BIOTECHNOLOGY
M. S. (Pharm.)

Course no.	Course Name	Credits
Semester I		
CORE SUBJECTS (ALL COMPULSORY)		
BT-510	Molecular Biology	2
BT-520	Cell Biology	2
BT-530	Biochemistry	2
BT-540	Microbial Genetics	1
GE-510	Biostatistics	2
GE-511	Seminar	0.5
LG-510	General Laboratory Experience	2.5
	Total	**12**
ELECTIVE SUBJECTS (4 CREDITS)		
EL-501	Biochemical Engineering Fundamentals	2
EL-502	Biotechnology in Pharmaceutical Sciences	1
EL-503	Microbiology	1
EL-504	Industrial safety and green chemistry	1
EL-505	Computer Application in Biomedical Engineering	1
EL-506	Biological System Analysis and Control	1
EL-507	Productivity in management and reengineering (Neha	1
EL-508	Biosynthesis of Natural Products	1
EL-509	Chemotherapy of Parasitic and Microbial Infections	1
	Choose any core courses of other department (MC/MD/PA/PC/PE)	
	Total Credits	**16**
Semester II		
CORE SUBJECTS (ALL COMPULSORY)		
BT-610	Immunology and Immunotechnology	2
BT-620	Analysis, Diagnostics and Cell Based screening	2
BT-630	Introduction to Bioinformatics	2
BT-640	Introduction to Cancer Biology	2
PC-610	Pharmacological Screening and Assays	1
GE-611	Seminar	0.5
LS-610	General Lab Experience in the Area of Specialization	2.5
	Total	**12**
ELECTIVE SUBJECTS (4 CREDITS)		
EL-601	Biomechanics	2

EL-602	Mathematical Methods in Biomedical Engineering	1
EL-603	Logistics & distribution	1
EL-604	Total quality control	1
EL-605	Lean system, 6 sigma	1
EL-606	Introduction to Ayurveda and Polyherbal Formulations	1
EL-607	Chemotherapy and Immunopharmacology	2
EL-608	Pharmacovigilance and Medical Writing	2
	Choose any core courses of other department (MC/MD/PA/PC/PE)	
	Total Credits	**16**
	Semester III	
TH- 598	Synopsis, Presentation	9
	Semester IV	
TH-698	Thesis Writing and Thesis Defense	9
	TOTAL CREDITS (I TO IV SEMESTERS)	**50**

BT-510

Molecular Biology (2 Credits)	Hrs
Genome Organization: DNA as the genetic material, Organization of bacterial genome, structure of eukaryotic chromosomes, nuclear matrix in chromosome organization, matrix binding proteins, heterochromatin and euchromatin, DNA reassociation kinetics, repetitive and unique sequences, satellite DNA, DNase I hypersensitive regions, DNA methylation & imprinting.	4
Replication: replication initiation, elongation and termination in prokaryotes and eukaryotes, enzymes and accessory proteins	2
Repair & Recombination: DNA repair-enzymes, nucleotide excision repair, mismatch correction; SOS repair, recombination (homologous and non-homologous, site specific recombination), Transposition, role of transposons	3
Prokaryotic Transcription: Prokaryotic transcription, transcription unit, Promoters, operators, regulatory elements, initiation, attenuation, termination, transcriptional regulation- positive and negative, Regulation of gene expression, negative and positive, trans acting products and cis acting sequences	5
Eukaryotic transcription, regulation and modification: RNA polymerase structure and assembly, RNA polymerase, promoters and enhancers, transcription factors, TATA binding proteins, transcriptional and post transcriptional gene silencing. Processing of hnRNA, tRNA, rRNA, 5'-cap formation; 3'-end processing and polyadenylation, Splicing	5
Translation: Translation machinery; Ribosomes, universal genetic code, degeneracy of codons, Wobble hypothesis, initiation, elongation and termination, post translational modifications, protein stability, turnover and degradation.	5
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.	4
DNA Modifying Enzymes: Type I, II and III restriction enzymes, reverse transcriptases ligases, polymerases, kinases and phosphatases.	2
PCR & Mutagenesis: PCR principle, components, primer design, applications of PCR. cDNA synthesis, Real time PCR. Random and site directed mutagenesis, primer extension, Types of mutagenesis (strand selection, cassette, PCR based, Quik Change).	4
Vectors & Cloning: Plasmids, selectable markers, blue-white selection, phage, Adenovirus, baculovirus, retrovirus based expression systems, yeast vectors. Tags for purification and visualization. Transformation of animal cells, stable and transient transfection, selection markers. Basics of cloning, strategies and its applications.	5
Protein 'pharm'ing: Design of second generation therapeutic molecules, tools for protein engineering	1

