PPP), glycolysis, TCA cycle, glyoxylic acid cycle, regulation of carbohydrate metabolism, electron transport chain and oxidative phosphorylation, disorders of carbohydrate metabolisms.
8. **Lipid metabolism:** Hydrolysis, absorption and transport of lipids, catabolism of lipids, ¬ʌ- ʟɤ- and ≡ - oxidation of fatty acids, ketone bodies formation, biosynthesis of fatty acids, disorders of lipid metabolisms.
9. **Protein metabolism:** Hydrolysis, of proteins, pathways of amino acid degradation, urea cycle and formation of uric acid, assimilation of ammonia, biosynthesis of amino acids, inborn error of protein metabolism.
10. **Nucleic Acid Metabolism:** Purine and pyrimidine biosynthesis, salvage pathway, degradation of nucleotides, role of ribonucleotidereductase, pharmaceutical importance, disorders of purine and pyrimidine metabolisms.

***Recommended books:***


1. Principles of Biochemistry by Lehinger.
2. Biochemistry by L. StryerAtulPrakashan.
3. Pharmaceutical Statistics: Practical and Clinical Applications, Fourth Edition, 2004 Sanford Bolton.
4. Biometry, Third Edition, 1995 Robert R. Sokal and F. James Rohlf.
5. Introduction to the Practice of Statistics, Fifth Edition, 2004 David S. Moore and George P. McCabe
6. Experimental Design in Biotechnology, 1989 Perry D. Haaland.
7. Probability Statistics and Queueing Theory, 2005 Kandasamy, K. Thilagavathi and K. Gunavathi.

**PT-520**
**Microbiology** (1 credit)

1. **Introduction aims and scope:** Organization and function of prokaryotic and eukaryotic cells; Structure and function of cell organelles-surface structure, special organelles, cellular reserve materials.
2. **Distinguishing features of various groups of micro organisms:** Actinomycetes, bacteria, moulds, yeasts and algae and their broad classification.
3. **Characteristics of selected groups of microbes:** Archaebacteria and microorganisms of extreme environment; Control of micro organisms by physical and chemical agents; Pure culture concept and cultural characteristics
4. **Microbial nutrition and growth principles:** Growth measurement techniques: assimilation of carbon, nitrogen and sulphur. Various growth media for the cultivation of organisms. Cultivation of anaerobes, rare actinomycetes etc.
5. **Microbial nutrition and growth principles:** Growth measurement techniques: assimilation of carbon, nitrogen and sulphur. Various growth media for the cultivation of organisms. Cultivation of anaerobes, rare actinomycetes etc.
6. **Isolation and preservation:** Isolation, development and preservation of industrial microorganisms; isolation of microorganisms from various sources and long term preservation and improvement of cultures.
7. **Biochemical pathways:** Energy transduction in microbial systems, phosphoketolase, Enterdoudruff and glyoxalate pathways; Anaerobic respiration; Microbial pathogenicity.
8. **Recycling of energy sources:** Bioassays, recycling of carbon, nitrogen and sulphur: Role of microbes in agriculture, public health, medicine and industry.
9. **Control of microorganisms:** Rate of death of bacteria; conditions influencing antimicrobial action; Mode of action of antimicrobial agents; control of microorganisms by physical agents; control of microorganisms by chemical agents; Antibiotics and other chemotherapeutic agents.
10. **Microbiology in the treatment of effluent:** Primary, secondary and tertiary treatment of effluent, aerobic and anaerobic system of treatment, sludge generation, definitions of total solids, soluble solids, fixed solids, volatile solids etc. kinetics of waste treatment.
11. **Microorganisms and disease:** Microbial flora of the healthy human host; natural resistance and nonspecific disease mechanisms; Basis aspects of the immune response; Bacterial agents of disease.

## *Recommended books:*


1. Prescott, Harley and Klein's Microbiology, Seventh Edition – 2008, M. Willey et. al. McGraw Hills Publication.
2. Microbiology: An Introduction, VIIIth Edition – 2006, Tortora et.al. Pearson Education.
3. General Microbiology, Fifth Edition – 2007, R. Stanier et.al., Macmillan Press.

4. Microbial Biotechnology : Fundamentals of Applied Microbiology, Alexander N. Glazer, Hiroshi Nikaido H. Freeman and Company.

