

**PONDICHERY UNIVERSITY  
PUDUCHERRY 605 014.**



**M.Sc. Microbiology**

**CURRICULUM AND SYLLABUS  
2013 ONWARDS**

**Microbiology Programme  
SCHOOL OF LIFE SCIENCES  
PONDICHERY UNIVERSITY**

**CURRICULUM AND SYLLABI FOR M.Sc., MICROBIOLOGY- COURSE STRUCTURE (2013 onwards)**

SL. NO.	COURSE NAME	COURSE CODE	TYPE OF COURSE	NUMBER OF CREDITS
<b>I Semester- Theory Courses</b>				
1	General Microbiology	MB 401	HC	3
2	Cell and Molecular Biology	MB 402	HC	3
3	Microbial Biochemistry	MB 403	HC	3
4	Immunology	MB 404	HC	3
5	Microbial Genetics	MB 405	HC	3
6	Biomolecules	MB 422	SC	3
7	Microbial Physiology	MB 423	SC	3
8	Microbial Technology	MB 424	SC	3
<b>I Semester- Lab Courses</b>				
1	General Microbiology Lab	MB 441	HC	1
2	Cell and Molecular Biology Lab	MB 442	HC	1
3	Microbial Biochemistry Lab	MB 443	HC	1
4	Immunology Lab	MB 444	HC	1
<b>II Semester- Theory Courses</b>				
1	Bacteriology	MB 451	HC	3
2	Mycology	MB 452	HC	3
3	Virology	MB 453	HC	3
4	rDNA Technology	MB 454	HC	3
5	Techniques in Microbiology	MB 455	HC	3
6	Marine Microbiology	MB 471	SC	3
7	Microbial Nanotechnology	MB 472	SC	3
8	Agricultural Microbiology	MB 473	SC	3
9	Mycotoxicology and Plant Pathology	MB 474	SC	3
<b>II Semester- Lab Courses</b>				
1	Bacteriology Lab	MB 491	HC	1
2	Mycology Lab	MB 492	HC	1
3	Virology Lab	MB 493	HC	1
4	Techniques in Molecular Cloning Lab	MB 494	HC	1
5	Instrumentation Techniques Lab	MB 495	HC	1
<b>III Semester- Theory Courses</b>				
1	Medical Microbiology	MB 501	HC	3
2	Food Microbiology	MB 502	HC	3
3	Applied & Industrial Microbiology	MB 503	HC	3
4	Environmental Microbiology	MB 504	HC	3
5	Microbial genomics	MB 505	HC	3
6	Fermentation Technology	MB 521	SC	3
7	Genome Technology	MB 522	SC	3
8	Cynobacteriology	MB 523	SC	3
9	Drug Design and Discovery	MB 524	SC	3
<b>III Semester- Lab Courses</b>				
1	Medical Microbiology Lab	MB 541	HC	1
2	Food Microbiology Lab	MB 542	HC	1
3	Applied & Industrial Microbiology Lab	MB 543	HC	1
4	Environmental Microbiology Lab	MB 544	HC	1
5	Microbial genomics Lab	MB 545	HC	1
<b>IV Semester</b>				
1	Project/ Dissertation	MB 599	HC	6
<b>Total Number of credits</b>				<b>98 credits</b>

## GENERAL MICROBIOLOGY

**Course Code: MB 401**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce the history and development of Microbiology. The contents of this course will help students understand history, biology of microorganisms, growth and control of microbes. A unit is exclusively focused on archaea which is one of the domains of Carl Woese's classification. Thus the beginners are rightly exposed to foundation of Microbiology which would lead them towards progressive advancement of the subject.*

### **Unit 1**

**10 h**

**Introduction to Microbiology** – Scope of microbiology - Ancient Microbiology - Refutation of a biogenesis: discovery of penicillin: discovery of vaccination: proposal of one gene one enzyme hypothesis - Major contribution of scientists– Leeuwenhoeck, Edward Jenner, Alexander - Flemming, Joshep Lister, Robert Koch, Louis Pasteur, Hargobind Khorana. Modern Microbiology - Landmark achievements in 20th century - **Microbial Taxonomy** - Definition and systematics, Nomenclatural rules and identification. Haeckel's three kingdom classification, Whittaker's five kingdom approach - Woese domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular taxonomy. Bergey's Classification of bacteria.