READING MATERIAL

1. Genes by Benjamin Lewin.
2. Principles of Genetics by Gardner, Simmons and Snustard.
3. Molecular Biology of the Cell, Bruce Alberts et.al. Taylor and Francis Group.
4. Molecular Cell Biology, by H. Lodhish et.al. W. H. Freeman and Company.
5. Gene Cloning and DNA Analysis, by T. A. Brown, Blackwell Science.
6. Molecular Cloning: A Laboratory Manual J. Sambrook CSHL Press.
7. Principles of Gene Manipulation, by S. B. Primrose et.al.

Outcomes:

Upon completion of the course the student shall be able to:

- Express the Indebt knowledge of structure and function of DNA, RNA, and proteins.
- Express understanding of the molecular mechanism of replication, transcription, and translation.
- Analyse various molecular processes in health and diseases processes such as DNA damage, DNA repair, recombination, and involvement of gene regulation.
- Demonstrate familiarity with the applications of molecular biology and genetic engineering tools in research, therapeutics, industries and forensics
- Develop expertise in the interpretation of molecular research published in the scientific research literature.
- Compile comprehensive knowledge about the genetic machinery of cells, gene transcription, translation, and regulation, along with technical understanding of gene editing tools and its applications.

BT-520

Cell Biology (2 Credits)	hrs
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	4
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	5
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.	4
Cell signaling: Receptor concept, receptor signaling and expression, orphan receptors, extracellular signals and cell functions, hormones, second messengers and hormone actions, growth factors	5
Transport across membranes: Osmosis, active and passive transport, protein transporters ion channels, antiporters, symporters. Applications in the field of medicine.	4
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.	4
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.	6
Relevance of Cell Biology: Stem cells, Stem cells isolation, culture and properties. Stem cells in health and diseases, Tissue engineering, infectious diseases.	4

READING MATERIAL

1. Molecular Cell Biology by Harvey Lodish
2. Molecular Biology of the Cell by Bruce Alberts
3. Biochemistry by L Stryer

Outcomes:

Upon completion of the course the student shall be able to:

• Demonstrate a coherent understanding of structure- function relationship of various biological elements in prokaryotic and eukaryotic cells.

•Develop an in-depth understanding of the fundamentals of cell movement and cell-cell communication and mechanisms of signal transduction.

• Define the principles of various cell biology techniques and demonstrate the application in various research projects.

• Interpret the processes that regulate cell-cycle and cell death

• Distinguish between the types and role of transport mechanisms in eukaroyotic cells

•Incorporate the advances in cell biology towards better understanding of tissue engineering.

