

## Semester –I

<b>Course code</b>	<b>Title</b>	<b>Credits</b>	<b>Page No.</b>
BT 401	Biochemistry	3	4
BT 402	Cell & Developmental Biology	3	5
BT 403	Molecular Biology	3	7
BT 404	Analytical Techniques	3	9
BT 405	Biostatistics and Computer Applications	3	11
BT 406	Seminar/Journal Club/Assignment	1	
BT 407	Lab I-Biochemistry and Analytical Techniques	3	12
BT 408	Lab II-Molecular Biology	3	13
	Total	22	

## NON CREDIT COURSES

<b>Course code</b>	<b>Title</b>	<b>Credits</b>	<b>Page No.</b>
BT 409	Introductory Biology/Introductory Mathematics	0	14
BT 410	Communication Skills	0	

## SEMESTER – II

<b>Course code</b>	<b>Title</b>	<b>Credits</b>	<b>Page No.</b>
BT 411	Immunology	3	17
BT 412	Microbiology and Industrial Applications	3	19

BT 413	Genetic Engineering	4	21
BT 414	Genetics	3	23
BT 415	Genomics & Proteomics	3	25
BT 416	Seminar/Journal Club/Assignment	1	
BT 417	Lab III-Immunology	2	26
BT 418	Lab IV-Microbiology	2	26
BT 419	Lab V-Genetic Engineering	2	27
	Total	23	

### SEMESTER – III

Course code	Title	Credits	Page No.
BT 420	Bioprocess Engineering & Technology	3	28
BT 421	Immunotechnology	3	30
BT 422	Molecular Virology	3	32
BT 423	IPR & Biosafety	3	33
	Elective-I	2	
	Elective-II.	2	
BT 424	Lab VI-Bioprocess Engineering & Technology	3	35
BT 425	Project Proposal Presentation	1	
	Total	20	

### SEMESTER – IV

Course code	Title	Credits	Page No.
BT 426	Bioentrepreneurship	3	36
BT 427	Project Work	12	
	Total	15	

**Total Credits: 22+23+20+15=80**

## **LIST OF ELECTIVES**

BT 429: Microbial Technology  
BT 431: Computational Biology  
BT 433: Animal Biotechnology  
BT 435: Plant Biotechnology  
BT 437: Environmental Biotechnology  
BT 439: Nanobiotechnology  
BT 441: Protein Engineering  
BT 442: Molecular Virology  
BT 444: Industrial & Food Biotechnology  
BT 446: Diagnostics  
BT 448: Cancer Genetics  
BT 450: Evolutionary Genetics  
BT 452: Model Genetic Systems  
BT 454: Pharmacogenomics  
BT 456: Stem Cell Biology  
BT 458: Vaccines  
BT 460: Metabolic Engineering  
BT 462: Molecular Therapeutics

**Unit - I**

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships

Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins.

**Unit - II**

Enzyme catalysis – general principles of catalysis; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, Allosteric enzymes.

**Unit - III**

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins.

**Unit - IV**

Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma

**Unit – V**

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Krebs's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers.

**Text books**

1. Voet and J.G.Voet, Biochemistry, 3<sup>rd</sup> edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4<sup>th</sup> edition, W.H Freeman and Company, 2004.

**Reference books**

1. L. Stryer, Biochemistry, 5<sup>th</sup> edition, W.H. Freeman and Company, 2002.

# **BT 402: Cell and Developmental Biology- L+T+P: 2 +1+0= 03 Credits**

## **Unit I**

### ***Cell Theory & Methods of Study***

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

### ***Membrane Structure and Function***

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and Function; Transport phenomenon ; Structural models; Composition and dynamics.

Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis.

Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

## **Unit II**

### ***Organelles***

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms.

Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

## **Unit III**

### ***Endo-membrane System and Cellular Motility***

Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and animals.

## **Unit IV**

### ***Cellular Movements and Pattern Formation***

Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis.

## **Unit V**

### ***Differentiation of Specialized Cells***

Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto-oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst

differentiation in Anabaena; Sex determination in Drosophila.

### ***Plant Meristem Organization and Differentiation***

Organization of Shoot Apical Meristem (SAM); Organization of Root Apical Meristem(RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis.

### **Text books**

1. Benjamin Lewin, Gene IX, 9<sup>th</sup> Edition, Jones and Barlett Publishers, 2007.
2. Watson et al., Molecular Biology of the gene 5<sup>th</sup> Edition, Pearson Prentice Hall. USA, 2003.

### **Reference books**

1. Lodish et al., Molecular cell Biology, 4<sup>th</sup> Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2<sup>nd</sup> Edition, Chapman & Hall, London, 1996.
3. B. M. Turner, Chromatin & Gene regulation, 1<sup>st</sup> Edition, Wiley-Blackwell, 2002.

# **BT 403: Molecular Biology - L+T+P: 2 +1+0= 03 Credits**

## **Unit I**

### ***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.

## **Unit II**

### ***DNA Structure; Replication; Repair & Recombination***

Structure of DNA - A-,B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

## **Unit III**

### ***Prokaryotic & Eukaryotic Transcription***

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA.