### **Unit 2**

**10 h**

**Biology of Microorganisms:** Differences between prokaryotic and eukaryotic cell. Biology of bacteria - cell structure, size, shape, arrangement membrane, cell wall, cytoplasmic inclusions, mesosomes, flagella and motility, slime, capsule, pili, chemotaxis, endospore - biology of fungi, structure, physiology and classification – biology of yeast – reproduction - virus (bacteriophages) structure, life cycle (lytic and lysogenic) – biology of algae – Mycoplasma – prions.

### **Unit-3**

**8 h**

**Microbial nutrition:** Microbial nutrient requirements – macro-nutrients, micro-elements – growth factors - sources of nutrients – nutritional classification of bacteria - Phototroph, Chemotroph, Autotroph (lithotroph), Heterotroph (organotroph), Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph - Nutritional patterns of pathogens – Saprophytes - Auxotroph

### **Unit-4**

**10 h**

**Extremophiles:** Diversity of microorganisms of arctic, Antarctic and hydrothermal vents – Archaeal biology - Acidophile , Alkaliphile, Anaerobe, Cryptoendolith, Halophile, Hyperthermophile, Hypolith, Lithoautotroph, Metal-tolerantmicrobes, Oligotroph,

Osmophile, Piezophile, Polyextremophile, Psychrophile/Cryophile, Radioresistant, Thermophile, Thermoacidophile, Xerophile – mechanism of extremophiles.

## Unit 5

10 h

**Cultivation and control of microbes:** Types of growth media (natural, synthetic, complex, enriched, selective- definition with example), pure culture methods (streak plate, spread plate, pour plate, stab culture, slant culture). Anaerobic (thioglycolate, anaerobic chamber, Robertson's media, microaerophilic), liquid shake culture of aerobic bacteria Control of microbes- Sterilisation, disinfection, antiseptic, tyndallisation, pasteurization: Physical- dry heat, moist heat, UV light, ionizing radiation, filtration, HEPA filter, Chemical methods.

### Recommended Text Books:

1. Bernard D. Davis. Renato Dulbecco. Herman N. Eisen. and Harold, S.
2. Ginsberg.(1990).Microbiology (4th edition).J.B.Lippincott company, Newyork.
3. Alexopoulos CJ and C W. Mims.(1993).Introductory Mycology(3rd edition).Wiley Eastern Ltd, NewDelhi.
4. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi.(4th edition).Prentice Hall International, Inc, London.
5. Heritage,J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press.
6. John Webster (1993). Introduction to Fungi.(2nd edition).Cambridge University press,Cambridge.
7. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.
8. Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elsevier Academic press, California.
9. Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology, A human perspective. IWOA, U.S.A.
10. Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York.

### Suggested Reading:

1. Madigan MT Martinko.JM and Parker J Brock TD (1997). Biology of Microorganisms.(8th edition).Prentice Hall International Inc, London.
2. Holt, J.S., Kreig, N.R., Sneath, P.H.A and Williams, S.T. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore.
3. Mara D.and Horan N. (2003).The Handbook of Water and waste water Microbiology. Academic Press-An imprint of Elsevier.

## CELL AND MOLECULAR BIOLOGY

**Course Code: MB 402**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce the fundamentals and basic biology of life. The contents of this course will help students understand the features of prokaryotic and eukaryotic cell and the difference between them. It will elaborate the central dogma of the cell i.e., gene expression viz. transcription and translation in both prokaryotes and eukaryotes.*

### **Unit 1**

**10 h**

**The dynamic cell** - the molecules of life - the architecture of cells - Cell Theory, Emergence of modern cell biology, Structure of Prokaryotic and Eukaryotic cells- Cell-wall, Membrane, Cell organelles-organization and functions - cell cycle events - molecular cell biology - Protein structure and function - Hierarchical structure of proteins - folding, modification and degradation of proteins - functional design of proteins - membrane proteins - purification, detection and characterization of proteins.

### **Unit 2**

**8 h**

**Structural Biology and Signalling:** Biosynthesis of macromolecules (proteins, polysaccharides, nucleic acids) - Biomembranes and subcellular organization of prokaryotic and eukaryotic cells - cell architecture - Cell signaling – types, Chemical signals and cellular receptors, G Protein-linked receptors, Protein Kinase-associated receptors, Growth factors as messengers, Cell signals and Apoptosis, Cytoskeleton: microfilaments-intermediate filaments-microtubules.