BT-530

Biochemistry (2 Credits)	hrs
Biomolecules: Carbohydrates, Lipids, chemistry and classification, structures of biomolecules, biochemical properties, pharmaceutical importance	4
Protein and Nucleic acids: Protein and Nucleic acids 2D and 3D Structures, properties, pharmaceutical importance	4
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, B_{12}-coenzyme), role of cofactors with specific examples.	4
Biochemical energetics Part I: free energy, concept of standard free energy, laws of thermodynamics, exergonic and endergonic reactions.	3
Biochemical energetics Part II: energy rich compounds, coupling of reaction, biological oxidation-reduction	3
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.	6
Lipid metabolism: Hydrolysis, absorption and transport of lipids, catabolism of lipids, α-, β- and ω- oxidation of fatty acids, ketone bodies formation, biosynthesis of fatty acids, disorders of lipid metabolisms.	4
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.	4
Nucleic Acid Metabolism: Purine and pyrimidine biosynthesis, salvage pathway, degradation of nucleotides, role of ribonucleotide reductase, pharmaceutical importance, disorders of purine and pyrimidine metabolisms.	4

READING MATERIAL

1. Principles of Biochemistry by Lehninger.
2. Biochemistry by L. Stryer Atul Prakashan.
3. Biochemistry, D. Voet and J. G. Voet John Willey and Sons.

Outcomes:

Upon completion of the course the student shall be able to:

- Demonstrate a clear understanding of structure and functions of various cellular biomolecules.
- Express acquisition of knowledge of the regulation of various biochemical processes.
- Define the biochemical regulation and differences between various metabolic pathways.
- Demonstarte familiarity with the classification of enzymes, their mode of action and kinetics.

BT- 540

Microbial Genetics (1 Credit)	hrs
Classical genetics: 'Transforming factor', Hershey and Chase's experiment, Replica plating, Types and selection of mutants	1
Mechanisms of genetic exchange: Transformation, Genetic mapping using transformation.	2
Mechanisms of genetic exchange: Transduction (generalized, specialized), Genetic mapping using transduction, Triple cross experiments, Cis-trans complementation	2
Mechanisms of genetic exchange: Conjugation (Hfr strains; Interrupted mating, time-of- entry mapping), Lederberg-Tatum experiment, Resistance plasmids.	2
Transposition: Mechanism and models. Insertion sequences. Composite transposons. Transposon-generated in vitro mutagenesis.	2
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.	3
Gene regulatory proteins: Different types of motifs. Structures of repressors. Mechanism of lac repressor.	2
Viruses: Structure, classification, genome, replication and growth, purification, quantification. Mechanism of infection by retroviruses. HAART. Life cycle of viruses: Lytic and Lysogenic phage.	2
Other infectious agents: Koch's postulates Viroids, satellites, prions.	1
Yeast: Model organism, Importance as a genetic tool. Mating type switch. Types 2of yeast vectors. Red-white screening.	2
Applications of yeast genetics: Two-hybrid system, Yeast artificial chromosomes. In vivo recombination	1

READING MATERIAL

1. Microbiology by Lansing Prescott, John Harley and Donald Klein, McGraw hill.
2. Lewin's Genes by Jocelyn E. Krebs. Elliott S. Goldstein and Stephen T. Kilpatrick. Jones and Bartlett.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA by Bernard R. Glick, Jack J. Pasternak and Cherly L. Patten, ASM press.
4. Gene Cloning and DNA Analysis, by, T. A. Brown, Blackwell Science.
5. Principles of Gene Manipulation, by S. B. Primrose et.al. Blackwell Science.

Outcomes:

Upon completion of the course the student shall be able to:

- Demonstrate an in-depth understanding of the genetics, transformation principle, mutants and their selection.

- Acquire knowledge about the mechanisms of different types of genetic exchange: transformation, transduction, conjugation.
- Demonstrate familiarity with the modes of gene regulation in prokaryotes, various regulatory proteins, and operon models.
- Develop a clear understanding about the biology of yeast, viruses, viroids and prions.
- Demonstrate aquiantaince of the mechanisms underlying the mode of action and the infection caused by different kinds of viruses, lytic and lysogenic phage.