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

## **Unit IV**

### ***Post Transcriptional Modifications***

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

### ***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; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

## **Unit V**

### ***Mutations; Oncogenes and Tumor suppressor genes***

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frameshift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes; Oncogenes as transcriptional activators.

### ***Text books***

1. Benjamin Lewin, Gene IX, 9<sup>th</sup> Edition, Jones and Barlett Publishers, 2007.
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.

### ***References***

1. Alberts et al; Molecular Biology of the Cell, 4<sup>th</sup> edition, Garland, 2002.



**Unit I*****Basic Techniques***

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

***Spectroscopy Techniques***

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, NMR, PMR, ESR and Plasma Emission spectroscopy

**Unit II*****Chromatography Techniques***

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

***Electrophoretic techniques***

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

**Unit III*****Centrifugation***

Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

**Unit IV*****Radioactivity***

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

**Unit V*****Advanced Techniques***

Protein crystallization; Theory and methods; API-electrospray and MALDI-TOF; Mass spectrometry; Enzyme and cell immobilization techniques; DNA & Peptide Synthesis.

***Text books***

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2<sup>nd</sup> Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5<sup>th</sup> Edition, Cambridge University Press, 2000.
3. D. Holme & H. Peck, Analytical Biochemistry, 3<sup>rd</sup> Edition, Longman, 1998.

***Reference books***

1. R. Scopes, Protein Purification - Principles & Practices, 3<sup>rd</sup> Edition, Springer Verlag, 1994.

## **BT 405: Biostatistics and Computer Applications -L+T+P: 2 +1+0= 03 Credits**

### **Unit I**

Fundamental concepts in applied probability; Exploratory data analysis and statistical inference; Probability and analysis of one and two way samples; discrete and continuous probability models; Expectation and variance; Central limit theorem; Inference; Hypothesis; Critical region and error probabilities; Tests for proportion; Equality of proportions; equality of means of normal populations (variance known, variance unknown); Chi-square test for independence; P-value and z-score of the statistic; Confidence limits; Introduction to one way and two-way analysis of variance; Data transformations

### **Unit II**

Elements of programming languages - C and PERL; Database concept; Database management system; Database browsing and Data retrieval; Sequence database and genome database; Data Structures and Databases; Databases such as GenBank; EMBL; DDBJ; Swissprot; PIR; MIPS; TIGR; Hovergen; TAIR; PlasmODB; ECDC; Searching for sequence database like FASTA and BLAST algorithm.

### **Unit III**

Data types, Proximity measures, Cluster analysis; Phylogenetic clustering by simple matching coefficients; Sequence Comparison; Sequence pattern; Regular expression based pattern; Theory of profiles and their use in sequence analysis; Markov models; Concept of HMMS; Baum-Welch algorithm; Use of profile HMM for protein family classification; Pattern recognition methods

### **Unit IV**

Goals of a Microarray experiment; Normalization of Microarray data; Detecting differential gene expression; Clustering of microarray data; Structure determination by X-ray crystallography; NMR spectroscopy; PDB (Protein Data Bank) and NDB (Nucleic Acid Data Bank); File formats for storage and dissemination of molecular structure.

### **Unit V**

Methods for modeling; Homology modeling; Threading and protein structure prediction; Structure-structure Comparison of macromolecules with reference to proteins; Force fields; Molecular energy minimization; Monte Carlo and molecular dynamics simulation

### ***Practicals***

Introduction to MS EXCEL-Use of worksheet to enter data, edit data, copy data, move data. Use of in-built statistical functions for computations of Mean, S.D., Correlation, regression coefficients etc. Use of bar diagram, histogram, scatter plots, etc. graphical tools in EXCEL for presentation of data. Introduction to SYSTAT package, Weka Package.

Searching PubMed, Introduction to NCBI, NCBI databases, BLAST BLASTn, BLASTp, PSI-BLAST, Sequence manipulation Suite, Multiple sequence alignment, Primer designing, Phylogenetic Analysis.

Protein Modeling, Protein structure Analysis, Docking, Ligplot interactions.

### ***Text books***

1. Prem S. Mann, Introductory Statistics, 6<sup>th</sup> Edition, Wiley, 2006.
2. John A. Rice, Mathematical Statistics and Data Analysis, 3<sup>rd</sup> Edition, John A. Rice, Duxbury Press, 2006.

### ***Reference books***

1. Campbell and Heyer, Discovering Genomics, Proteomics, & Bioinformatics, 2<sup>nd</sup> Edition, Benjamin Cummings, 2002.
2. Cynthia Gibas and Per Jambeck, Developing Bioinformatics Computer Skill, 1<sup>st</sup> Edition, O'Reilly Publication, 2001.
3. Wayne W. Daniel, Biostatistics: A foundation for Analysis in the Health Sciences, 8<sup>th</sup> Edition, Wiley, 2004.

