Course Structure and Syllabus Content for the Masters Program

M.Sc. Molecular Microbiology

Department of Plant Sciences
School of Life Sciences
University of Hyderabad
Hyderabad-500046

Updated on 31st July, 2016

DEPARTMENT OF PLANT SCIENCES, SCHOOL OF LIFE SCIENCES

M.Sc. Molecular Microbiology

I Semester

S.No	Subject code	Subject Name	Name of the Faculty	Credits
1	MB 401	Genetics	GP/KM/AMK	3
2	MB 403	Macromolecular Structure and Function	SR	3
3	MB 404	Cell and Molecular Biology	PBK/SDT	4
4	MB 402	Microbiology	ARP/CHVR/KGN	3
5	MB 405	Practicals (Computer Applications in Biology, Microbiology Genetics and other exercises) + viva voce	GP/CHVR/SDT /SR	6

II Semester

S.No	Subject code	Subject Name	Name of the Faculty	Credits
1	MB 502	Bioprocess Engg. & Technology	(Biotech. Dept)	3
2	MB 455	Mol. Biology and Genetic Engg.	SDT /SD/ MS	4
3	MB 503	Molecular Plant Pathology	ARR/RM	2
4	MB 452	Microbial Physiology and Biochemistry	CHVR/SR	2
5	MB 453	Enzymology	(Bio Chemistry)	3
6	MB 456	Practicals (Microbial Physiology and Biochemistry, Mol. Biology and Genetic Engg., Enzymology) + viva voce	KGN/SDT/RM/ CHVR	6
7	MB457	Seminar		2

III Semester

S.No	Subject code	Subject Name	Name of the Faculty	Credits
1	MB 501	Genomics and Proteomics	YSL/IAG	3
2	MB 451	Basic Immunology	(Bio Chemistry. Dept)	3
3		Elective		2
4	MB 504	Microbial Genetics	RM/GP	2
5	MB 454	Molecular Virology	KGN	2
6	MB 505	Practicals (Basic Immunology, Genomics and Proteomics, Microbial Genetics) Project work + Seminar	KGN/YSL/IAG/ RM	6

IV Semester

S.No	Subject code	Subject Name	Name of the Faculty	Credits
1	MB 551	Antibiotics and Chemotheraphy	IAG/SDT/KGN	3
2	MB 552	Microbial Metabolomics	CHVR/SR/YSL	3
3	MB 572	Microbial Technology (Optional)	ARP/RM	2
4	MB 553	Comprehensive Viva-voce	All Faculty	2
5	MB 554	Project Work + Seminar	All Faculty	4

Faculty-In-Charge:

RPS	Prof.R.P.Sharma	GP	Prof G.Padmaja	KM:	Dr. Krishnaveni Mishra
ASR	Prof.A.S.Raghavendra	SDT	Dr.T.Sarada Devi	AMK:	Dr. M. K. Arunasree
MNVP	Prof.M.N.V.Prasad	KGN	Dr.K.Gopinath	SD:	Prof. S. Dayananda
PBK	Prof.P.B.Kirti	RM	Dr.R.Makandar	MS:	Prof. Manjula Sridharan
ARP	Prof .P.Appa Rao	SR	Dr.S.RajaGopal		
ARR	Prof.A.R.Reddy	IAG	Dr.Irfan A Ghazi		
KS	Prof.K.Seshagirirao	YSL	Dr.Y.Sreelakshmi		
CHVR	Prof.Ch. Venkata.Ramana				

CORE COURSES AND ELECTVES (OPTIONAL COURSES) OFFERED FOR MSc MOLECULAR MICROBIOLOGY PROGRAM

CORE COURSES:

First Semester

Genetics	MB401	3 Credit Hrs	Prof. GP/ Dr. KM/ Dr. AMK
Microbiology	MB402	3 Credit Hrs	Prof. ARP/Prof. Chvr/ Dr. KGN
Macromolecular Structure & Function	MB403	3 Credit Hrs	Dr. KPS/ Dr. YSL
Cell & Molecular Biology	MB404	4 Credit Hrs	Prof. PBK/ Dr. SDT

Second Semester

Mol. Plant Pathology	MB503	2 Credit Hrs	Prof. ARP/ Dr. RM
Enzymology	MB453	3 Credit Hrs	Dr. BM/ Dr. SB
Mol. Biology & Genetic Engineering	MB455	4 Credit Hrs	Prof. SD/Prof. MS/ Dr. SDT
Bioprocess Engg. &Technology	MB502	2 Credit Hrs	Dr. IAQ/ Dr. MVR
Microbial Physiology & Biochemistry	MB452	2 Credit Hrs	Prof. CHVR/ Dr. SR

Third Semester

Basic Immunology	MB451	3 Credit Hrs	Prof. JP/ Dr. SB
Genomics & Proteomics	MB501	3 Credit Hrs	Dr. IAG/ Dr. YSL/ Dr. VV
Microbial Genetics	MB504	2 Credit Hrs	Dr. RM/ Prof. GP
Molecular Virology	MB454	2 Credit Hrs	Dr. KGN/ Dr. MV