## PT-530
## Biochemical Engineering Fundamentals (2 credits)

1. **Homogenous reactions:** Reaction thermodynamics; Reaction yield; Reaction rate; Reaction kinetics; Calculation of reaction rates from experimental data; General reaction kinetics for biological systems; Zero-order kinetics; Michaelis-Menten kinetics; Determining enzyme kinetic constants from batch data.
2. **Microbial growth:** Kinetics of microbial growth; substrate utilization and product formation; Structured and unstructured model for growth; Equations for substrate utilization and product formation and related numericals.
3. **Reactor design:** Bioreactor configurations; Stirred tank; Airlift reactor; Packed bed; Monitoring and control of bioreactors; Ideal reactor operation; Batch operation of a mixed reactor; Total time for batch reaction cycle; Fed-batch operation of a mixed reactor; Continuous operation of a mixed reactor; Chemostat cascade; Continuous operation of a plug flow reactor; Detailed studies on the batch, continuous and fed-batch bioreactors.
4. **Agitation:** Need of agitation in aerobic fermentation; Effect of agitation; How agitation helps aeration; different types of agitational methods; impeller design and relationship with the characteristics of the fluid; flow behaviour etc.
5. **Aeration:** Need of aeration in aerobic fermentation; Effect of aeration; How aeration helps agitation; different types of aeration methods; aeration in high density fermentation; aeration in qualescence and non-qualescence medium; flow behaviour etc.
6. **Sterilization of air and medium:** Different methods of sterilization; Kinetics of sterilization; batch and continuous sterilization; advantages and disadvantages thereof; Calculation of del factor and solving of numerical.
7. **Mass transfer:** Mass and energy balance in microbial processes; Resistance encountered in fermentation medium by the oxygen molecule; Role of dissolved oxygen concentration in mass transfer; Determination of mass transfer co-efficient (KLa), Factors affecting KLa and their relationship.
8. **Heat transfer in bioreactors:** Mechanisms of heat transfer; heat transfer between fluids; Calculation of heat transfer co-efficients; Heat transfer equipment; Steady state conductance; LMTD calculation; Relationship between heat transfers; Cell concentration and stirring conditions.
9. **Dimensional analysis:** Various types of dimensionless analysis in terms of mass transfer; Heat transfer and momentum transfer; Importance of dimensionless number in designing the bioreactors; heat exchangers etc.
10. **Scale-up:** Principles and criteria; Different methods of scale up and the detailed analysis with case studies; Instrumentation and control of bioprocesses.

*Recommended books:*

1. Bioprocess engineering: Basic concept by Michael L. Shuler, FikretKarg
2. Bioprocess engineering Principles by Pauline M. Doran
3. Biochemical Engineering Fundamentals by James Edwin Bailey, David F. Ollis
4. Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, Stephen J. Hall
5. Biotol series (This series has many books pertaining to all fields of Biotechnology, students have to select the books as per the topic of interest)

**MC-511**
**Spectral Analysis** (2 credits)

1. **Ultra Violet (UV) and visible spectroscopy:** a) Energy levels and selection rules: Definitions, molecular orbital approach for energy absorption, various modes of transitions. b) Correlation of structural variation with UV absorption: Factors influencing the position and intensity of absorptions, Inductive and resonance effects, effect of ring size, influence of stereochemical factors. c) Predicting UV absorption: Woodward-Fieser, Fieser-Kuhn and Nelson rules. d) Other factors: Non-conjugated interactions, Solvent effect, S-Cis band.
2. **Infrared (IR) spectroscopy:** a) Characteristic regions of the spectrum: Various modes of vibrations, Energy levels b) Correlation of structure with IR spectra: Influence of substituents, ring size, hydrogen bonding, vibrational coupling and field effect on frequency. c) Applications: Determination of stereochemistry, Spectral interpretation with examples.
3. **Nuclear Magnetic Resonance (NMR) spectroscopy:** a) Fundamentals: Physical basis, Magnetic nuclei, resonance, relaxation processes, signalsensitivity b) Instrumentation: Continuous-Wave (CW) instrument, Pulsed Fourier Transform (FT) instrument, Functions, Relation with sensitivity, Sampling. c) 1H NMR, correlation of structure with spectra: chemical environment and shielding, chemical shift and origin of its concept, reference compound, local diamagnetic shielding and magnetic anisotropy, relation with chemical shift, chemical and magnetic non-equivalence, spin-spin splitting and its origin, Pascal's triangle, coupling constant, mechanism of coupling, integral, NMR solvents and their residual peaks, protons on heteroatoms, quadrupole broadening and decoupling, effect of conformations and stereochemistry on the spectrum, Karplus relationship, diastereomeric protons, Heteronuclear coupling to 19F and 31P, virtual coupling, long range coupling-epi, peri, bay effects. Shift reagents-mechanism of action, spin decoupling and double resonance. Explanation of spectra of some compounds and drugs. d) 13C NMR, correlation of structure with spectra: Chemical environment, shielding and carbon-13 chemical shift, calculation, proton-coupled 13C spectra, Proton-decoupled 13C spectra, Nuclear Overhauser Enhancement (NOE), Problem with integration, Distortionless Enhancement by Polarisation

Transfer (DEFT), Heteronuclear coupling for carbon to deuterium, carbon to 19F, carbon to 31P, Explanation of spectra of some compounds and drugs.