### **Unit 3**

**10 h**

**DNA Replication:** Prokaryotic and Eukaryotic DNA replication, mechanisms of DNA replication, fidelity of replication, enzymes and accessory proteins involved in DNA replication. **Gene mutations:** Types of mutations. Suppression, Transposable Genetic Elements, Ames' test. **DNA damage and repair mechanisms,** Global response to DNA damage, DNA repair and aging, Medicine and DNA repair modulation.

### **Unit 4**

**10 h**

**Prokaryotic Transcription:** RNA Polymerase holoenzyme and apoenzyme, different sigma factors, details of initiation, elongation, termination. **Eukaryotic Transcription:** Three types of RNA polymerases. Promoter of RNA polymerase II. Enhancers. General and inducible transcription factors. **Post-translational modification:** mRNA processing, Processing, Capping, Cleavage and polyadenylation, splicing of nuclear pre-mRNA, mRNA stability.

### **Unit 5**

**10 h**

**Genetic code:** Characteristics, deciphering the code. **Protein biosynthesis:** Prokaryotic and eukaryotic translation, the translational machinery, mechanism of initiation, elongation and termination. **Regulation of expression in eukaryotes:** Britten-Davidson model. DNA

binding and activation domains of transcription factors. Packaging of chromosomes and its relation to transcription regulation. Regulation of translation by 3' and 5' UTR motifs.

**Recommended Text Books:**

1. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 5<sup>th</sup> The Benjamin / Cummings Pub. Co. Inc, 2003
2. Weaver. R. F. Molecular Biology. 3<sup>rd</sup> ed. Mc Graw Hill publication , 2005
3. Alberts Bruce (2008) *Molecular Biology of Cell*, 5<sup>th</sup> Ed. Garland Pub.
4. Russel Peter. Essential Genetics. 2<sup>nd</sup> Edn, Blackwell Science Pub.
5. Friefelder D. (1995). Molecular Biology, 2<sup>nd</sup> Edn. Narosa Publishing House

**Suggested Reading:**

1. Darnell, Lodish and Baltimore. Molecular Cell Biology, 5<sup>th</sup> Ed. Scientific American Publishing Inc, 2000
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. 4<sup>th</sup> ed. Garland publishing Inc, 2002
3. Benjamin Lewin. Gene VIII. Pearson Education Inc. NJ, 2004

# MICROBIAL BIOCHEMISTRY

**Course Code: MB 403**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*It is an interdisciplinary course designed to introduce the essential fundamentals of biochemistry. This course focuses on the concepts of biochemistry and important microbial macromolecules and their metabolism. On completion of the course a student will be well versed with the knowledge of bioenergetics, energy calculations at physiological conditions and central metabolic pathways in bacteria and eukaryotes.*

## **Unit- 1**

**10 h**

**Chemistry of Life and Special Microbial Molecules:** Bonds: ionic bonding, Ion-dipole, covalent, H-bonds, Van der Waals' interaction, Hydrophobic and hydrophilic interactions. Water as a biological solvent and its role in biological processes. pH, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, range of buffer, important biological buffers. **Structure of Special Microbial Molecules:** Peptidoglycan, bacteriorhodopsin, biphytanyl chains and lipids in archaeal cell membranes and their significance in adaptation in extreme conditions.

## **Unit- 2**

**10 h**

**Bioenergetics:** Laws of thermodynamics, entropy, enthalpy, free energy, free energy and equilibrium constant, Gibbs free energy equation, determination of free energy of hydrolytic and biological oxidation reduction reactions, under standard and non-standard conditions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds.

## **Unit- 3**

**10 h**

**Macromolecules I- Proteins and Nucleic Acids:** Proteins: Structural features of amino acids, classification of amino acids, peptide linkage: partial double bond nature, determination of primary structure of polypeptide (N-terminal, C-terminal determination, method of sequencing of peptides), structural classification of proteins, primary, secondary, tertiary, quaternary structures of proteins. Ramchandran plot. Nature of Nucleic Acids: Structure of purines, pyrimidines, nucleosides and nucleotides. Physicochemical properties of nucleic acids - Denaturation of nucleic acids. Hyperchromic effect and  $T_m$ . Chargaff's rule, Secondary structure of DNA - Watson and Crick model. Secondary structure of tRNA - clover leaf model.

## **Unit- 4**

**8 h**

**Macromolecules II- Carbohydrates and Lipids:** Carbohydrates: Monosaccharides, disaccharides, oligosaccharides and polysaccharides, concepts of epimer, isomer. Lipids: Saturated and unsaturated fatty acids, Fatty acid oxidation. Biosynthesis of fatty acids, triacylglycerols and phospholipids.