## **BT 406: Lab II on Biochemistry and Analytical Techniques**

**L+T+P: 2 +1+0= 03 Credits**

1. To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of Amino Acids and separation of aliphatic, aromatic and polar amino acids by TLC.
4. AN ENZYME PURIFICATION THEME (such as E.coli Alkaline phosphatase or any enzyme of the institutions choice). Preparation of cell-free lysates
5. Ammonium Sulfate precipitation
6. Ion-exchange Chromatography
7. Gel Filtration
8. Affinity Chromatography
9. Generating a Purification Table
10. Assessing purity by SDS-PAGE Gel Electrophoresis
11. Assessing purity by 2-D gel Electrophoresis
12. Enzyme Kinetic Parameters: Km, Vmax and Kcat.
13. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).
14. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry

**Experiments 5 & 6 will be implemented only after the availability of equipments**

## **BT 407: Lab II on Molecular Biology- L+T+P: 0 +0+3= 03 Credits**

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Agarose gel electrophoresis
5. Restriction Enzyme digestion of DNA
6. Purification of DNA from an agarose gel
7. DNA Ligation
8. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency
9. Polymerase Chain reaction, using standard 16srRNA eubacterial primers
10. RFLP analysis of the PCR product

## **NON CREDIT COURSES**

### **BT 408: Introductory Biology**

#### **Unit I**

##### *Introduction to Macromolecules*

Introduction to Biology; Macromolecules; Carbon chemistry; Proteins: Structure, folding, catalysis; Nucleic acids: storage and transfer of genetic information; Lipids: membranes, energy storage; Carbohydrates: energy storage, building blocks

#### **Unit II**

##### *Molecular genetics*

Genes; Basics of DNA replication, transcription, translation, Genome organization; Mutations; Gene technology

#### **Unit III**

##### *Cell biology and energetics*

Cell structure; Membranes; Function of cell organelles; Energetics; ATP and glycolysis; Respiration; Photosynthesis

#### **Unit IV**

##### *Reproduction, Heredity, Evolution*

Reproduction and Heredity; Cell division: mitosis, meiosis, gamete formation, pollination; Mendelian genetics; Evolution; Gene variation (Hardy-Weinberg principle); Darwin's theory of evolution.

#### **Unit V**

##### *Principles of Classification*

Viruses, bacteria, protists, fungi; Physiology aspects of Plants & Animals; Regulatory systems (nervous, endocrine, immune systems); Ecology; Populations and communities; Biosphere; Conservation

##### *Text books*

1. W. K. Purves et al. Life, The Science of Biology, 7<sup>th</sup> Edition, W. H. Freeman and Co., 2003.  
[http:// www.whfreeman.com/thelifewirebridge2/](http://www.whfreeman.com/thelifewirebridge2/)

##### *Reference books*

1. Peter H. Raven et al., Biology, 6<sup>th</sup> Edition, McGraw Hill, 2007.  
<http://www.ravenbiology.com>

***Notation, error analysis, and probability***

Scientific notation: significant digits, rounding off, scientific notation; Error analysis; Counting and Probability; Addition rules; Permutations; Combinations; Inclusion-exclusion rule; Sampling with and without replacement; Conditional probability: Bayes' theorem; Independence.

***Descriptive statistics and Random variables***

Measures of central tendency: mean, median, mode; Expectation; Measures of spread: range, percentile, standard deviation; Higher moments: kurtosis, skew; Displaying data: Histograms, stem-and-leaf plots, box plots, frequency distributions; Discrete random variables: Bernoulli, Binomial, Poisson, Geometric distributions, Continuous random variables: Normal, Exponential distributions, Standard normal distribution

***Inferential statistics and one sample hypothesis testing***

Samples and populations: Random, stratified and cluster sampling. Single- and Double-blind experiments. Point and interval estimates, Sampling distributions:  $t$ , chi-square,  $F$  distributions, Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, the meaning of statistical significance, power of a test, One sample hypothesis testing: Normally distributed data:  $z$ ,  $t$  and chi-square tests. Binomial proportion testing.

***Multi-sample and nonparametric hypothesis testing***

Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test, Kruskal-Wallis test, Analysis of variance: One-way ANOVA. Curve fitting, Regression and correlation: simple linear regression, the least squares method, Analysis of enzyme kinetic data. Michaelis-Menten, Lineweaver-Burk and the direct linear plot, Polynomial curve fitting.

***Text books***

1. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8<sup>th</sup> Edition, John Wiley, 2005
2. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9<sup>th</sup> Edition, ISE Reprint, Addison-Wesley, 1998.

***Reference books***

1. E. Kreyszig, Advanced engineering mathematics, 8<sup>th</sup> Edition, John Wiley, 1999.

## **BT 410: Communication Skills**

**0 Credits**

### ***Process of communication***

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication-Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

### ***Presentation skills***

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions

### ***Technical Writing Skills***

Types of reports; Layout of a formal report; Scientific writing skills: Importance of communicating Science; Problems while writing a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts

### ***Computing Skills for Scientific Research***

Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness

### ***Texts/References***

1. Mohan Krishna and N.P. Singh, Speaking English effectively, Macmillan, 2003.



## **SEMESTER – II**

**BT 411: Immunology -**

**L+T+P: 2 +1+0= 03 Credits**

### **Unit I**

#### *Immunology- fundamental concepts and anatomy of the immune system*

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue (MALT&CALT); Mucosal Immunity; Antigens - immunogens, haptens.

### **Unit II**

#### *Immune responses generated by B and T lymphocytes*

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation- endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

### **Unit III**

#### *Antigen – Antibody Interactions*

Precipitation, Agglutination; Advanced immunological techniques- RIA, ELISA, Western blotting ELISPOT assay and Immunofluorescence.