Fourth Semester

Antibiotics & Chemotherapy	MB551	3 Credit Hrs	Dr. IAG/ Dr. SDT/ Dr. KGN
Microbial Metabolomics	MB552	3 Credit Hrs	Prof. CHVR/ Dr. SR/ Dr. YSL

OPTIONAL COURSES
(Dept. of Plant Sciences):

Microbial Technology	MB572	2 Credit Hrs	Prof. ARP
Biodiversity	MB571	2 Credit Hrs	Prof. KS
Molecular Plant Breeding	MB573	2 Credit Hrs	Dr. RM

SEMESTER-WISE COURSE CONTENT
M.Sc MOLECULAR MICROBIOLOGY

SEMESTER-I:

GENETICS (MB401) 3 Credit Hrs

- Mendelian Genetics and analysis: Extension of Mendelian analysis
- Chromosomal basis of Inheritance
- Chromosome characteristics
  Chromosome structure, Euchromatin and heterochromatin, Coding and Non-coding sequences, transposons
- Genetic Recombination in Eukaryotes
  Linkage and Crossing Over, Chromosome mapping, Tetrad analysis and Gene Conversion
- Mutations and mutagenesis
  Detection, Molecular basis and Applications
- Chromosomal Changes: Number variation – Euploidy (auto and allopolyploidy), aneuploidy
  Structural variations – Deficiences, duplications, Inversions, translocations
- Interaction of Genotype and Environment, Twin studies, genetic environment, non-genetic environment, phenocopies, penetrance and expressivity
- Gene expression regulation during differentiation and growth
  Heterochromatization in human beings and other mammals, dosage compensation, mechanism, sex chromatin, position effect
- Quantitative inheritance
  Continuous traits – multigenic variability, dominance – additivity, norms of reaction
- Non-Mendelian Inheritance; Plastid mutations – nature and mode of transmission
  Mitochondrial traits – nature and mode of transmission; Applications
- Population Genetics: Genotype and allelic frequencies, the Hardy-Weinberg equilibrium, non-random mating, consequences of homozygosity, factors affecting gene frequencies, heterosis, mutation – effect on allele frequencies, migration and genetic drift
- Developmental Genetics: Model system *Drosophila*, Genetic screen, Pattern formation, Maternal effect, Homoetic transformations.

Reference Material:

1. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. (1997) An Introduction to Genetic Analysis, W. H. Freeman & Company, New York.
2. Strickberger, M. W. (1985) Genetics, 3rd Edition, Macmillan Publishing co., New York.
3. Gardner, E. J., Simmons, M. J. and Snustad, D. P. (1984) Principles of Genetics, 8th Edition, John Wiley & Sons, New York.
4. An Introduction to genetic analysis. Anthony A. J. F. Griffiths; Susan R. Wessler; Sean B. Carroll; John Deebly. 11th Edition, 2015
5. Genetics: A Conceptual approach. Benjamin A. Pierce. 5th Edition, 2014.
6. Genetics: analysis of genes and genomes. Daniel L Hartl; Maryellen Ruvolo. 8th Edition.

MICROBIOLOGY (MB402) **3 Credit Hrs**

- Beginnings of microbiology: Discovery, Evolution of microbiology as a discipline
- Microbiological techniques, Pure culture techniques, Enrichment, Anaerobic culturing
- Importance of microorganisms in medicine, agriculture, environment and industry
- Nutritional requirements of microorganisms: Nutritional types, Requirements, Uptake of nutrients, Design and types of nutrient media
- Discovery of microorganisms: Bacterial and fungal diversity, Culture techniques, Bacterial systematics
- Microbial growth: Prniciples of growth,Kinetics of growth Methods of measuring growth, Batch and continuous growth, Synchronous culture, Diauxic growth
- Cell wall of bacteria and fungi, Gram+ve cell wall, Gram-ve cell wall,Cell wall of fungi and yeasts
- Micrbial Ecology, Denitrification, Phosphate solubilization, Free-living nitrogen fixation
- Plant-microbe interactions, Symbiotic nitrogen fixation, Mycorrhizae and Plant pathogens

Reference Material:

1. Microbiology Edited by Prescott
2. Microbiology Edited by Torfora
3. Microbiology Edited by Peltzar
4. Microbiology Edited by Stanier
5. Biology of Microorganisms Edited by M.T. Medican, J.M. Martiniko and J. Parker

MACROMOLECULAR STRUCTURE AND FUNCTION
(MB402) **3 Credit Hrs**

- Review of basic concepts of solution chemistry- acid, base, ionic strength, ion salvation; principles of thermodynamics: chemical potential, free energy, entropy, enthalpy, heat capacity; dimensions of atoms, bonds, and molecules; covalent and non-covalent bonds

- Dihedral angles, steric conflict, potential energy

- Classes of organic compounds and functional groups

- Amino acids and peptides: chemical reactions and physical properties

- Proteins and enzymes: secondary structures- helices, beta sheets, loops, turns, conformational map, tertiary structure and quaternary structure.

- Glycobiology (glycomics): sugars and polysaccharides: chemistry, classification, and function; glycoproteins: structure and function

- Nucleic acids: nucleotides, single and double-stranded structures, uncoiling.