**Metabolic pathways and Fermentations:** Glycolytic pathway, Pentose phosphate pathway (HMP), Entner- Doudroff pathway, Tricarboxylic acid cycle, PDH Multi-enzyme complex Amphibolic pathway, anaplerotic reactions. Electron transport chain, generation and maintenance of proton motive force PMF, chemiosmotic theory, Q cycle, Ubiquinone, Cyt C. Substrate level and oxidative phosphorylation, inhibitors and un-couplers of electron transport chain and function of ATPase (bacterial and mitochondrial), Shuttle systems. **Fermentation-** Lactic acid fermentation, LDH- Alcoholic fermentation ADH - Catabolism of Glycogen. Amino acid catabolism- Urea Cycle Deamination and transamination reactions. de novo biosynthesis of purines and pyrimidines, Ribonucleotide reductase and its role in nucleic acid metabolism.

**Recommended Text Books:**

1. Nelson D L, Cox M. M. Lehninger s Principle of Biochemistry. 4th ed. Freeman, 2004.
2. Lansing M. Prescott. Microbiology. 5th ed. The McGraw–Hill Companies, 2002.

**Suggested Reading:**

1. Berg, J. M., Tymoczko, J. L., Stryer, L. Biochemistry. 6th Ed. Freeman, 2006.
2. White David. Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York, 2000



# IMMUNOLOGY

**Course Code: MB 404**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce host defense system and host-microbial interactions. It focuses on the essential concepts of immune factors and immune system. It elaborates further on the antigen-antibody and immune-diagnosis, an emerging advancement of immunology.*

## **Unit- 1** **10 h**

Introduction to the field of Immunology: Historic perspective, Discovery of humoral and cellular immunity; Types of Immunity: Innate immunity components-physical, physiological defenses; – complement, acute phase proteins. Acquired immunity: (specific) natural, artificial, active and passive immunity. Inflammatory response; Phagocytic system-mononuclear phagocytes, macrophages, neutrophils, Natural killer cells, mast cells, basophils, and eosinophils.

## **Unit- 2** **10 h**

Organs, and tissues of immune system: Primary and Secondary Lymphoid organs- Thymus and Bone marrow; Lymph node, spleen and tonsils, MALT, GALT; cells of the humoral Immunity (HI) and Cell mediated Immunity (CMI); Immune tolerance; Antigen presenting cells (APCs), T lymphocytes, B lymphocytes. MHC restriction-antigen presentation, T-subsets; Cytotoxic T cell (CTL) mediated killing.

## **Unit- 3** **10 h**

**Antigens and Antibodies:** Immunogenicity versus Antigenicity, Nature of antigens; Role of T helper cells in B cell activation; Antibody-structure and functions-subtypes; structural basis of Antibody diversity; Theories of Antibody formation., Genetic basis of antibody diversity-somatic hyper mutation recombination, class switching and clonal selection, Recent advances in the production of monoclonal antibodies and their applications.

## **Unit- 4** **10 h**

Host-microbe interactions- antibacterial, antiviral and anti parasitic immune responses; Immune system Disorders-Hypersensitivities-Type-I to TypeIV, Immunodeficiency diseases; Primary and secondary immunodeficiencies, AIDS; Auto immune diseases-organ specific and systemic; Vaccines–definition, conventional vaccines and modern trends in development of vaccines, recombinant and DNA vaccines; current vaccines, safety, active and passive immunization.

## **Unit- 5** **8 h**

**Immunotechniques and Immunodiagnosis:** Antigens and Antibody reactions *in vitro*; precipitation agglutination, complement fixation, ELISA, Western Blotting, Nanoprobe Immuno assay, Immunodiffusion, Immunoelectrophoresis, Immunofluorescence, Immunoprecipitation, Radioimmunoassay and Flowcytometry

### **Recommended Text Books:**

1. Kuby Immunology- 6th edition. Publisher W. H. Freeman & Company
2. I.Roitt. Essential Immunology. 10th ed. Blackwell Science, 2005
3. Janways Immunobiology. 7th edition. Publisher-Garland Science, 2007

### **Suggested Reading:**

1. Richard A. Goldsby, Thomas J. Kindt and Barbara A. Osborne. Kuby Immunology. 4th ed. W. H. Freeman & Company, 2000.
2. Eli Benjamini, Richard Coico, G. Sunshine. Immunology- A Short Course. 4th Ed. Wiley's Publication, 2000.
3. William E. Paul. Fundamental Immunology. 6 th Edition. Lippincott Williams and Wilkins.