### **Unit IV**

#### *Clinical Immunology*

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases.

## **Unit V**

### ***Transplantation and tumor immunology***

Transplantation – Immunological basis of graft rejection; Tumor immunology – Tumor antigens; Immune response to tumors and immune evasion by the tumor, Immunodeficiency-Primary and acquired immunodeficiency.

### ***Text books***

1. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6<sup>th</sup> Edition, Freeman, 2002.
2. Janeway et al., Immunobiology, 4<sup>th</sup> Edition, Current Biology publications., 1999.

### ***Reference books***

1. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6<sup>th</sup> Edition, Gower Medical Publishing, 2002.
2. Paul, Fundamental of Immunology, 4<sup>th</sup> edition, Lippencott Raven, 1999.
3. Goding, Monoclonal antibodies, Academic Press. 1985.

# **BT 412: Microbiology & Industrial Applications -L+T+P: 2 +1+0= 03 Credits**

## **Unit I**

### ***Microbial Diversity & Systematics***

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergeys manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

## **Unit II**

### ***Microbial Growth & Physiology***

Ultrastructure of Archaea (Methanococcus); Eubacteria ( E.coli ); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Microbial physiology: Physiological adaptation and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group)

## **Unit III**

### ***Microbial Interactions and Infection***

Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence

## **Unit IV**

### ***Microbes and Environment***

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines

## **Unit V**

### ***Industrial Applications***

Basic principles in bioprocess technology; Media Formulation; Sterilization; Thermal death kinetics; Batch and continuous sterilization systems; Primary and secondary metabolites; Extracellular enzymes; Biotechnologically important intracellular products; exopolymers; Antimicrobial drugs

and drug resistance.

Microbial processes-production, optimization, screening, strain improvement, factors affecting down stream processing and recovery; Representative examples of ethanol, organic acids, antibiotics etc.

Enzyme Technology-production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformations- steroids, antibiotics, alkaloids, enzyme/cell electrodes.

### ***Text books***

1. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
2. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.

### ***Reference books***

1. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11<sup>th</sup> Edition, Pearson Prentice Hall, USA, 2006.
2. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5<sup>th</sup> Edition, Tata McGraw Hill, 1993.
3. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006

# **BT 413: Genetic Engineering - L+T+P: 3 +1+0= 04 Credits**

## **Unit I**

### ***Basics Concepts***

DNA modifying enzymes; Cohesive and blunt end ligation; Linkers; Adaptors Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting;

## **Unit II**

### ***Cloning Vectors***

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors.

## **Unit III**

### ***Cloning Methodologies***

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

## **Unit IV**

### ***PCR and Its Applications***

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

## **Unit V**

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Introduction to siRNA; siRNA technology; Micro RNA Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

### ***Text books***

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6 t h Edition, S.B.University Press, 2001.
2. Brown TA, Genomes, 3rd ed. Garland Science 2006

### ***Reference books/ suggested readings***

1. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
2. Selected papers from scientific journals.
3. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

**Unit I*****Bacterial mutants and mutations***

Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletions; tandem duplication); Reversion vs. suppression; Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test)

***Gene transfer in bacteria***

History; Transduction – generalized and specialized; Conjugation – F, F', Hfr; F transfer; Hfr-mediated chromosome transfer; Transformation – natural and artificial transformation; Merodiploid generation; Gene mapping; Transposable genetic elements; Insertion sequences; Composite and Complex transposons; Replicative and non-replicative transposition; Genetic analysis using transposons.

**Unit II*****Bacteriophages and Plasmids***

Bacteriophage–structure; Assay; Lambda phage – genetic map, lysogenic and lytic cycles; Gene regulation; Filamentous phages such as M13; Plasmids – natural plasmids; their properties and phenotypes; Plasmid biology - copy number and its control; Incompatibility; Plasmid survival strategies; Antibiotic resistance markers on plasmids (mechanism of action and resistance); Genetic analysis using phage and plasmid

***Restriction-modification systems***

History; Types of systems and their characteristics; Methylation-dependent restriction systems; applications.

**Unit III*****Mendelian Genetics***

Introduction to human genetics; Background and history; Types of genetic diseases; Role of genetics in medicine; Human pedigrees; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance; Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co dominance; Sex influenced expression; Hemoglobinopathies - Genetic disorders of hemoglobin and their diseases.

***Non Mendelian inheritance patterns***

Mitochondrial inheritance; Genomic imprinting; Lyon hypothesis; isodisomy; Complex inheritance-genetic and environmental variation; Heritability; Twin studies; Behavioral traits; Analysis of

quantitative and qualitative traits

## **Unit IV**

### ***Cytogenetics***

Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes; Molecular cytogenetics – Fluorescence In Situ Hybridization (FISH); Comparative Genomic Hybridization (CGH).

### ***Immunogenetics***

Major histocompatibility complex; Immunoglobulin genes - tissue antigen and organ transplantation; Single gene disorders of immune system.

## **Unit V**

### ***Genetic variation***

Mutations; kinds of mutation; agents of mutation; genome polymorphism; uses of polymorphism.