- Ribonucleoprotein and ribozyme

- Lipids (lipidomics):fatty acids- saturated, unsaturated, and eicosanoids; phospho- and spingolipids- structure, classification, lipoprotein, liposomes

- Brief discussion of EM, AFM, crystallography, and NMR

Reference Material:

1. Biochemistry text book by Lubert Stryer
2. Reading material shall be provided by Course-In-Charge

CELL AND MOLECULAR BIOLOGY
(MB404) **4 Credit Hrs**

- Diversity of cell size and shape
- Cell theory
- Structure of prokaryotic and eukaryotic cells-isolation and growth of cells
- Microscopic techniques for study of cells
- Sub-cellular fractionation and criteria of functional integrity
- Cellular organelles-plasma membrane, cell wall and their structural organization
- Transport of nutrients, joints and macromolecules across membranes
- Cellular energy transactions-role of mitochondria and chloroplast
- Cell cycle, molecular events and model systems
- Cell motility, celia, flagella of eukaryotes and prokaryotes
- Out line on concept of gene/cistron - structural organization of prokaryotic and eukaryotic genes and genome. Indigenous plasmids, plasmid incompatibility, chromatin structure, condensation and decondensation, structure of mitotic chromosome

- Replication: Replication machinery - Mechanism of DNA replication - models φX174, *E.coli* and yeast.
- Transcription: Transcriptional machinery - Mechanism of transcription in prokaryotes and eukaryotes, post transcriptional modifications, RNA splicing and editing

Reference Material:

3. Biochemistry text book by Lubert Stryer
4. The cell by Bruce Alberts

SEMESTER-II:

BIOPROCESS ENGINEERING AND TECHNOLOGY
(MB502) 3 Credit Hrs

- Introduction to bioprocess engineering, Bioreactor, Isolation, preservation and maintenance of industrial microorganisms. Kinetics of microbial growth and death, Media for industrial fermentation, Air and media sterilization.
- Types of fermentation processes; analysis of batch, fed batch and continuous; Biotransformation, stability of microbial reactors, analysis of mixes of Microbial populations, specialized bioreactors (pulsed fluidized photo-bioreactors, etc).
- Measurement and control of bioprocesses parameters; Downstream processing; introduction removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, and cell disruption, liquid-liquid Extractions, chromatography, membrane processes, drying and crystallization.
- Effluent treatment, DOC and COD treatments and disposal of effluents, Enzyme and whole cell immobilization and three industrial applications.
- Industrial production of chemicals, alcohol (ethanol), acids (citric, acetic and Gluconic), solvents (glycerol, acetone, butanol), antibiotics (penicillin, streptomycin, tetracycline), amino acids (lysine, glutamic acid), single cell protein. Use of microbes in mineral beneficiation and oil recovery.
- Introduction to food technology; Elementary idea of canning and packing. Sterilization and pasteurization of food products.
- Technology of typical food/food products (bread, cheese, idly); Food preservation

Reference Material:

1. Biochemical engineering, Aibal. S. Humphrey, A.E. and Millis, N.F. University of Tokyo press, Tokyo.
2. Biochemical reactors, Atkinson. B, Poin ltd, London.
3. Biochemical engineering and fundamentals, bialy, j. E. and Ollis, D.F. McGraw-Hill book co., New York.
4. Bioprocess technology: Fundamentals and Applications, KTH, Stocholm.
5. Process engineering in biotechnology, Jackson, A.T. Prentice Hall, Englewood Cliffs.
6. Bioprocess engineering basic concepts, Sdhuler, M.L. and Kargi, F, Prentis Hall Englewood Cliffs.
7. Principles of fundamental technology, Stanbury P.F. and Whitaker, A. Peregamon Press, Oxford.
8. Bioreaction Engineering Principles, Nieson, J. and Villadsen, J., plenum press.
9. Biochemical engineering, Lee. J.M. Prenticel Hall Inc.

MOLECULAR BIOLOGY AND GENETIC ENGINEERING
(MB455) **3 Credit Hrs**

- Translation machinery - Genetic code, structure of Pro and Eukaryotic ribosomes, mechanism of translation, post transnational modifications, Protein trafficking.
- Regulation of gene expression –Regulation of *lac*, *ara*, *trp*, *gal*, *nif* genes, MADS box genes in flower whorl determination etc., DNA protein interactions – Eukaryotic transcriptional factors and their role in regulation of gene expression – Hormonal regulation of gene expression.
- Isolation of DNA fragment/genes: Mechanical Shearing, Restriction Enzyme digestion, PCR amplification, cDNA synthesis, Chemical synthesis of DNA.
- Vectors: Generation of genomic libraries: Structure of Cosmid , BAC and YACs and their use in construction of genomic libraries. Vectors for construction of cDNA libraries. Characteristic features of a complete library.

  Multi purpose vectors: Puc18/19, T-vectors, pBluescript, M13 vectors. subcloning and unidirectional deletion of cloned DNA fragments – promoter probe vectors.

  Cloning vectors for eukaryotes: Yeast vectors, Vectors for higher plants – Ti plasmid derived vectors.