4. **Mass spectrometry (MS):** Molecular ion and meta stable peak, fragmentation patterns, nitrogen and ring rules, McLafferty rearrangement, electron and chemical ionization modes, applications.

*Recommended books:*


1. Introduction to Spectroscopy: A Guide for Students of Organic Chemistry, Donald L. Pavia, Gary M. Lamlma and George S. Kriz Thomson.
2. Spectroscopy of Organic Compounds, 6th edition P. S. Kalsi, New Age Internation United Publication. 3. Instrumental Methods of Analysis,7th edition, Hobart H. Willard, Lynne L. Merrit, John A. Dean and Frank A. Settle, CBS Publishers.
4. Spectrometric Identification of Organic Compounds, 6th edition Robert M. Silverstein and Webster Fransis Wiley-VCH.


**NP-510**
**Separation Techniques** (1 credit)

1. **Separation Techniques:** Need for learning separation techniques, separation techniques in natural product research and drug discovery, extraction techniques.
2. **Chromatography:** General principles, classification of chromatographic techniques, normal and reversed phase, bonded phase chromatography, stationary phases, activity of stationary phases, elutropic series, and separation mechanisms.
3. **Column chromatography and column chromatography:** column packing, sample loading, column development, detection.
4. **Flash chromatography and Vacuum liquid chromatography:** objectives, optimization studies, selecting column and stationary phases, selecting suitable mobile phases, automated flash chromatography, and reverse phase flash chromatography.
5. **High Pressure Liquid Chromatography(HPLC):** Principles, instrumentation, peak shapes, capacity factor, selectivity, plate number, plate height, resolution, band broadening, pumps, injector, detectors, columns, column problems, gradient HPLC, HPLC solvents, trouble shooting, sample preparation, method development.
6. **Planer chromatography – TLC/HPTLC/ OPLC:** Basic principles, sample application, development of plates, visualization of plates, 2D TLC, densitometry, over pressure layer chromatography.
7. **Counter-current chromatography:** Basic principles, droplet counter current chromatography, centrifugal partition chromatography, choice of solvents for SP and MP.
8. **Gas chromatography:** principles, instrumentation, split-splitless injector, head space sampling, columns for GC, detectors, quantification.

9. **Biochromatography:** Size exclusion chromatography, ion exchange chromatography, ion pair chromatography, affinity chromatography general principles, stationary phases and mobile phases.
10. **Gas chromatography:** Introduction to GC-MS and LC-MS techniques and their application in natural products.

### *Recommended books:*


1. Applied Thin Layer Chromatography, 2nd edition, Elke Hahn Deinstrop Wiley-VCH
2. HPLC Made to Measure: A Practical Handbook for Optimization Stavros Kromidas, Wiley-VCH
3. Thin Layer Chromatography: A Modern Practical Approach Practical HPLC method development Lloyd R. Snyder, Joseph J. Kirkland and Joseph L. Glajch John Wiley and Sons.


## GE-510
## Biostatistics (2 credits)

1. **Statistics:** Introduction and its role and uses, Collection, Organization, Graphics and pictorial representation of data, Measures of central tendencies and dispersion, Coefficient of variation.
2. **Probability:** Basic concepts, Common probability distributions and probability distributions related to normal distribution.
3. **Sampling:** Simple random and other sampling procedures, Distribution of sample mean and proportion.
4. **Estimation and Hypothesis testing:** Point and interval estimation including fiducial limits, Concepts of hypothesis testing and types of errors, Student-t and Chi square tests, Sample size and power.
5. **Experimental design and analysis of variance:** Completely randomized, randomized blocks, Latin square and factorial designs, Post- hoc procedures.
6. **Correlation and regression:** Graphical presentation of two continuous variables, Pearson's product moment correlation coefficient, its statistical significance, Multiple and partial correlations, Linear regression, Regression line, coefficient of determination, interval estimation and hypothesis testing for population slope, Introduction to multiple linear regression model, Probit and logit transformations.
7. **Non-parametric tests:** Sign, Mann Whitney U, Wilcoxon matched pair, Kruskalwallis and Friedman two way Anova tests, Spearman rank correlation.
8. **Statistical techniques in pharmaceutics:** Experimental design in clinical trials, Parallel and crossover designs, Statistical test for bioequivalence, Dose response studies, Statistical quality control.