## MICROBIAL GENETICS

**Course Code: MB 405**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*Microbial Genetics is an important tool in dissecting the genetic structure of an organism. The basic principles presented in this paper is of major importance in constructing new organisms for practical applications leading to research in Genetic recombination and genetic engineering.*

### **Unit- 1**

**10 h**

**Microbial Genetics-** Definition and scope of Genetics. Premendelian genetic concepts – Preformationism, Epigenesis, Inheritance of acquired characters, traits, Germplasm theory. Hereditary and Environment, Genotype and Phenotype. Microbes as genetic tools for genetic studies.

### **Unit- 2**

**10 h**

**Viral Genetics-** General characteristics of viral genome, T<sub>4</sub> virulent Phage- Structure- life cycle. Lambda temperate phage- Structure - Lytic and lysogenic cycle, Lysogenic repression. Genetic mapping of viruses, Recombination in viruses; Genetics of Bacteriophage.

### **Unit- 3**

**10 h**

**Bacterial Genetics-** Organization of genetic material in bacteria, Gene transfer mechanisms- Conjugation, Transformation and Transduction. Recombination in bacteria. Natural transformation systems- *Streptococcus pneumoniae* and *Haemophilus influenzae*. Transfection and forced competence. Bacterial Conjugation- Properties of the F plasmid, F<sup>+</sup> x F<sup>-</sup> mating, F' x F<sup>-</sup> conjugation. Transduction- Generalized and specialized transduction, Drug resistance in bacteria.

### **Unit- 4**

**8 h**

**Fungal Genetics-** Features and consequences of heterothallism, homothallism, mating types, Vegetative incompatibility, Polyploidy and aneuploidy. *Neurospora*- Tetrad analysis and linkage detection - 2 point and 3 point crosses – Induction of Mutations - Mitotic recombination in *Neurospora* – Transposable elements - Gene conversion. Yeast plasmids, Mating type genetics of yeast.

### **Unit- 5**

**10 h**

**Gene Regulation and expression-** Operon concept, Repression of the *lac* operon, Regulation of tryptophan biosynthesis operon by attenuation, catabolite repression instability of bacterial RNA, positive and negative regulation, inducers and co-repressors. Negative

regulation - *E. coli lac* operon; Regulation of the heat-shock regulon by an alternate sigma factor, Two component regulatory systems.

**Recommended Text Books:**

1. Larry Snyder and Wendy Champness. Molecular Genetics of Bacteria. 3<sup>rd</sup> edition, ASM Press, Washington, D.C. 2007
2. Baumberg. S. Prokaryotic gene expression. Oxford University Press. 2002.
3. Daniel L. Hartl. Essential Genetics. A genomics perspective, 5<sup>th</sup> edition, 2009.
4. Jeremy W. Dale and Simon F. Park. Molecular Genetics of Bacteria. 2010.
5. Nancy Trun and Janine Trempy. Fundamental Bacterial Genetics. Wiley-Blackwell
6. Stanley R. Maloy, John E. Cronan, Jr., David Freifelder, 1994. Microbial Genetics. Jones & Barlett Pub, Boston.

**Suggested Reading:**

1. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 5<sup>th</sup> Edn. The Benjamin / Cummings Pub. Co. Inc, 2003.
2. Uldis N. Streips, Ronald E. Yasbin. Modern Microbial Genetics. Second Edition Wiley-Liss, Inc. 2002.

# BIOMOLECULES

**Course Code: MB 422**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course deals with important macromolecules in biological system viz. Carbohydrates, Proteins, Lipids, Nucleic Acids. Students will study the fundamental concepts of these biomolecules, their structures, types and biological importance. It also deals with the major and minor bioelements like vitamins and metal ions. This syllabus will prepare students to study more advanced topics.*

## **Unit-1**

### **CARBOHYDRATES**

**10 h**

Definition – classification - Structures and Properties of Simple Sugars - The Variety of Monosaccharides - conformation. Concept of epimer, isomer, enantiomer. Polysaccharides - Conformations of Polysaccharide Chains. Homopolysaccharides - Heteropolysaccharides. Polysaccharides of Bacterial surfaces

## **Unit-2**

### **LIPIDS AND STEROLS**

**10 h**

Lipid Composition of Microorganisms - Naming of fatty acids, degree of unsaturation, essential and non-essential fatty acids, common types of membrane lipids: Phospholipids, Cholesterol, Glycolipids, Archaeal Lipids, ganglioside, cerebroside, sphingomyelin, triacylglycerols, arachidonic acid, prostaglandins, - properties, amphipathic molecules, micelle formation, liposomes, lateral diffusion, transverse diffusion, membrane fluidity, hydrophathy plot, artificial membranes.