GE-510

Biostatistics (2 Credits)	hrs
Statistics: Introduction and its role and uses, Collection, Organization, Graphics and pictorial representation of data, Measures of central tendencies and dispersion, Coefficient of variation.	5
Probability: Basic concepts, Common probability distributions and probability distributions related to normal distribution	5
Sampling: Simple random and other sampling procedures	2
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	6
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, Linear regression, Regression line, coefficient of determination.	4
Non-parametric tests: Sign, Mann Whitney U, Wilcoxon matched pair, Kruskal wallis and Friedman two way Anova tests, Spearman rank correlation	6
Statistical techniques in pharmaceutics: Experimental design in clinical trials, Parallel and crossover designs, Statistical test for bioequivalence, Dose response studies, Statistical quality control	6

READING MATERIAL

1. Mathematics and Biostatistics, by G. K. Jani, Atul Prakashan
2. Pharmaceutical Statistics: Practical and Clinical Applications, by SanfordBolton
3. Biometry, by Robert R. Sokal and F. James Rohlf
4. Introduction to the Practice of Statistics, by David S. Moore and George P.McCabe
5. Experimental Design in Biotechnology, by Perry D. Haaland
6. Probability Statistics and Queueing Theory, by P. Kandasamy, K. Thilagavathi and K. Gunavathi

Outcomes:

Upon completion of the course the student shall be able to:

•Demonstrate expertise in applying statistical analysis to experimental groups using various tools such as Microsoft excel, Prism, Statistica.
• Develop the capability to design experiment to get enough statistical difference.
• Demonstrate familiarity with the data collection and data management.
• Develop an understanding of handling the data ethically.
• Demonstrate acquisition of comprehensive knowledge of the statistical principles, methods, experimental design, and its application in pharmaceutics.

GE-511

Seminar (0.5 Credit)	hrs
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.	2/ week

LG-510

General Laboratory Experience - (2.5 Credits)	hrs
As per lab manual of NIPER-Ahmedabad	-

EL-501

Biochemical Engineering Fundamentals (2 Credits)	hrs
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.	3
Microbial growth: Kinetics of microbial growth; substrate utilization and product formation; Structured and unstructured model for growth	4
Reactor design-I: Bioreactor configurations; Stirred tank; Airlift reactor; Packed bed; Monitoring and control of bioreactors; Ideal reactor operation	4
Reactor design-II: Batch operation of a mixed reactor; Total time for batch reaction cycle; Continuous operation of a mixed reactor; Chemostat cascade; Continuous operation of a plug flow reactor	4
Agitation: Need of agitation in aerobic fermentation; Effect of agitation; How agitation helps aeration; different types of agitational methods; impeller design	3
Aeration: Need of aeration in aerobic fermentation; Effect of aeration; How aeration helps agitation; different types of aeration methods; aeration in high density fermentation;	3
Sterilization of air and medium: Different methods of sterilization; Kinetics of sterilization; batch and continuous sterilization; advantages and disadvantages	4
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.	4
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	4
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	4
Scale-up: Principles and criteria; Different methods of scale up and the detailed analysis with case studies; Instrumentation and control of bioprocesses.	3

READING MATERIAL

1. Bioprocess engineering: Basic concept by Michael L. Shuler, Fikret Karg
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 Stanbury, Allan Whitaker, Stephen 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).

Outcomes:

Upon completion of the course the student shall be able to:

-Determine the effect of physical and chemical factors on microbial growth, death, and metabolism
-Interpret the principles of thermodynamics and their applications for biological systems.
-Analyze the principles and practices of sterilization, agitation and bioreactor design
-Interpret and demonstrate the theoretical and mathematical concepts of unit operations, heat transfer, and mass transfer for the laboratory and industrial scale.