  Expression vectors: Vectors for heterologous expression in GRAS organisms. *E.coli, P. putida, Yeast*, insect and mammalian cells, strategies to synthesize fusion proteins.
- Cloning strategies: RE digestion, cohesive and blunt end ligation, use of linkers and adapters in generation of recombinant DNA, significance of dephosphorylation.
- Strategies for introducing recombinant molecules into host. Transformation, transfection, transduction, particle bombardment, conjugation. *Agarobacterium* mediated transformation.
- Screening the libraries: Genetic and molecular hybridization techniques, immunochemical techniques, PCR based techniques.
- Characterization of cloned genes: DNA sequencing – promoter mapping-S1 nuclease mapping- primer extension - chromosome walking, site directed mutagenesis and its significance

Reference Material:

1. DNA cloning, a practical approach Edited by D. M. Glover
2. Genomes by T. A. Brown

MOLECULAR PLANT PATHOLOGY
(MB 503) **2 Credit Hrs**

- An overview of nature of pathogens and pests and their impact on plant growth. A brief history, terminology involved, pathogen penetration, establishment, colonization in host.
- Genetic and molecular basis for disease resistance or susceptibility, Flor's hypothesis, Koch postulates, disease triangle, surveillance, disease epidemics and epidemiology.
- Preformed plant defenses, induced host defenses, biochemical and physiological responses, host-pathogen interaction mechanisms, disease signaling, pathogen recognition and signal transduction, Physiology and biochemistry of plant disease reaction, Primary metabolism, Secondary metabolism, role of cell wall in plant defense
- Molecular determinants of pathogenicity, virulence, effectors, elicitors, defensins, phytoalexins, common phenolics, plant cell wall degrading enzymes, host specific toxins, host non-specific toxins, hormones and their role in signaling, plant immunity.
- Plant disease resistance, classes of resistance genes, adapted host resistance, non-adapted host resistance, adapted pathogens vs. non-adapted pathogens, Systemic acquired resistance, Induce Systemic acquired resistance
- Pathogenesis-related (PR)-proteins, Hypersensitive Reaction, Reactive oxygen species (ROS) generation, scavenging of ROS, programmed cell death vs. pathogen induced necrosis. Models explaining Host-pathogen specificity and genetics of host pathogen interactions.
- Transgenic and genetic manipulation approach and molecular marker approach to tag disease resistance and avirulence genes
- Use of data bases and applications of bioinformatics in plant pathology

Reference Material:

1. Plant Pathology, T.N. Agrios, Academic Press, 2001
2. Introduction to Plant Pathology, Richard N Strange, 2003, Springer publication
3. Host Pathogen Interactions, Lucas, 2001, Blackwell publication
4. Annual Review of Phytopathology
5. Annual Review of Plant Biology
6. Current Opinion in Plant Biology

MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
(MB 452) **2 Credit Hrs**

- Introduction to Microbial Physiology
- Structure, Function, Growth and Cell Division
- Photosynthesis
- Regulation of Metabolic pathways
- Metabolism of C1, carbohydrates, lipids, nucleotides, amino acids
- Inorganic metabolism
- Fermentations
- Response to environmental stress
- Nutrition as indication of physiological complexity: growth requirements, Nutrient requirements, nutrient mutants as physiological probes
- Physiology of antimicrobial chemicals

Reference Material:

1. Microbial Physiology & Metabolism (2001) by Daniel R. Caldwell , W. C. Brown Publishers
2. Microbial Physiology (2007) by Albert G. Moat et al., 4th Edition, Wiley Liss, Inc.
3. The Physiology and Biochemistry of Prokaryotes (2006) by David White, 3rd Edition, Oxford University Press.
4. Advances in Microbial Physiology (2006) by Roberts K. Poole, Vol. 50, Academic Press

ENZYMOLOGY (MB 453) **3 Credit Hrs**

- Enzymes: basic definitions, Nomenclature (EC recommended and classification).
- Enzyme isolation and purification: Measurement of enzyme activity, specific activity, Molar activity (Turmover number). Criteria for purity.
- Enzyme kinetics: Single substrate-single intermediate. Michaelis-menten and Briggs-Haldane kinetics. Graphical analysis of kinetic data. Progress curves and linear plots. Determination of V_{max} and K_m Experimental aspects.
- Enzyme inhibition: Mechanisms and rate studies. Degree of inhibition. Competitive, non-competitive and uncompetitive inhibition. Activation Graphical analysis (Primary and secondary kinetic plots)
- Two substrate reactions. Sequential and Ping-pong mechanisms. Nature of the rate equations.
- Allosteric enzymes: subunit interactions, regulation of enzyme activity feed back inhibition.
- Jocob and monod model of allosteric enzymes. Koshland model, detailed discussion using haemoglobin, ATcase (effects of ATP and CTP) as examples.
- Enzymes structure and function. Single and double displacement reactions. Folding of the polypeptide chain. Active site and its location. Binding site.
- Immobilized enzymes: Covalent and non-covalent attachments to various substrates. Characteristics of immobilized enzymes. Applications in industry and medicine.
- Coenzymes; Structure and their function in metabolism.