## **Unit-3**

### **PROTEINS**

**10 h**

The building blocks of proteins: amino acids, peptides, polypeptides - Amino acids: Classification of amino acids – molecular mass, properties of amino acids, Ramchandran Plot. Three dimensional structure of protein. Classification - Fibrous and globular proteins. Structural organization of proteins- Primary structure, Secondary structure-  $\alpha$ -Helix,  $\beta$ - pleats and  $\beta$  – turn. Hierarchy of structural organization.

## **Unit-4**

### **NUCLEIC ACIDS**

**10 h**

Structure and Chemistry of Nucleotides - Names and Abbreviations. Acid–Base Chemistry and Tautomerism. Absorption of Ultraviolet Light. Base Pairs - Double Helices - The B Form of DNA. Other Double-Helical Forms of DNA - Ribonucleic Acids (RNA) - types - RNA Loops and Turns.

## **Unit-5**

### **VITAMINS AND BIOELEMENTS**

**8 h**

Vitamins: Classification, sources and properties - coenzymes - Bioelements: Major and minor bioelements, their sources and some of their functions in microorganisms.

**Recommended Text Books:**

1. Nelson D L, Cox M M. Lehninger s Principle of Biochemistry. 4th ed. Freeman, 2004.
2. Metzler D. Biochemistry: the chemical reactions of living cells. Second edn.

**Suggested Reading:**

1. Berg J M, Tymoczko J L, Stryer L. Biochemistry. 6th ed. Freeman, 2006.
2. White David. Physiology and Biochemistry of Prokaryotes. 2nd ed. Oxford University Press, New York, 2000.

# MICROBIAL PHYSIOLOGY

**Course Code: MB 423**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*Microorganisms have tremendous metabolic diversity hence it's intriguing to learn how these small creatures deal with different environmental conditions and either adopt themselves to it or convert it to favorable conditions by involving different physiological processes. The contents of this course will help students how microbes can grow on substrates other than glucose, their inorganic metabolism and photosynthesis and how do they respond to the changes in environment. It will elaborate the anaerobic respiration by variety of groups of microbes and non-genetic regulation at metabolic pathways.*

## **Unit-1**

### **METABOLIC DIVERSITY**

**10 h**

*Heterotrophic metabolism on substrates other than glucose*

Hydrolysis of polymers - Starch hydrolysis, Cellulose hydrolysis, Oxidation of aliphatic hydrocarbons - Amino acid utilization: Oxidative deamination, Transamination - Oxidation of aromatic compounds - Methanotrophy; Characteristics of methanotrophs, Dissimilation of methane by methanotrophs - Carbon assimilation by methylotrophs - Energy efficiency in C1 metabolism

## **Unit-2**

### **PHOTOSYNTHESIS AND INORGANIC METABOLISM**

**10 h**

Characteristics and Metabolism of Autotrophs, Photosynthetic Bacteria and Cyanobacteria Autotrophic CO<sub>2</sub> Fixation and Mechanisms of Photosynthesis, Photosystem I and II in cyanobacteria – Methanogenesis - Nitrification: Nitrifying Bacteria, Ammonia oxidation, Nitrite oxidation, anaerobic nitrification - Sulfur bacteria and the oxidation of sulfur compounds

## **Unit-3**

### **ANAEROBIC RESPIRATION**

**10 h**

Denitrification: Biochemistry of denitrification, - Regulation of denitrification - Metal reduction: Fe(III) and Mn(IV) reduction, Microbial reduction of other metals, Metal reduction and the environment - Sulfidogenesis: Biochemistry of sulfidogenesis, Reduction of sulfate and sulfur, - sulphur reducing bacteria.