EL – 502

Biotechnology in Pharmaceutical Sciences (1 Credit)	hrs
Biotechnology in pharmaceutical perspective: Biology in drug discovery; Traditional drug discovery vs. rational drug discovery, rational drug discovery pipeline, concept of target based drug design and target discovery, role of plant biotechnology in edible vaccine development	2
Genomics in target discovery: Concept of genome, genes and gene expression, genome sequencing and sequence comparison methods (e.g. BLAST), gene expression comparison methods (microarray). Comparative genomics and expression genomics for target discovery of communicable diseases and lifestyle disease.	2
Systems and methods of molecular biology: Isolation and validation of targets, PCR, RT-PCR nucleic acid isolation, cloning vectors (some examples), enzymes used in molecular cloning methods (some examples). Cloning and characterization of biopharmaceuticals.	2
Protein expression systems: Gene expression in bacteria, yeast, insect and mammalian cells.	2
Enzyme purification and assay: Various protein purification methods, enzyme based assay for small molecule screening.	2
Bioprocess technology: Upstream process: Introduction to microbial growth, media formulation, sterilization, inoculum preparation.	2
Bioprocess technology: Fermentation: Fermentation process design, operation and characteristics of fermentation processes; batch, fed-batch and continuous culture systems, instrumentation and bioprocess control.	2
Downstream process: Introduction to various downstream process operations in biopharmaceutical manufacturing such as centrifugation, filtration, tangential flow filtration, cell disintegration, solvent-solvent extraction, supercritical fluid extraction etc.	2
Biotechnology in pharmaceutical industry: Major areas for biotechnology in the pharmaceutical industry such as antibiotics, vaccines, diagnostics, antibodies, biopharmaceuticals (insulin, interferon, GSF, CSF & therapeutic proteins etc.); Commercial aspects, priorities for future biotechnological research.	2
Industrial enzymes in drug development: Penicillin amidase, lipase, oxidoreductase, nitrilase, protease etc. Use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs / drug intermediates, future directions.	2

READING MATERIAL

1. Molecular Biology of The Cell, by Bruce Alberts et.al. Taylor and Francis Group.
2. Principles of Gene Manipulation, by S. B. Primrose et.al. Blackwell Science.
3. Gene Cloning and DNA Analysis, by T. A. Brown Blackwell Science.
4. Biotechnology - The Science and the Business, by D. G. Springham.
5. Pharmaceutical Biotechnology, by D. J. A. Cromelin and R. D. Sindelar Taylor and Francis Group.
6. Basic Biotechnology, by C. Ratledge and B.Kristiansen CambridgeUniversity Press.

Outcomes:

Upon completion of the course the student shall be able to:

- Demonstrate familiarity with the application of molecular biology and genetic engineering tools in research, therapeutics, industries and forensics.
- Develop expertise in the interpretation of molecular research published in the scientific research literature.
- Acquire comprehensive knowledge about the genetic machinery of cells, gene transcription, translation, and regulation, along with technical understanding of gene editing tools and its applications.
- Incorporate the advances in immunology towards biotechnology, development of hybridoma, vaccines, peptides, lymphokines, antibodies.

BIOTECHNOLOGY - SEMESTER II

BT-610

Immunology and Immuno-Technology (2 Credits)	hrs
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	4
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.	4
Humoral immunity: Antigen-antibody interactions, affinity, avidity, immunoglobulins, molecular mechanism of generation of antibody diversity, molecular biology of IgG.	6
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	6
Natural immunity: Inflammation, stimuli, chemotaxis, arachidonic acid Metabolite and cytokines, vascular modifications, healing and fibrosis.	3
Natural killer cells: Functional definition, mechanism of lysis, recognition structures, phosphorylation.	3
Immune memory: B-cell and T -cell memory, significance, loss of memory.	1
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.	4
Disorders and Diseases: Hypersensitivity reaction, immunosuppression, autoimmune and immuno deficiency disorders, (AIDS), H1N1, HIV, Ebola, COVID19, tumor immunology.	4
Immuno biotechnology: Hybridoma, vaccines, genetically engineered production of lymphokines, second generation antibodies, cell based therapies, immunological tools for diagnosis and treatment of diseases; antibodies of various kinds: scFv, IgG, fusion mAbs, bispecific mabs, vaccines, cytokines/lymphokines, cell based therapies such as CAR-T & CAR-NK cells.	5