Reference Material:

Reading material shall be provided by the Course-In-Charge

SEMESTER-III:

GENOMICS AND PROTEOMICS
(MB501) **3 Credit Hrs**

Genomics:

- Genomes
  Genomes of prokaryotes, Eukaryote nuclear genomes, packaging, repetitive DNA, gene density, C-value paradox, Organelle genomes.
- Mapping genomes
  Genetic mapping- Genetic Markers, RFLP, SSLP, SNPs, Linkage analysis,
  Physical mapping- restriction map, FISH, STS
- Genome sequencing
  DNA sequencing methodology, Assembly of DNA sequence, Contig approach and shotgun approach, BACs and YACs.
- Analysis and understanding a genome sequence
  Locating the genes by sequence inspection, coding regions, Homology search
  Experimental techniques for gene location,
  Exon-intron boundaries, determining functions of individual genes
- Annotating the genome
  Annotation by sequence comparison, secondary structure and large-scale mutagenesis, Analysis of genome sequences-tools and web resources
- Transcriptome, Studying Gene expression in microorganisms,
  Microarrays – DNA chips, Genome wide expression studies
- Comparative Genomics

Proteomics:

- Protein structure and post-translational modifications
- An introduction to proteomics
- Choice of material, handling and storage of samples
- Sample preparation and fractionation techniques, analytical methods
- A view of HPLC and MudPIT
- A detailed view of 2-DE
- An introduction to mass spectrometry, various methods available
- And how these methods benefit proteomics
- Bioinformatics and data analysis

Reference Material:

1. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition-A. Malcolm Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4)-Cold Spring Harbor Laboratory press and Benjamin Cummings, 28 Feb 2006.

2. Methods in Enzymology, Volume 182: Guide to Protein Purification (Methods in Enzymology) by John N. Abelson (Editor), Melvin I. Simon (Editor), Murray P. Deutscher (Editor) Academic. Press, New York.

3. Principles of gene manipulation and genomics by Richard M. Twyman, Sandy Blackadder

BASIC IMMUNOLOGY (MB451) 3 Credit Hrs

- Immunity- innate and acquired, innate immune mechanisms, acute phase reactants, properties of acquired immunity. Immunogens and antigens- Properties, factors governing immunogenicity, haptens, epitopes- size and identification. Adjuvants- properties and mechanism of action.
- Immunoglobulins- structure, isotypes, allotypes and idiotypes. Functions of antibody in relation to structure. Antigen-antibody interactions- affinity of antibody, avidity, bonus effect, classical precipitin reaction, antigen-binding site of antibody, forces involved in antigen - antibody complex formation.
- Lymphoid tissue- primary and secondary lymphoid organs, structure and cellular organization. Lymphocyte traffic. Cells involved in the immune response- T cells, B cells, CD antigens, neutrophils, eosinophils and natural killer cells.
- Antigen presentation - pathways of antigen processing and presentation of intracellular and extracellular antigens. Antibody response - Primary and secondary antibody response, antibody response to haptens, enumeration of antibody-forming cells, T- dependent and T- independent antigens.
- Macrophage- role in immune response and activation. Cell mediated immunity- helper, cytotoxic, suppressor T cells. In vivo and in vitro assays for assessment of cell mediated immunity
- Complement- classical and alternative pathways of activation. Regulation of complement activation and functions. Antigen receptors -On T and B cells. Generation of receptor diversity.
- Development of immune system- T cell ontogeny in thymus, thymic hormones, B cell development. Immunological tolerance pathways of tolerance and mechanisms of tolerance in T and B cells.
- Immunological tests- Immunodiffusion, immunoelectrophoresis, immunofluorescence, radioimmunoassay and enzyme-linked immunosorbent assay.

Reference Material:

Reading material shall be given by the Course-In-Charge.

MICROBIAL GENETICS (MB504) 2 Credit Hrs

- Microbial genome and its evolution; the evolutionary link between Prokaryota and Eukaryota, endophytic association, microbial diversity, related terminology, natural selection, genetic drift, genetic migration, selection differential, role of mutations, genetic recombination and segregation in the evolution of microorganisms.
- Genome- cValue, genome expansion and factors affecting changes in genome organization, structure of prokaryotic chromosome, its organization into a nucleod, nuclear proteins involved in chromosome winding and unwinding for gene regulation
- Techniques that enabled sequencing of microbial genomes, physical mapping, library preparation, contigs of gene sequences, phylogentic tree drawing and analysis of genome of microorganisms.
- Variations: Genetic and molecular basis of mutations, types of variations or mutations; Mutants, mutagens and mutation –types of mutants, isolation of mutants, role of mutants in mapping of gene, deletion mapping, Genetic analysis of mutants.
- Extra-chromosomal genetic material: Types of plasmids, properties of plasmids, plasmid replication, role of extra chromosomal material and their applicability in microbial studies.
- Mechanisms of gene transfer in prokaryotes: Genetic exchange, transformation, conjugation and transduction, host restriction and modification, vertical and horizontal gene transfer.
- Viral genetics: Viral structure, bacteriophase, lytic and lysogenic growth.
- Transposable elements: Insertion sequences, transposons, transposition, uses of transposons, transposons and evolution, application of transposans in microbial studies