### *Recommended books:*


1. Mathematics and Biostatistics, Second Edition, 2007-2008, G. K. Jani, AtulPrakashan

2. Pharmaceutical Statistics: Practical and Clinical Applications, Fourth Edition, 2004 Sanford Bolton
3. Biometry, Third Edition, 1995, Robert R. Sokal and F. James Rohlf
4. Introduction to the Practice of Statistics, Fifth Edition, 2004, David S. Moore and George P. McCabe
5. Experimental Design in Biotechnology, 1989, Perry D. Haaland
6. Probability Statistics and Queueing Theory, 2005 P. Kandasamy, K. Thilagavathi and K. Gunavathi

**GE-511**
**Seminar** (1 credit)

Introduction, Information retrieval systems. Writing term papers and reports. Organization of scientific material, thesis, dissertation and references. Reading research papers Skills in oral presentation. Each student has to present a seminar before end of the semester.

**LG-510**
**General Laboratory Experience** (3 credits)

As per laboratory manual of NIPER-Guwahati

## SEMESTER-II

**BT-610**
**Molecular Biology** (2 credits)

1. **Genome Organization:** Organization of bacterial genome, structure of eukaryotic Chromosomes, role of nuclear matrix in chromosome organization and function, matrix binding proteins, heterochromatin and euchromatin, DNA reassociation kinetics (Cot curve analysis), repetitive and unique sequences, satellite DNA, DNA melting and buoyant density, nucleosome phasing, DNase I hypersensitive regions, DNA methylation & imprinting.
2. **DNA Structure:** Structure of DNA- A-, B-, Z-, P- and triplex DNA, measurement of properties-spectrophotometric, CD, AFM and electron microscope analysis of DNA Structure.
3. **Replication:** replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins, fidelity, replication of single stranded circular DNA, gene stability.
4. **Repair & Recombination:** DNA repair-enzymes, photoreactivation, nucleotide excision repair, mismatch correction; SOS repair, recombination,

homologous and non-homologous, site specific recombination, chi sequences in prokaryotes.

5. **Prokaryotic & Eukaryotic Transcription:** Prokaryotic transcription, transcription unit, Promoters- constitutive and inducible, operators, regulatory elements, initiation, attenuation, termination-Rho-dependantand independent, anti-termination, transcriptional regulation positive and negative, Regulation of gene expression, negative and positive, trans acting products and cis acting sequences, control of structural gene clusters, induction and repression of genes, role of antisense RNA in gene inactivation, regulator RNA's and micro RNA's as regulators in eukaryotes.
6. **Eukaryotic transcription and regulation:** RNA polymerase structure and assembly, RNA polymerase I, II, III, eukaryotic promoters and enhancers, general transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), activators and repressors, transcriptional and post transcriptional gene silencing.
7. **Post Transcriptional Modifications:** Processing of hnRNA, tRNA, rRNA, 5'-cap formation; 3'-end processing and polyadenylation, Splicing, RNA editing, mRNA stability, catalytic RNA.
8. **Translation & Transport:** Translation machinery; Ribosomes, composition and assembly, universal genetic code, degeneracy of codons, termination codons, Isoaccepting tRNA, Wobble hypothesis, Mechanism of initiation, elongation and termination, Co-and post translational modifications, genetic code in mitochondria, protein stability, protein turnover and degradation.
9. **Mutations, Oncogenes and Tumor suppressor genes:** Nonsense, missense and point mutations, Intragenic and Intergenic suppression, Frame shift mutations, Physical, chemical and biological mutagens. Viral and cellular oncogenes, Tumor suppressor genes from humans, structure, function and mechanism of action of PRB and p53 tumor suppressorproteins, activation of oncogenes and dominant negative effect, suppression of tumor suppressor genes, oncogenes as transcriptional activators.
10. **Transposable elements:** Transposition Transposable genetic elements in prokaryotes and eukaryotes, mechanisms of transposition, role of transposons in mutation.