### ***Gene mapping and human genome project***

Physical mapping; linkage and association

### ***Population genetics and evolution***

Phenotype; Genotype; Gene frequency; Hardy Weinberg law; Factors distinguishing Hardy Weinberg equilibrium; Mutation selection; Migration; Gene flow; Genetic drift; Human genetic diversity; Origin of major human groups.

### ***Texts books***

1. N. Trun and J. Trempy, Fundamental Bacterial Genetics, Blackwell publishing, 2004.
2. Strachan T and Read A P, Human molecular genetics, 3<sup>rd</sup> Edition Wiley Bios, 2006.

### ***Reference books***

1. Mange E J and Mange A. P., Human genetics, 2<sup>nd</sup> Edition, Sinauer Associates publications, 1999.
2. S.R. Maloy, J.E. Cronan, D. Friefelder, Microbial Genetics, 2<sup>nd</sup> Edition, Jones and Bartlett Publishers, 1994.



## **BT 415: Genomics and Proteomics - L+T+P: 2 +1+0= 03 Credits**

### **Unit I**

#### ***Introduction***

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

### **Unit II**

#### ***Genome sequencing projects***

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

### **Unit III**

#### ***Proteomics***

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

### **Unit IV**

#### ***Pharmacogenetics***

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

### **Unit V**

#### ***Functional genomics and proteomics***

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

#### ***Text books***

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2 nd Edition. Wiley 2006
2. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2 n d Edition. Benjamin Cummings 2007

### *Reference books*

1. Brown TA, Genomes, 3<sup>rd</sup> Edition. Garland Science 2006
2. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7<sup>th</sup> Edition, Blackwell, 2006.

### **BT 417: Lab on Immunology - L+T+P: 0 +0+2= 02 Credits**

1. Antibody titre by ELISA method.
2. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
3. Isolation and purification of IgG from serum or IgY from chicken egg.
4. SDS-PAGE, Immunoblotting, Dot blot assays
5. Blood smear identification of leucocytes by Giemsa stain
6. Separation of leucocytes by dextran method
7. Demonstration of Phagocytosis of latex beads
8. Separation of mononuclear cells by Ficoll-Hypaque
9. Flowcytometry, identification of T cells and their subsets
10. Lymphoproliferation by mitogen / antigen induced
11. Lymphnode Immunohistochemistry (direct and indirect peroxidase assay)
12. Hybridoma technology and monoclonal antibody production.
13. Immunodiagnostics using commercial kits

**Experiments No. 9, 10, 11 and 12 can be conducted subject to availability of the instruments.**

### **BT 418: Lab on Microbiology - L+T+P: 0 +0+2= 02 Credits**

1. Sterilization, disinfection, safety in microbiological laboratory.
2. Preparation of media for growth of various microorganisms.
3. Identification and culturing of various microorganisms.
4. Staining and enumeration of microorganisms.
5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
6. Assay of antibiotics production and demonstration of antibiotic resistance.
7. Isolation and screening of industrially important microorganisms.

## **BT 419: Lab on Genetic Engineering - L+T+P: 0 +0+2= 02 Credits**

1. Isolation of genomic DNA from *Bacillus subtilis*\* genome.
2. PCR amplification of *ScoC* gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid, pET-28a from *E.coli* DH5 $\alpha$  and gel analysis.
4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI
5. vector and Insert ligation
6. Transformation in *E.coli* DH5  $\alpha$  .
7. Plasmid isolation and confirming recombinant by PCR and RE digestion.
8. Transformation of recombinant plasmid in *E.coli* BL21 (DE3) strain.
9. Induction of *ScoC* protein with IPTG and analysis on SDS-PAGE
10. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE

\*Any other bacterial strain can be used.

## **SEMESTER – III**

### **BT 420: Bioprocess Engineering and Technology - L+T+P: 2 +1+0= 03 Credits**

#### **Unit I**

##### *Basic principle of Biochemical engineering: Basic Principles in bioprocess technology*

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

#### **Unit II**

##### *Concepts of basic mode of fermentation processes*

Bioreactor designs; Types of fermentation and fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media; Fermenter design- mechanically agitated; Pneumatic and hydrodynamic fermenters; Large scale animal and plant cell cultivation and air sterilization; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

#### **Unit III**

##### *Downstream processing*

Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of effluent and its disposal.

#### **Unit IV**

##### *Applications of enzymes and microbes*

Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing, bio-sensors, bio-pesticide, bio-fertilizers.

#### **Unit V**

Enzyme kinetics; Two-substrate kinetics and pre-steady state kinetics; Allosteric enzymes; Enzyme mechanism; Enzyme inhibitors and active site determination Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial

applications.

***Text books***

1. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
2. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2<sup>nd</sup> Edition, McGraw-Hill Book Co., New York, 1986.

***Reference books***

1. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2<sup>nd</sup> Edition, University of Tokyo press, Tokyo, 1973.
2. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
3. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
4. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
5. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2<sup>nd</sup> Edition, Taylor & Francis Ltd, UK, 2007.