Reference Material:

1. Microbial Genetics. Stanley R. Maloy, John E. Cronan, Jr. and David Freifelder. Second Edition, 1994. Jones and Bartolett Publishers.
2. Bacterial and Bacteriophage Genetics. Edward A. Birge. Fourth Edition, 2000. Springer-Verlag, New York.
3. Modern Microbial Genetics. Uldis N. Streips and Ronald E. Yasbin. 2002, Wiley-Liss Inc., New York.
4. Annual Reviews of Microbiology

MOLECULAR VIROLOGY (MB454) 2 Credit Hrs

- Classification of viruses

- Genome Organization of viruses:

    - General properties of viral genomes
    - Double stranded DNA viruses
    - Single stranded DNA viruses
    - Double stranded RNA viruses
    - Single stranded RNA viruses
    - Positive sense RNA viruses
    - Negative sense RNA viruses

- Expression of Viral Genomes:
    - Virus entry uncoating
    - Viral genome expression
    - Synthesis of mRNAs and by reverse transcription and integration
    - Viral genome strategies

- Virus replication:
    - Positive sense Single stranded RNA viruses
    - Negative sense single stranded RNA viruses
    - Double stranded RNA viruses
    - Reverse transcribing viruses
    - Single stranded DNA viruses and
    - Replication of viroids

- Viral transport, transmission and trafficking

Reference Material:

Reading material shall be given by the Course-In-Charge.

SEMESTER-IV:

ANTIBIOTICS AND CHEMOTHERAPY
(MB551) 3 Credit Hrs

- Introduction, classification of antibiotics
- Production of Antibiotics with two or three examples
- Microbial transformation of antibiotics
- Microbial screening, selection and strain improvement for pharmacologically active agent
- Chemotherapy: General characterization of antimicrobial drugs, determination of the level of antimicrobial activity, mechanism of action of antimicrobial agents antifungal and antiviral drugs, antitumor antibiotics, antiprotozoan drugs and antihelminthic drugs, synthetic chemotherapeutic agents.
- Drug delivery and targeting
- Screening and selection of new drugs by computer aided drug design (CADD)
- Tools to detect novel targets in infectious organisms for chemotherapy
- Recent advances in cancer chemotherapy, antiretroviral therapy
- Drug resistance
- Drugs used for immunosuppression

Reference Material:

1. Biotechnology: A Text Book of Industrial Microbiology
Wulf Crueger & Anneliese Crueger
2. Basic Biotechnology
John Bulock and Bjorn Kristiansen, Publisher: Academic Press
3. Industrial Microbiology
L. E. Cosida,
Publisher: New Age International
4. Microbiology: An Introduction
Tortora, Funke and Case
5. Microbiology
Pelczar, Chan and Krieg, Publisher: TATA McGraw-Hill edition
6. The Pharmacological basis of Therapeutics
Alfred Goodman Gilman, Alan S. Nies, Palmer Taylor
Edition 8th Volume I & II

MICROBIAL METABOLOMICS (MB552) **3 Credit Hrs**

- Introduction to metabolomics and terminologies

  Metabonomics, Endometbolome, Exometabolome, Metabolic fingerprinting, Metabolic foot printing, Metabolite target analysis.

- Analytical plat forms:

  Spectroscopy: - UV-Visible, FT-IR, Raman, NMR (^{13}C, ^{1}H, ^{15}N), Mass (LC/GC-MS, DIMS, IRMS, MALDI-TOF)

  Chromatography: - Column, TLC, HPTLC, HPLC, FPLC, GC & UPLC.

- Metabolome Foot printing and Finger printing: (*E. coli, Lactobacillus, Corynibacterium, Yeast, Aspergillaus,* P*encillium)*
- Quenching protocols for microbial metabolite profiling: Sampling device & procedures
- Prospects:

  Metabolic pathways discovery

  Drug metabolism and pharmacology

  Mining for novel and new metabolites

  Environmental sciences and toxicology

  Molecular markers and Systematics.

Reference Material:

1. Dunn, W.B., Bailey, N.J. & Johnson, H.E. (2005) Measuring the Metabolome: current analytical technologies. Analyst 130: 606-525
2. Lin, C.Y., Viant, M.R. & Tjeerdema, R.S. (2006) Metabolomics: Methodologies and applications in the environmental sciences. J. Pestic. Sci. 31: 245-251.
3. Birkemeyer, C., Luedemann, A., Wagner, C., Erban, A & Kopka, J. (2005). Metabolome analysis: the potential of in vivo labeling with stable isotopes for metabolite profiling. Trends in Biotechnol. 23: 28-33.
4. Meshego, M.R., Rumbold, K., De Mey, M., Vandamme, E., Soetaert, W & Heijnen, J.J. (2007). Microbial metabolomics: past, present and future methodologies. Biotechnol. Lett. 29: 1-16.
5. Kell, D.B. (2004). Metabolomics and systems biology: making sense of the soup. Curr. Opinion in Microbiol. 7: 296-307.