## *Recommended books:*


1. Genes VIII by Benjamin Lewin.
2. Principles of Genetics by Gardner, Simmons and Snustard.
3. Molecular Biology of the Cell, Fourth Edition, 2002, Bruce Alberts et.al. Taylor and Francis Group.
4. Molecular Cell Biology, Sixth Edition, 2008, H. Lodhish et.al. W. H. Freeman and Company.
5. Gene Cloning and DNA Analysis, Fourth Edition, T. A. Brown, Blackwell Science.
6. Principles of Gene Manipulation, Sixth Edition, 2004, S. B. Primrose et.al. Blackwell
Science.
7. Gene IX, Benjamin Lewin, Jones and Bartlett Publishers.

**BT-620**
**Recombinant DNA Technology** (2 credits)

1. **Basic techniques in Gene analysis:** Purification and analysis of nucleic acids: Isolation of DNA and RNA, Plasmid purification, agarose, polyacrylamide and pulse field gel electrophoresis, southern, northern and western blotting.
2. **DNA Modifying Enzymes:** Type I, II and III restriction enzymes, reverse transcriptases ligases, polymerases, kinases and phosphatases.
3. **PCR & Mutagenesis:** PCR enzymes, primer design, RT-PCR, Real time PCR cDNA synthesis, applications of PCR, random and site directed mutagenesis, primer extension, mutagenesis, strand selection mutagenesis, cassette mutagenesis PCR based mutagenesis, Quik Change mutagenesis.
4. **Vectors:** Cloning, and expression vectors, Plasmids, selectable markers, blue-white selection, phage, yeast vectors and YACs. Tags for purification and visualization bacterial transformation, manual and automated sequencing.
5. **Plant Biotechnology:** Agrobacterium tumefaciens, vectors, nuclear, chloroplast transformation, pest resistance, delay of fruit ripening, antibody generation in plants, edible vaccines. Ethics of rDNA products.
6. **Animal biotechnology:** Transformation of animal cells, stable and transient transfection, selection markers.
7. **Viral vectors:** Adenovirus, adeno-associated virus, baculovirus, herpes virus, retrovirus based expression systems.
8. **Gene targeting:** Random and specific, Cre/lox Psystem, knock-out mice.
9. **Transgenic animals:** Principal, nuclear transfer from somatic cells, stem cells, tests for pluripotency, mouse, frog, Drosophila.
10. **Protein 'pharm'ing:** Design of second generation therapeutic molecules, examples of engineered proteins of therapeutic potential, tools for protein engineering, library-based selection methods.
11. **Gene therapy:** Somatic cell gene transfer, autologous and non-autologous ex vivo genetherapy, prospects and limitations.
12. **Nucleic acid therapeutics:** Antisense technology, siRNA, trans-splicing, ribozymes, aptamers, case studies, advantages and challenges.

## *Recommended books:*


1. Principles of Gene Manipulation and Genomics(7/e) by Sanday Primrose and Richard Twyman, Wiley-Blackwell
2. Analysis of Genes and Genomes by Richard J Reece, John Willey & Sons
Molecular Biotechnology: Principles and Applications of Recombinant DNA(4/e)by Bernard R. Glick, Jack J. Pasternak and Cheryl L. Patten. ASM Press.
3. Relevant review & research papers.
4. Molecular Cloning: A Laboratory Manual J. Sambrook et.al. Cold Spring Harbor Laboratory Press.
5. Principles of Gene Manipulation S. B. Primrose et.al. Blackwell Science.
6. Elements of Biotechnology, P. K. Gupta, Rastogy Publishers.
7. An Introduction to Genetic Analysis, A. J. F. Griffiths et.al., W. H. Freeman and Company
8. Gene IX, Benjamin Lewin Jones and Bartlett Publishers
9. Genetic Engineering Principles and Practice, 2007 Sandhya Mitra, Macmillan

India Ltd.
10. Biotechnology in Healthcare: An Introduction to Biopharmaceuticals, 1998 Eds., G. Brooks Pharmaceutical Press