## **Unit-4**

### **METABOLIC REGULATION:**

**8 h**

Regulation through modulation of enzyme activity: fine regulation, Feedback inhibition  
Enzyme activity modulation through structural changes, Phosphorylation Adenylylation, Acetylation, Other chemical modifications, Regulation through physical modification and dissociation/association  
Allosteric regulation and Feedback control- Regulation of *E. coli* aspartate carbamoyltransferase

## **Unit-5**

### **ADAPTIVE AND DEVELOPMENTAL CHANGES**

**10 h**

Myxobacterial Developmental Cycle: Life Cycle of Myxobacteria, Aggregation and Fruiting Body Formation, Intercellular signaling in myxobacteria - *Caulobacter* Differentiation: Life Cycle of *Caulobacter crescentus*, The Stalk, the Holdfast, and the Flagellum: Structure,

Genetics, and Regulation, Regulation and Checkpoints of the Cell Cycle of *C. crescentus* - Oxidative stress, Heat shock response, Quorum sensing, Response to changes in osmotic pressure, Chemotaxis

**Recommended Text Books:**

1. Moat A.G. Foster J.W.Spector M.P. 2002. Microbial Physiology (4th ed). Wiley.
2. Caldwell, D.R. 1995 Microbial Physiology and Metabolism, Wm. C. Brown Publishers, U.S.A.
3. White, D., 2003 The Physiology and Biochemistry of Prokaryotes, second edn, Oxford University Press
4. Gottschalk,G. 1985 Bacterial Metabolism, second edn, Springer

**Suggested Reading:**

1. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
2. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington. D.C.
3. Tortora, G.J., Funke, B.R. and Case C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.
4. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury. Massachusetts.



# MICROBIAL TECHNOLOGY

**Course Code: MB 424**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce the basic and applied Microbiology. The contents of this course will help students to understand importance of microorganisms. The microbial production of beverages, Antimicrobials, Organic acids and enzymes, Microbiology of wastewater and solid waste treatment, Plant Growth Promoting Rhizobacteria and Renewable bioenergy using microorganisms given in detail.*

## **Unit-1** **9 h**

Beverages and enzymes – role of microorganisms in food and dairy industry. Fermented beverages-beer, wine and other alcoholic beverages. Microbial preparation of Tempeh, sauerkraut, Miso, yogurt. Probiotics. Single cell protein. Mushroom cultivation.

## **Unit-2** **10 h**

Antimicrobials, Organic acids and enzymes- microbial production of penicillin, Tetracycline and peptide antibiotics; Acetic acid; Lactic acid; Gluconic acid. Microbial production and commercial applications of Amylases, Proteases, Lipases. Biotransformation of steroids.

## **Unit-3** **10 h**

Microbiology of wastewater and solid waste treatment: - biological, aerobic, anaerobic, primary, secondary and tertiary treatments. Activated sludge and Anaerobic digestion process. Treatment of industrial effluents by microorganisms. Composting. Microbiology of degradation of xenobiotics. Bioremediation of insecticides, pesticides and heavy metals.

## **Unit-4** **9 h**

Plant Growth Promoting Rhizobacteria ( PGPR). Biofertilizers- *Rhizobium*, *Azospirillum*, *Azotobacter*, *Gluconacetobacter*, Azorhizobium, phosphobacteria - mycorrhizae - Blue Green Algae and Azolla. Biopesticides - *Bacillus thuringiensis*, NPV, *Beauveria bassiana*. Mass production of biofertilizers and biopesticides.

## **Unit-5** **10 h**

Renewable bioenergy using microorganisms – Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanol production by using microorganisms. Biohydrogen Generation, Microbial Fuel. Biodiesel from algae.

### **Recommended Text Books:**

1. Prescott's Microbiology, Joanne M. Willey , Linda M. Sherwood , Christopher J. Woolverton 8th Edition McGraw-Hill Publishers.
2. Wulf Cruger and Anneliese Cruger., Biotechnology, (A text book of industrial Microbiology), Panima Publishers, New Delhi, 2<sup>nd</sup> edition, 2003.
3. Prescott and Dunn, Industrial Microbiology, CBS Publishers, New Delhi, 4<sup>th</sup> Edition, 1987.
4. Waste Water Engineering - Treatment, Disposal and Re-use by Metcalf and Eddy, Inc.,Tata MacGraw Hill, New Delhi.
5. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A. D. Russell Sixth edition. Blackwell scientific Publications.
6. Bioremediation by Baker K.H. And Herson D.S. 1994.. Mac Graw Hill Inc. N.Y.