READING MATERIAL

1. Cellular and Molecular Immunology by A.K. Abbas, Andrew Lichtman , Shiv Pillai.
2. Kuby – Immunology, by Richard Goldsby and T. J. Kindt
3. Immunology, by David Male et.al. ASM Press

Outcomes:

Upon completion of the course the student shall be able to:

- Demonstrate a coherent understanding of the concept of immunity, immunogenicity,

antigenicity and the physiology of immune response

- Acquire familiarity with the various cell types and organs of the immune system.
- Distinguish between the various types of immune responses, cell types involved, and their regulation.
- Determine the applications and molecular consequence of immunological memory and tolerance.
- Identify different types of immunological disorders, hypersensitivity reactions, autoimmune diseases
- Incorporate the advances in immunology towards biotechnology, development of hybridoma, vaccines, peptides, lymphokines, antibodies.

BT-620

Analysis, Diagnostics and Cell based Screening (2 credits)	hrs
Total protein assay: Quantitative amino acids analysis, Folin-Lowry protein assay, BCA assay, UV spectrophotometry etc.	4
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.	4
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	4
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	4
Diagnostics: Biomarkers and NGS in Diagnostics, human retroviral diseases specially AIDS, Role of enzymes in diagnostics.	4
High-throughput screening: Requirements and parameters, Advantages and disadvantages of biochemical and cellular assays; miniaturization and automation.	4
Screening assays: Advantages over in vitro assays. Formats: radioactive, luminescence, fluorescence, etc. Assays compatible with cell membranes: GTPyS, cAMP accumulation	4
Yeast two-hybrid system: Different Y2H systems, their advantages and disadvantages, examples.	2
Potential Therapeutic targets: GPCRs, orphan GPCRs, adaptor proeins, kinases, ion channels and their drug targets.	4
CRISPR Cas9 system: Mechanism, Diagnostic application, advantages and disadvantage	2

READING MATERIAL

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, by K. Wilson and J. Walker
4. Experimental Biochemistry, by R. L. Switzer and L. F. Garrity W. H.
5. Principles of Biochemistry by Lehinger.
6. Biochemistry by L. Stryer Atul Prakashan.

Outcomes:

Upon completion of the course the student shall be able to:

- Determine the concentration and purity of protein samples
- Conduct cytotoxicity and apoptotic assays
- Extract protocol for high-throughput screening assay and its implementation

• Develop assays and method for determining the effect on cell cignalling
• Analyze NGS data
• Plan immunodiagnostic and DNA-based diagnostic assays

BT-630

Introduction to Bioinformatics (2 Credits)	hrs
Introduction to Bioinformatics: Importance of computational biology in drug design	1
Introduction to databases: Database concept; Protein and nucleic acid databases, structural databases. The cancer genome atlas (TCGA)	5
The NCBI: publicly available tools, Resources at NCBI and EBI, DNA and protein information resources on the web.	2
DNA Sequence Analysis: Biological background for sequence analysis. Detection of protein-coding regions, promoters, transcription factor binding sites, Retrieval of DNA sequences and searching of databases for similar sequence. Submitting DNA sequence to databases, where and how to submit.	6
Protein sequence analysis: Comparison of protein sequences and database searching. Methods for discovering conserved patterns in protein sequences and structures and protein motifs, Sequence alignment, Pairwise alignment, Techniques, Multiple Sequence Alignment.	8
BLAST: various methods of DNA and protein BLAST and interpretation of output	2
Predicting structure from protein sequences: Protein structure prediction, homology modeling. Comparison of protein three-dimensional structures. Protein family- based methods for homology detection and analysis	4
Phylogentic analysis sequence-based taxonomy: Overview and assumptions from Multiple Alignment to phylogeny. Neighbour joining, maximum likelihood vs.parsimony. Computational tools for phylogentic analysis.	4
Next generation sequencing and Realtime PCR: Concept theory and applications in sequence detection and analysis, metabolomics, CLC genomics	5
Drug discovery: Basics of molecular docking and in silico screening	3