OPTIONAL COURSES:

OFFERED BY THE DEPARTMENT OF PLANT SCIENCES:

BIODIVERSITY (MB 571) 2 Credit Hrs

- Importance, Concepts and Concern of Biodiversity
- Species and Speciation
- Microbial, Plant and Animal Diversity
- Biogeography (Phytogeography and Zoogeography)
- Concepts of Ecology and Ecosystems
- Wildlife Management
- Conservation Biology
- Impact and assessment of exotic species
- Human role on Biodiversity

Reference Material:

1. Bryant, P.J. 2007: Biodiversity and Conservation (A Hypertext Book – http:// www.dbc.uci.edu/~sustain/bio65/Titlpage.htm) School of Biological Sciences, University of California, Irvine, USA.

2. Cox, G.W., 1997: Conservation Biology – Concepts and Applications (2nd Edn), McGrawHill, USA.

3. Chakrawarty, S., 2007: Biodiversity, Daya Publishing House, New Delhi

4. Gaston, K.J. and Spicer, J.I., 2004: Biodiversity: An Introduction, Blackwell Science, Cambridge University Press, New York, USA. and other Books/Journals/Periodicals of online subscribed/purchased by IGML, UOHYD.

MICROBIAL TECHNOLOGY (MB572) **2 Credit Hrs**

- Scope of importance of Microbial Biotechnology
- Single cell protein, microbial flavours and food colorants
- Energy recycling and production using micro-organisms.
  Hydrogen evolving bacteria
  Microbial degradation of cellulose and lignocellulose
  Biogas process, methanogenesis.
- Microbial technology for agriculture:
  Mycorrhizae
  Rhizobacteria
  Viruses as pest control agents
  Bacterial pest control –Microbial toxins for insect and weed control
- Microbial transformations

Reference Material:

1. Microbial Biotechnology (Fundamentals of Applied Microbiology)
   Alexander N. Glazer, Hiroshi Nikaido, W.H. Freeman and Company
2. Biotechnology: A Text Book of Industrial Microbiology, Wulf Crueger & Anneliese Crueger
3. Annual Review of Microbiology
4. Current opinion in Microbiology
5. Current Opinion in Biotechnology

MOLECULAR PLANT BREEDING (MB573) **2 Credit Hrs**

1. Introduction to Plant Breeding – genetic basis of Plant Breeding – creation of variability
2. Reproduction and pollination control – molecular mechanisms of self and cross fertilization, gametogenesis and embryogenesis, molecular basis of male sterility, self compatibility and apomixis.
3. Domestication, plant introduction, acclimatization, genetic variation, crop genetic resources, germplasm conservation and molecular basis of varietal adaptation.
4. Biometric techniques in Plant Breeding – assessment of variability, statistical tools in genetic analysis of variation.
5. Genetic basis of self pollinated crops- breeding procedures for self pollinated crops – concepts and methods – case studies.
6. Genetic basis of cross pollinated crops- breeding procedures for cross pollinated crops – concepts and methods – case studies.
7. Breeding for vegetatively propagated plants- clonal selection – distant hybridization and in vitro techniques.
8. Genetic and molecular basis of heterosis and inbreeding depression- hybrids and synthetic production.
9. Mutation breeding and selection of mutations for crop improvement.
10. Innovative approaches in crop improvement – Molecular markers for tagging disease resistance, insect resistance, quality and special characteristics - gene transfer in crop breeding program through ransgenic approach.

Reference Material:

1. Principles of Plant Breeding - R.W. Allard. John Willey and sons Inc., New York.
2. Plant Breeding- Theory and Practice – Neal C. Stoskpf, Dwight T. Tomes and B.R. Christie. First Indian Print, 1999. Scientific Publishers, India.
3. Plant Breeding – V.L. Chopra. Reprint 1994oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
4. Plant Breeding Principles and Methods – B.D. Singh, fourth edition, 1990. Kalyani Publishers, New Delhi, India.
5. Crop Science- Journal; Trends in Genetics- Journal; Plant Breeding- Journal

OPTIONAL COURSES:

OFFERED BY DEPARTMENTS OTHER THAN PLANT SCIENCES:

PRINCIPLES IN CANCER AND CANCER STEM CELL BIOLOGY

(IV Semester)

(BC575)

- Normal cell versus Cancer cell
- Cell immortalization and tumorigenesis
- Oncogenes and tumor suppressor genes
- Maintenance of Genomic integrity and development of cancer
- Invasion and metastasis
- Cancer stem cells
- Rationale treatment of cancer
- Special emphasis on Breast cancer

Reference Material:

Biology of Cancer by Robert Weinberg; latest Review articles

ENDOCRINE BIOCHEMISTRY
(III Semester)
(BC521) **2 Credit Hrs**

- Basic Concepts in biological communication,
- various signal transduction mechanisms,
- Endocrine system: General features, mechanism of action of hormones.
- Biosynthesis, structures and functions of the hormones of pituitary, thyroid, adrenal, pancreas and gonads-secretion,
- Biochemical nature of hormones, regulation of secretion, mechanism of action and biological effects.
- Hormones in sex determination,
- Gastrointestinal hormones, their synthesis and function.
- Structure and function of Insulin like growth factors and their receptors.