## **BT 421: Immunotechnology - L+T+P: 2+0+0= 02 Credits**

### **Unit I**

#### *Introduction to Immunotechnology*

Kinetics of immune response, memory; Principles of Immunization; Techniques for analysis of Immune response

### **Unit II**

#### *Antibody Related Techniques*

Immuno-chemistry of Antigens - immunogenicity, Antigenicity, haptens, Toxins-Toxoids, Hapten-carrier system; Genetic bases of immune response – Heterogeneity; Role and properties of adjuvants, Immune modulators; B cell epitopes; Hybridoma Rabbit, human; Antigen – Antibody interaction, affinity, cross reactivity, specificity, epitope mapping; Immuno assays RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, Surface plasmon resonance, Biosensor assays for assessing ligand –receptor interaction

### **Unit III**

#### *New Generation Antibodies*

Multigene organization of immunoglobulin genes, Ab diversity; Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes

### **Unit IV**

#### *CMI and Imaging techniques*

CD nomenclature, Identification of immune Cells; Principle of Immunofluorescence Microscopy, Fluorochromes; Staining techniques for live cell imaging and fixed cells; Flow cytometry, Instrumentation, Applications; Cell Functional Assays – lymphoproliferation, Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In-situ gene expression techniques; Cell imaging Techniques-In vitro and In vivo ; Immuno-electron microscopy; In vivo cell tracking techniques; Microarrays; Transgenic mice, gene knock outs

### **Unit V**

#### *Vaccine technology*

Rationale vaccine design based on clinical requirements: Hypersensitivity, Immunity to Infection, Autoimmunity, Transplantation, Tumor immunology, immunodeficiency; Active immunization, live, killed, attenuated, Sub unit vaccines; Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology; Peptide vaccines, conjugate vaccines; Passive Immunization; Antibody, Transfusion of immuno-competent cells, Stem cell therapy; Cell based vaccines

### *Text books*

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4 t h Edition-, Blackwell Publishing, 2002

### *Reference books*

1. S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Selected Methods for Antibody and Nucleic Acid probes, Volume1, Cold Spring Harbor Laboratory Press,1993.
2. Ed Harlow, David Lane, Antibodies Laboratory Manual, Cold Spring Harbor, Laboratory Press, 1988.

## **BT 422: Molecular Virology - L+T+P: 2 +0+0= 02 Credits**

### **Unit I**

Structure of animal viruses and plant viruses; Classification of animal and plant viruses; Satellite viruses; Viroids; Virusoids etc.; Diseases caused by animal viruses and plant viruses; Economic loss due to important viruses

### **Unit II**

Genome organization of animal viruses; Replication of RNA viruses; Replication of DNA viruses

### **Unit III**

Genome organization of DNA and RNA plant viruses; Replication of DNA and RNA plant viruses

### **Unit IV**

Methods to diagnose animal virus infections: Electron microscopy, Tissue culture growth of viruses, Virus quantitation assays, Viral serology: ELISA, neutralization assays; Molecular methods: hybridization, PCR, real time PCR, sequencing, microarray, gene silencing and antiviral assays

### **Unit V**

Methods to study plant viruses; Infectivity assays – Sap transmission, insect vector transmission, agroinfection (using *Agrobacterium*); Ultracentrifugation, electron microscopy, serological methods, immunoelectrophoresis in gels, direct double-antibody sandwich method, Dot ELISA, Immunosorbent electron microscopy (ISEM), Decoration technique, Polymerase chain reaction; DNA and oligonucleotide microarray; PTGS & TGS, viral suppressors of gene silencing.

### ***Text books***

1. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987



## **BT 423: IPR & Biosafety- L+T+P: 2 +1+0= 03 Credits**

### **Unit I**

#### *Introduction to Intellectual Property*

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP

IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

#### *Concept of ‘prior art’*

Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

### **Unit II**

#### *Basics of Patents*

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

### **Unit III**

#### *Patent filing and Infringement*

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives Patent infringement- meaning, scope, litigation, case studies and examples

### **Unit IV**

#### *Biosafety*

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

## **Unit IV**

Moral and Ethical issues in Biotechnology.

### ***Important Links***

<http://www.w3.org/IPR/>

<http://www.wipo.int/portal/index.html.en>

[http://www.ipr.co.uk/IP\\_conventions/patent\\_cooperation\\_treaty.html](http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html) [www.patentoffice.nic.in](http://www.patentoffice.nic.in)

<http://www.iprlawindia.org/> - 31k - Cached - Similar page

<http://www.cbd.int/biosafety/background.shtml>

<http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm>

<http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html>

## **BT 424: Lab on Bioprocess Engineering & Technology- L+T+P: 0 +0+3= 03 Credits**

1. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
2. Determination of mixing time and fluid flow behaviour in bioreactor under variety of operating conditions.
3. Rheology of microbial cultures and biopolymers and determination of various rheological constants.
4. Production of microbial products in bioreactors.
5. Studying the kinetics of enzymatic reaction by microorganisms.
6. Production and purification of various enzymes from microbes.
7. Comparative studies of Ethanol production using different substrates.
8. Microbial production and downstream processing of an enzyme, e.g. amylase.
9. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.

**Experiments 1 & 3 can only be conducted subject to the availability of the equipment.**

## SEMESTER - IV

### **BT 426: Bioentrepreneurship - L+T+P: 2 +1+0= 03 Credits**

#### *Accounting and Finance*

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

#### *Marketing*

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing

#### *Negotiations/Strategy*

With financiers, bankers etc.; With government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking

#### *Information Technology*

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management.