## BT-630
## Immunology and Immunotechnology (2 credits)

1. **Immunity:** Innate and adaptive, immune response memory, specificity and recognition of self and non-self, immunogenicity, antigenicity, physiology of immune response, epitope analysis, synthetic peptides and immune response, immunity to virus, bacteria, fungi.
2. **Cells and organs of the immune system:** Lymphoid cells, T cells, B cells, monocytes, phagocytes, mast cells and basophils, primary and secondary lymphoid organs, interplay between cells.
3. **Humoral immunity:** Antigen-antibody interactions, affinity, avidity, immunoglobulins, molecular mechanism of generation of antibody diversity, molecular biology of IgG.
4. **Cell mediated immunity:** T cell subset and surface marker, T cell-dependent and independent markers, structure and function of MHC, association of MHC with disease susceptibility, structure of T cell antigen receptor.
5. **Natural immunity:** Inflammation, stimuli, chemotaxis, arachidonic acid Metabolite and cytokines, vascular modifications, healing and fibrosis.
6. **Natural killer cells:** Functional definition, mechanism of lysis, recognition structures, phosphorylation.
7. **Immune memory:** B-cell memory significance, mutations and switches in memory cells, T cell memory, lack of mutations and switches in T -cell memory, activation, super activation, loss of memory.
8. **Immune tolerance:** B-cell tolerance, reversible and irreversible tolerance, antigen induced tolerance, induction, T-cell tolerance, partial engagement of signal transducer, self-antigens, molecular consequence of tolerance.
9. **Disorders:** Hypersensitivity reaction, immunosuppression, autoimmune disorders, its molecular mechanism, immuno deficiency disorders (AIDS), tumor immunology.
10. **Immunobiotechnology:** Hybridoma, vaccines, viral, bacterial peptides, genetically engineered production of lymphokines, second generation antibodies a brief outline.

### *Recommended books:*

1. Cellular and Molecular Immunology by A.K. Abbas, Andrew H. Lichtman and Shiv Pillai.
2. Kuby., Immunology by Thomas J. Kindt. Barbara A. Osborne, and Richard A. Goldsby
3. Kuby – Immunology, Sixth Edition, 2007, T. J. Kindt et.al. W. H. Freeman and Company
4. Immunology, Seventh Edition, 2006, David Male et.al. ASM Press

**BT-650**

**Analysis, Diagnostics and Cell Based Screening** (2 credits)

1. **Total protein assay:** Quantitative amino acids analysis, Folin-Lowry protein assay, BCA assay, UV spectrophotometry etc.
2. **Purity:** Protein impurities, contaminants, electrophoretic analysis, HPLC based analysis, DNA content analysis, immunological assays for impurities, combined immunological and electrophoretic methods, host-cell impurities etc. ICH guidelines.
3. **Potency assays:** In-vitro biochemical methods MTYT assay, assay for apoptosis, cell-line derived assays, whole animal assays etc.
4. **Principles, methods and applications of immuno-diagnostics:** Principles and methods of some clinically used diagnostic immunoassays, e.g., homogeneous immunoassays, fluorescence, chemiluminescence and bioluminescence enzyme immunoassays, immunoblot, immunoaffinity, immunoprecipitation, biotinylation, immunosensors.
5. **Principles, methods and applications of DNA-based diagnostics:** DNA probe based diagnostics, sample preparation, hybridization, separation, detection, PCR-RFLP in paternity and forensic cases SNP detection MALDI and DHPLC.
6. **Diagnostics:** Cancer diagnostics, human retroviral diseases specially AIDS. Role of enzymes in diagnostics.
7. **High-throughput screening:** Requirements and parameters, Advantages and disadvantages of biochemical and cellular assays; miniaturization and automation. Cell-based. screening assays: Advantages over in vitro assays. Different formats: radioactive, luminescence, fluorescence, etc. Assays compatible with cell membranes: GTPyS, cAMP accumulation.
8. **Yeast two-hybrid system:** Different Y2H systems, their advantages and disadvantages, examples.
9. **GPCRs as targets:** Identification of drug molecules; Important parameters: intracellular calcium, cAMP, $_{L\chi}$-arrestin, receptor internalization, reporter gene assays; orphan GPCRs; desensitization and internalization.

## *Recommended books:*


1. The immunoassay Handbook by David Wild
2. High Throughput Screening: The Discovery of Bioactive Substances by John P. Devlin
3. Practical Biochemistry: Principles and Techniques, Fifth Edition, 2005, K. Wilson and J. Walker 4. Experimental Biochemistry, Third Edition, 1999, R. L. Switzer and L. F. Garrity W. H. Freeman and Company
4. US Pharmacopeia, Vol. 1-3, 2007 National Formulary 25, (Biotechnological drugs) The USP Convention
5. Indian Pharmacopoeia, Vol. 1-3, 2007 (Biotechnology products) The IP Commission, Ghaziabad
6. Related Review Articles.