READING MATERIAL

1. Essential Bioinformatics, by Jin Xiong
2. Bioinformatics: Sequence and Genome Analysis, by David W. Mount
3. Relevant Research and Review Papers

Outcomes:

Upon completion of the course the student shall be able to:

• Demonstrate acquisition of in-depth knowledge related to the theory of various

bioinformatics tools.
• Demonstrate familiarity with the various databases employed to store, retrieve, and analyze the biological data.
•Demonstrate the usage of computational tools and databases in determining structure and functional properties of various biomolecules, and their role in drug discovery.

BT-640

Introduction to Cancer Biology (2 Credits)	Hrs
Introduction to Cancer: Define cancer, various types, hallmarks of cancer, stages of carcinogenesis, Tumor microenvironment, importance of extracellular matrix, immunosurvelliance and immunoediting with respect to tumorigenesis	7
Molecular Carcinogenesis: Mutations, oncogenes, tumor suppressor genes, mutagens, gene dysregulation, DNA damage and repair, epigenetic alterations, role of transcription factors and miRNA	7
Cancer Signaling and Metabolism: Role of receptors (GPCRs, TRKs), cell cycle dysregulation in cancer, altered metabolism, warburg effect.	6
Recent Advances in Cancer: Cancer stem cells, their role in cancer progression, cancer stem cell markers, extracellular vesicle (exosomes etc.), *in-vitro* tumor models (2D, 3D, patient-derived models), pre-clinical mouse models.	7
Diagnostics: Preclinical molecular imaging, biopsy (tissue and liquid), laboratory investigations, tumor and circulating biomarkers, therapeutic targets, TNM staging, NGS based diagnostics.	6
Cancer therapy: Surgery, radiotherapy, chemotherapy, immunotherapy, hormonal, and combinational therapy, precision medicine, chemoprevention (natural or chemically synthesized compounds), development of resistance, synthetic lethality	7

READING MATERIAL

1. The Cell: A Molecular Approach by Geoffrey M. Cooper, Robert E. Hausman
2. Molecular Biology of the Cell, by Bruce Albert
3. Hallmarks of Cancer: The Next Generation by Douglas Hanahan, Robert A. Weinberg
4. Relevant review & research papers.

Outcomes:

Upon completion of the course the student shall be able to:

- Develop detailed understanding of the molecular and cellular process that leads to cancer.
- Demonstrate familiarity with the recent advances and methods involved in cancer research
- Demonstrate acquisition of comprehensive knowledge of the tools and techniques involved in cancer diagnostics and research
- Develop understanding of current cancer therapies and the scientific rationale for developing new treatments

PC-610

Pharmacological Screening and Assays (1 Credit)	hrs
General principles of screening, correlations between various animal models and human situations, animal ethics	6
Pharmacological screening models for therapeutic areas such as Hypertension, CerebralIschaemia, Pain, Epilepsy, Depression, Parkinson's disease, Alzheimer's disease, Diabetes, Leishmaniasis	6
Correlation between *in-vitro* and *in-vivo* screens; Special emphasis on cell-based assay, biochemical assay, radioligand binding assay, high through put screening, high through put pharmacokinetic analysis, specific use of reference drugs and interpretation of results	8

READING MATERIAL

1. Drug discovery and evaluation pharmacological assays Hans Gerhard Vogel, Springer.
2. CPCSEA Guidelines

GE-511

Seminar (0.5 Credit)	hrs
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.	2/ week

LG-510

General Laboratory Experience - (2.5 Credits)	hrs
As per lab manual of NIPER-Ahmedabad	-