#### *Human Resource Development (HRD)*

Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

#### *Fundamentals of Entrepreneurship*

Support mechanism for entrepreneurship in India

#### *Role of knowledge centre and R&D*

Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

### *Case Study*

Candidates should be made to start a , mock paper company, systematically following all the procedures.

- The market analysis developed by them will be used to choose the product or services.

A product or service is created in paper and positioned in the market. As a product or services available only in paper to be sold in the market through the existing links. At this juncture, the pricing of the product or the service needs to be finalized, linking the distribution system until the product or services reaches the end consumer.

Candidates who have developed such product or service could present the same as a project work to the Panel of Experts, including representatives from industry sector. If the presented product or service is found to have real potential, the candidates would be exposed to the next level of actual implementation of the project.

Go to any venture capital website (like sequoiacap.com) and prepare a proposal for funding from venture capital.

## **ELECTIVES**

### **BT 429: Microbial Technology      L+T+P: 2+1+0=03 Credits**

#### **Unit I**

Isolation and Screening of industrially important Microbes; Large scale cultivation of industrial microbes; Strain improvement to improve yield of selected compounds for eg. Antibiotics, enzymes or recombinant proteins

#### **Unit II**

Basic Principles of bioprocess as applied to selected microbes; Process optimization of selected products

#### **Unit III**

Recombinant Protein production in microbes; Commercial issues pertaining to the production of recombinant products from microbes; down stream processing approaches; Industrial Microbes as cloning hosts ( Streptomyces/Yeast)

#### **Unit IV**

Environmental Application of microbes; Ore leaching; Toxic waste removal; Soil remediation.

#### **Unit V**

Microbial application in food and health care industries; Food Processing and food preservation; Antibiotics and enzymes of pharmaceutical use.

#### ***Text books***

1. Glazer and Nikaido, Microbial Biotechnology, 2<sup>nd</sup> Edition, Cambridge University Press 2007.
2. Peter F Stanbury, A Whitaker and S J Hall, Principles of fermentation technology, 2<sup>nd</sup> Edition (Paper back), BH, Elsevier Science Ltd.2003.

#### ***References/ suggested readings:***

1. Murray Moo- Young, H. W. Blanch Comprehensive Biotechnology: V:3, Pergamon Press.
2. Journals: (A) Nature Biotechnology (B) Trends in Microbiology (C) Current opinion in Microbiology

# **BT 433: Animal Biotechnology- L+T+P: 2+1+0=03 Credits**

## **Unit 1**

### *Animal Cell Culture*

Structure of Animal Cell; History of animal cell culture; Basic requirement for animal cell culture; Cell culture media and reagents; Animal cell; Tissue and organ cultures; Primary culture secondary cell culture; Continuous cell lines; Suspension culture somatic cell cloning and hybridization; Transfection and transformation of cells; Commercial scale production of animal cells; Stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity for environmental pollutants in cell culture; Application of cell culture technology in production of human and animal plant vaccines and pharmaceutical proteins.

## **Unit II**

### *Animal health Biotechnology*

Introduction to immune systems; Cellular and Humoral immune response; History of development of vaccines; Introduction to the concept of vaccines; Conventional methods of vaccine production; Recombinant approaches to vaccine production; Hybridoma technology; Phage display technology for production of antibodies; Antigen antibody based diagnostic assays including radio immunoassays and enzyme immunoassays; Immunoblotting; nucleic acid based diagnostic methods including nucleic acid probe hybridization; restriction endo-nuclease analysis; PCR, Real time PCR; Nucleic acid sequencing; commercial scale production of diagnostic antigens and anti-sera; animal disease diagnostic kits; probiotics; Structure of sperms and ovum; cryopreservation of sperms and ova of live stocks; artificial insemination; super ovulation; in-vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer; embryo splitting; embryo sexing.

## **Unit III**

### *Animal genomics:*

Different methods of characterization of animal genomes; SNP; STR; QTLs, RFLP; RAPD; Proteomics; Metabolomics; Genetic basis for disease resistance; gene knock out technology and animal models for human genetic disorders.

## **Unit IV**

### *DNA Forensics*

Immunological and nucleic acid based methods for identification of animal species; detection of

adulteration in meat using DNA based methods; detection of food/ feed adulteration with animal protein; identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts of the confiscated by anti poaching agencies; Human forensics; microbial forensics; bio-terror agents; Bio-crimes and Bio-terrorism.

*Text books*

1. Animal cell biotechnology Portner, 2nd edition, Humana Press, 2007.
2. Pinkert, Transgenic animal technology, Academic Press 2006.

*Reference books*

1. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition , Oxford University Press, 2000.
2. Gordon, Reproductive technologies in farm animals, CAB Intl, 2005.



**Unit I**

Plant tissue and cell cultures; callus, meristem culture etc, secondary metabolites in plant tissue cultures; protoplast culture and somatic hybridization; haploid plants and somaclonal variation.

**Unit II**

Germplasm conservation- in situ, ex situ conservations and in vitro conservation; cryopreservation- techniques, storage, thawing, reculture and plant regeneration; cold storage, low pressure and low oxygen storage and applications of germplasm storage.