**BT-660**
**Sequence Analysis** (2 credits)

1. **Basics of Computational Biology:** Database concept; Protein and nucleic acid databases, structural databases.
2. **The NCBI:** publicly available tools, Resources at NCBI and EBI, DNA and protein information resources on the web.
3. **DNA Sequence Analysis Part I:** Analysis of sequencing chromatogram editing and contig building. Sequence-function relationship; Detection of protein-coding regions, promoters, transcription factor binding sites, restriction enzyme cleavage sites and intron-exon boundaries.
4. **DNA Sequence Analysis Part ll:** Databases and search tools; Biological background for sequence analysis. Retrieval of DNA sequences and searching of databases for similar sequence. Submitting DNA sequence to databases, where and how to submit.
5. **Protein sequence analysis:** Comparison of protein sequences and database searching. Predictive methods for protein sequences. Methods for discovering conserved patterns in protein sequences and structures and protein motifs.
6. **BLAST, various methods of DNA and protein BLAST and interpretation of output:** Sequence alignment, Pairwise alignment, Techniques, Multiple Sequence Alignment.
7. **Predicting secondary structure from protein sequences:** Protein structure prediction, homology modeling. Comparison of protein three-dimensional structures. Protein familybased methods for homology detection and analysis.
8. **Phylogentic analysis sequence-based taxonomy:** Overview and assumptions from Multiple Alignment to phylogeny. Neighbour joining, maximum likelihood vs.parsimony. Computational tools for phylogentic analysis.
9. **Next generation sequencing and Realtime PCR:** Concept theory and applications in sequence detection and analysis.

## *Recommended books:*


1. Essential Bioinformatics, by Jin Xiong
2. Bioinformatics: Sequence and Genome Analysis, by David W. Mount
3. Systems Biology by Bernhard Palsson
4. Systems Biology in Practice, Concepts, Implementation and Application by E. Klipp, R. Herwig, A. Kowald, C. Wieriing, H. Lehrach
5. Relevant Research and Review Papers
6. Systems Biology: Principle, Methods and Concepts. CRC Press.Taylor & Francis Group (2007).
7. An Introduction to System Biology. CRC Press.Taylor & Francis Group (2007).

**BT-611**
**Seminar** (1 credit)

Students are required to submit written record and present details of the project to be pursued in semester-III and IV. This should include the purpose and basis of the project, stating aims, objectives and probable outcomes, be able to supplement these with necessary information, literature review towards it, and process for the project itself.

**LS-610**

**General Laboratory Experience in the area of specialization** (2 credits)

As per laboratory manual of NIPER-Guwahati

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# Syllabus

# PhD

# Biotechnology

| SEMESTER-I | | |
|---|---|---|
| **Course Code** | **Course Name** | **Credits** |
| BT-710 | Interfacial Enzymology | 2 |
| BT-720 | Therapeutic and Diagnostic approaches in Neglected Tropical Diseases | 2 |
| **SEMESTER-II** | | |
| BT-810 | Protein Structure and Stability | 2 |
| BT-820 | Host-Pathogen Interaction in Infectious Disease | 2 |

## SEMESTER-I

**BT-710**
**Interfacial Enzymology** (2 credits)

1. **Enzymology:** fundamental, enzyme kinetics, enzyme inhibition and inhibitors, example of enzymatic reactions, regulation of enzyme.
2. **Biophysics of enzyme:** lipid interaction : structural features of membrane lipids, critical micellar concentration, cooperativity of micellization, liposomes, lipoprotein particles.
3. **Membrane properties modulating structure-function of enzymes:** Properties of lipid bilayer phases, effect of sterols on aggregates of lipids, membrane fluidity.
4. **Interfacial and non-interfacial enzymes:** issues of interfacial and non-interfacial enzymology, interfacial enzymes of lipid metabolism, phospholipase A , interfacephenomenon.
5. **Interfacial Activation:** Enzyme versus substrate model, interfacial processivity, interfacial catalytic turnover, Scooting and Hopping model, interfacial allostery, inhibition and Inhibitors.
6. **Methods to study interface and interfacial enzymes:** IR spectroscopy, Attenuated total reflection Fourier transform infra-red (ATR-FTIR) spectroscopy, IRE, sample preparation, use of fluorescent substrate and indicators.
7. **Determination of protein secondary structure :** dynamic and orientation in lipid-protein mixture, methods for ATR-FTIR spectra evaluation.
8. **Lipoproteins:** Lipoproteins, different types, major components, apolipoproteins, reverse cholesterol transport.
9. **Lipoproteins associated enzymes:** Various enzymes associated with lipoproteins, their role in physiology and pathology.
10. **Screening of enzyme inhibitors:** various methods available to screen enzyme inhibitors.