Reference Material:

1. Endocrine Physiology by Ojeda;
2. Endocrinology by Mc Hadley;
3. Endocrinology- Review articles

IMMUNOBIOLOGY (AB503) **2 Credit Hrs**

This course provides an in-depth knowledge of molecular, cellular and genetic regulation of immune system function and development, antigen recognition, host-pathogen interactions and wide variety of autoimmune disorders. The major topics include:

Cell, molecular and developmental biology of immune system: Evolution of the immune system, development and survival of immune cells. molecular mechanisms of immune recognitions, and effector responses against pathogens.

Molecular components of Immune system: Structure, function and generation of antigen receptors, regulation of immune responses, signal transduction, autoimmunity, tolerance.

Innate immune system: The effector mechanisms of innate immune system, pattern recognition, complement system, antimicrobial peptides, cytokine products in response to viral, bacterial and parasitic pathogens and antigen processing, and presentation.

Adaptive immune system: Antigen recognition, lymphocyte activation, humoral and cell mediated immunity, immunological memory, physiological and pathological aspects of inflammation.

Immune Dysfunction: Autoimmunity, immunodeficiency, allergy, hypersensitivity, alloantigens and transplantation rejections.

Cancer immunology: Tumor cell recognition, Mechanic insights of anti-tumor immunity, immunosuppressive mechanisms, inhibitory receptors, cancer vaccines, and new approaches for delivery of immunotherapies into tumors.

Reference Material:

1. Goldsby RA, Kindt TK, Osborne BA and Kuby J (2012) Immunology, 7th Edition, W.H. Freeman and Company, New York, New York

2. Janeway CA, Travers P, Walport M, and Shlomchik M (2012) Immunobiology, 8th Edition, Garland Publishing, New York, New York

CELL AND NUCLEAR DIVISION
(BC573) **2 Credit Hrs**

- This course is designed as an advanced cell biology course intended for students who have had a relatively detailed molecular biology and basic genetics course.
- It is designed to give a cell biological perspective to cell and nuclear division, focusing on how macromolecular assemblies and organelles are distributed during cell division. Another focus will be with respect to unequal segregation of organelles and chromosomes which are important aspects of stem cell biology and aging.
- Overview of Cell Cycle
- Brief introduction to regulation of cell cycle and check points
- Chromosome segregation and spindle assembly
- **Mechanism of cytokinesis**
- Nuclear envelope assembly and disassembly
- Organelle division and segregation (mitochondria, ER, Golgi, peroxisomes, lysosomes)
- Specialized cell divisions: Embryonic cell cycle, asymmetric cell division, meiotic cell division
- Abnormalities in cell division

Reference Material:

1. Molecular Cell Biology Lodish et al or any equivalent book
2. Reviews (will be suggested in class)

EPIGENETICS AND NUCLEAR DYNAMICS (Semester -III)
(AB524)

2 Credit Hrs

- **Epigenetic Reprogramming, Genomic Imprinting**: Nuclear Cloning, Epigenetic Reprogramming, and Cellular Differentiation in Early Mammalian Development, Genomic Imprinting: Germ Line and Early Embryo.
- **DNA & Histone modifications:** Reading the DNA Methylation Signal, Role of De Novo DNA Methyltransferase, The Rigidity and Plasticity of the Marks, Histone code hypothesis, Histone Deposition Proteins: Links between the DNA Replication Machinery and Epigenetic Gene regulation, Non-covalent Modification of Chromatin: chromatin remodelling and accessibility complexes, Chromatin Dynamics through Nucleosome Sliding.
- **Regulatory roles of Non coding RNA**: miRNAs, LincRNAs, Chromatin RNA interactions, Mammalian X–Chromosome Inactivation: An Imprinted cis–silencing Transcripts (AIR and Kcnqot non coding RNA), RNA Interference and Related Mechanisms
- **Structural organization of chromatin in the nucleus:** Electron microscopy studies on nuclear organization. Chromosome territories, euchromatin, heterochromatin, nuclear matrix, chromosome and gene positioning, primary secondary and tertiary structural organization of genes and genome, fractal geometry and thermodynamics of nucleus.
- **Functional organization of chromatin in the nucleus:** Chromatin movements: extent and timing, Movements with respect to nuclear periphery or interior, Nuclear bodies and its significance: RNA PolII transcription factories, Polycomb silencing bodies, PML bodies, splicing speckes, Cajal bodies and other nuclear domains, Molecular crowding.
- **Structure and function correlations in the nucleus:** Gene clustering and long range chromatin interactions, Nucleolus, Telomere Clustering, The Circe Effect, epigenetic regulation of higher order chromatin structure, chromatin boundaries, and Gene regulation in 3-dimensions. Gene clustering for transcriptional activation or silencing.

Reference Material:

1. Nuclear organization and function: Cold spring harbour symposia on quantitative biology Volume LXXV (2010).
2. Epigenetics: Cold Spring Harbor Laboratory Press, Edited by C. David Allis et al. 2007
3. Epigenetics: Garland Science publishers Editied by Lyle Armstrong (2014).