**Unit III**

Genetic engineering of crop plants; Agrobacterium-mediated gene transfer, direct gene transfer to protoplasts; Biolistic gene transfer, alternative approaches of gene transfer - microinjection, micro-targeting and electroporation.

**Unit IV**

Plant gene expression signal and genetic markers - constitutive promoters, tissue specific and inducible promoters, expression vectors, selectable marker genes and reporter genes.

**Unit V**

Transgenic crop plants - Review of transgenic plants (Bt-cotton and other Bt- plants, Golden rice etc), development of pathogen resistant cultivars using resistant lines.

**Unit VI**

Metabolite production - Production of secondary metabolites, culture conditions, elicitations, immobilization of cells, hairy root culture, biotransformation, permeabilization of cells, removal of secreted products.

**Unit VII**

Bioreactors- Stirred tank, Bubble column, Air lift, Rotating drum and immobilized plant cell reactor.

### ***Text books***

1. Slater, A., Scott, N. W., Fowler, M. R Plant Biotechnology: The Genetic Manipulation of Plants (Oxford University Press, USA; 2 edition 2008)
2. U. Satyanarayana Biotechnology (Books and Allied (P) Ltd. 2005)

### ***Reference Books***

1. Adrian, S. Plant Biotechnology: The Genetic Manipulation Of Plants (Oxford University Press, 2008)
2. Bohnert, H.J. et al Bioengineering and Molecular Biology of Plant Pathways, Volume 1 (Elsevier, USA, 2008)
3. Davey, M.R. Plant Cell Culture: Essential Methods (Wiley-Blackwell Publishing, 2010)

# **BT 437: Environmental Biotechnology-L+T+P: 2+1+0=03 Credits**

## **Unit I**

### ***Introduction***

Environment; Basic concepts; resources; eco-system; Plants, Animals, Microbes: Ecosystem management; Renewable resources; Sustainability; Microbiology of degradation and decay; Role of biotech in environmental protection; Control and management of biological processes.

## **Unit II**

### ***Pollution***

Environmental pollution; Source of pollution: Air, Water as a source of natural resource: Hydrocarbon, Substituted Hydrocarbons: Oil pollution; Surfactants; Pesticides; Measurement of pollution; Water pollution; Bio-film; soil pollution; Radioactive Pollution; Radiation; Ozone depletion; Green House effect; Impact of pollutants ; Measurement techniques; Pollution of Milk and aquatic Animals.

## **Unit III**

### ***Control Remediation and Management***

Waste water Collection; Control and management; Waste water treatment; sewage treatment through chemical, microbial and biotech techniques; Anaerobic processes ; Anaerobic filters; Anaerobic sludge; Blanket reactors; Bioremediation of organic pollutants and odorous compounds; Use of bacteria, fungi, Plants, Enzymes and GE organisms; Plasmid borne metabolic treatment; Bio-augmentation; Bio-remediation of contaminated soil and waste land; Bioremediation of contaminated ground water; Macrophytes in water treatment ; Phytoremediation of soil metals; Treatment for waste water from Dairy, Distillery, Tenary, Sugar and Antibiotic industries.

## **Unit IV**

### ***Alternate source of energy***

Biomass as source of energy; Bioreactor; Rural Biotechnology; Bio-composting; Bio-fertilizers; Vermiculture; Organic farming; Bio-mineralization; bio-fuels; Bio-ethanol and Bio hydrogen; Solid waste management.

## **Unit V**

### ***Environment and Health in respect to genetics***

Gene and environment; effect of carbon and other nano-particles upon health; Gene mutation; genetic testing; genetic sensors; environmental pollution and children; Human bio-monitoring

### ***Text books***

1. B.C. Bhattacharyya and R. Banerjee, Environmental Biotechnology, Oxford University Press

### *Reference books*

1. MetCalfe and Eddy Inc. Wastewater engineering: Treatment, Disposal and re use, 4th edition, McGraw Hill Book Co., 2003
2. MAckenzi L. Davis and David A. Cornwell, Introduction to environmental engineering, 4th edition, McGraw Hill Book Co., 2006
3. R.M. Maier, I.L. Pepper and C.P. Gerba, Elsevier, Environmental microbiology: A Laboratory Manual, 2nd Edition, Academic Press, 2004.

## **BT 439: Nanobiotechnology--- L+T+P: 2+1+0=03 Credits**

### **Unit I**

Introduction to Nano-Biotechnology; Nano technology-Definition and concepts; cellular nanostructures; Nanopores; Bio-molecular motors; criteria for suitability of nanostructures for biological applications.

### **Unit II**

Basic characterization techniques; Electron microscopy; Atomic Force microscopy; Photon correlation spectroscopy

### **Unit III**

Thin films; Colloidal nanostructures; Nano vesicles; Nanospheres; Nano Capsules.

### **Unit IV**

Nanostructures for drug delivery, Concepts, Targeting, Routes of delivery and advantages

### **Unit V**

Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; nanodevices for sensor development

#### ***Text books***

1. Biomedical nanotechnology editor: Neelina H.Malsch Publisher: CRC Press. ISBN: 0-8247-2579-4.
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell publisher; Wiley-Liss ISBN: 047141719X

#### ***Reference books***

1. Multilayer thin films, Editor(s): Gero Decher, Joseph B Schlenoff Publisher; Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401