**BT-720**

**Therapeutic and Diagnostic approaches in Neglected Tropical Diseases**

(2 credits)

1. **Application of biotechnology in drug discovery:** Introduction, identification of sources for isolating the gene that encodes the target proteins, engineer expression system for target protein.
2. **Protein expression systems:** Optimization of cell expression system to maximize production of target proteins; application of TAP tagging in protein protein interaction anddrug discovery.
3. **Identification of potential vaccine candidates:** Basic concepts of vaccines, types of vaccines, techniques for identification of potential vaccine candidates, conventional vaccinology vs. reverse vaccinology.
4. **Genomics:** Key role of genomics in modern vaccine and drug design for emerging infectious diseases. Genomics and diagnosis of infectious diseases.
5. **Biomarkers in infectious diseases:** Introduction to biomarkers, classification of biomarkers, types of biomarkers-genes, proteins, RNA, biomarkers of infectious diseases, technologies for identification of biomarkers-PCR, Combined PCR-Elisa and other non PCR methods.
6. **Monoclonal antibodies as therapeutic targets:** Antibody structure and function, antibody classes and biological actions, monoclonal antibody and infectious diseases.
7. **Epitope mapping:** Epitope mapping and its application in vaccines and protein therapeutics, advantages of monoclonal antibodies over existing chemotherapy.
8. **Immunogenecity and immunotoxicity of Biopharmaceuticals:** Biotech derived productscytokines, plasminogen, growth factors, monoclonal antibodies and fusion proteins, preclinical and clinical levels of biopharmaceuticals,rules for regulation of synthesis and testing of biopharmaceuticals.
9. **RNA silencing technologies in drug discovery and target validation:** Silencing of genes inducible and reversible RNAi mediated knockdown, antisense oligonucelotides, mechanism of action of antisense oligonucelotides, antisense oligonucelotides for neglected tropical diseases,RNAi as an anti-infectious agent.
10. **Generation of mutant strains for functional analysis of essential genes:** Gene knock out and knock in by double displacement and overexpression strategies.

# SEMESTER-II

**BT-810**
**Protein Structure and Stability** (2 credits)

1. **Protein structure:** Diversity, Taxonomy, Higher levels of organization, Post-translational modifications.
2. **Analytical chromatographic methods:** Chromatography of peptides and high molecular weight proteins.
3. Spectroscopic techniques for protein structure analysis.
4. **Strategies for sequence determination:** Enzymatic and chemical.
5. **Forces responsible for protein structure and stability:** Thermodynamics.
6. **Kinetics of protein folding:** Two-state and multistate kinetics, Transition states and intermediates.
7. **Protein folding in the cell :** Lessons learnt.
8. **Stability of proteins:** Kosmotropes and chaotropes. Denaturation and renaturation of proteins.
9. **Protein stabilization:** Theories.
10. **Stabilization of proteins:** Role of additives.

**BT-820**
**Host-Pathogen Interaction in Infectious Disease** (2 credits)

1. **Introduction Infectious Disease and relevance:** Causative agents, bacterial and viral diseases, Pandemics.
2. **Tuberculosis:** Mycobacterium tuberculosis-a global epidemic, reasons for resurgence, drug resistance and emergence of new diseases.
3. **Fundamentals of the process of Infection:** Basic concepts of Immunology & Cell Biology, Intercellular pathogens; extracellular pathogens.
4. **Survival strategies of Mycobacterium tuberculosis:** Cell wall, phagocytosis, virulence factors, secretion systems in M.tb and other pathogens and their importance.
5. **Immunity and Resistance:** Host-pathogen interaction, Invasion, adhesion, cell signalling and trafficking, manipulating host resources, extracellular matrix and cytoskeleton, fibrinolytic pathway.
6. **Iron metabolism:** Iron and copper, iron metabolism, iron uptake and transport mechanisms in host and pathogen, role in infection, essential requirement of iron in tuberculosis.
7. **Multifunctional proteins:** Concept of multifunctionality, role in pathogenesis, interplay and regulation of these proteins during infection.
8. **In vivo and in vitro techniques:** Cell culture models, fluorescent proteins, rDNA techniques, lentiviral and retroviral vectors, microscopy, FACS analysis, animal models.

9. **In vivo and in vitro techniques:** Cell culture models, fluorescent proteins, rDNA techniques, lentiviral and retroviral vectors, microscopy, FACS analysis, animal models.
10. **Intervention Strategies:** Drugs and their limitation, targeted delivery of drugs, utilizing cell and pathogen biology to design new drugs, newer approaches for drug discovery.
11. **Vaccines:** Types of vaccines, Future perspectives.

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