## I-Semester Lab Courses

### **GENERAL MICROBIOLOGY LAB**

**Course Code: MB 441**

**Total Number of Credits: 01**

1. Principles and methods of sterilization.
2. Direct microscopic observations of bacterial shape – cocci, rods, chains, fungal spores, mycelium, yeast budding.
3. Preparation of Media: Nutrient broth, Nutrient agar, plates, slants, soft agar.
4. Pure culture technique: Streak plate, spread plate and pour plate methods.
5. Measurement of size of microbes – micrometry.
6. Motility determination – Hanging drop method.
7. Enumeration of bacterial / yeast cells-viable count (Plate count) Total count (Haemocytometer count).
8. Isolation and purification of cyanobacteria, actinomycetes, fungi and protozoans.
9. Staining methods: Simple, Negative, acid fast, Gram staining , spore, Capsule,
10. Metachromatic granular staining, Lactophenol cotton blue staining - Fungal slide culture.

### **CELL AND MOLECULAR BIOLOGY LAB**

**Course Code: MB 442**

**Total Number of Credits: 01**

1. Preparation of permanent slides
2. Observation of prokaryotic and eukaryotic cells and cell types
3. Study of cell organelles adopting preparations/models.
4. Squash preparation of giant chromosome of salivary gland of chironomous larva.
5. Squash preparation of onion root tip, testis and anther lobes.
6. Preparation of buccal smear.
7. Red blood cell as osmometer.
8. Subcellular fractionation and biochemical/ enzymological analysis.
9. Metaphase chromosome preparations and preliminary banding techniques.

## **MICROBIAL BIOCHEMISTRY LAB**

**Course Code: MB 443**

**Total Number of Credits: 01**

1. Preparation of standard buffers and determination of pH of a solution.
2. Qualitative tests for Carbohydrates- Tests for sugars: Fructose, lactose, maltose, glucose and starch.
3. Qualitative tests for amino acids.
4. Quantitative estimation of glucose by DNS method
5. Quantitative estimation of protein by Biuret method.
6. Quantitative estimation of protein by Lowry's method.
7. Determination of Iodine value.
8. Estimation of carbohydrates by anthrone method.
9. Estimation of amino acids by ninhydrin method.
10. Estimation of DNA/RNA

## **IMMUNOLOGY LAB**

**Course Code: MB 444**

**Total Number of Credits: 01**

1. Virtual demonstration (as per UGC guidelines) of handling of laboratory animals.
2. Different ways of injecting antigens to mouse (IP, SC, IV, retroorbital)
3. Isolation of organs and tissues of immune system from mouse.
4. Quantification of Blood cells using Haemocytometer.
5. Precipitation on gels-Ouchterlony test and Mancini technique
6. Widal test
7. Immunoelectrophoresis
8. ELISA technique
9. Western blotting
10. VDRL test

# BACTERIOLOGY

**Course Code: MB 451**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This syllabus is designed to have a holistic approach about the bacteria. It is structured to have a comprehensive knowledge about the bacterial systematics, type study of major bacterial genera, basic principles to understand the bacterial ultrastructure, methods to isolate, detect and enumerate the bacterial growth and kinetics, economic importance of the bacteria with respect to agriculture, medicine & industry, control of bacterial diseases by chemotherapy and understanding the mode of action of the drugs.*

## **Unit-1**

**10 h**

**Bacterial taxonomy and Diversity:** Classification based on Bergey's manual of Determinative Bacteriology-the Gram negative, Gram positive, the mycoplasmas and archea ; Classification based on serology, biochemistry, 16s rRNA, G+C content and other molecular tools. Ultrastructure of Bacteria- bacterial size, shape, components of bacterial cell wall, cell wall synthesis, plasma membrane, Cytoplasmic matrix, nucleoid, Inclusion bodies, Ribosomes, Flagella and Pili. Staining procedures for identification of bacteria-Basic and Acidic dyes-methylene blue, safranin, Grams stain, acid fast staining, flagella and spore stains.

## **Unit-2**

**8 h**

**Biology of bacteria:** *Staphylococcus, streptococcus, Pneumococcus, Nesseria, Corynebacterium, Bacillus, Clostridium, Proteus, Shigella, Salmonella, Vibrio, Pseudomonas, Yersinia, Haemophilus, Bordetella, Brucella, Mycobacterium, Spirochetes, Mycoplasmas, rickettsiae and chlamydiae.*

## **Unit-3**

**10 h**

**Bacterial growth:** Culture conditions for bacteria -bacterial culture media- chemically defined, complex, differential and special selective media - for aerobic and anerobic bacteria; Bacterial growth curve-Phases of Growth; Effect of physical and chemical factors on growth - pH, temperature, media components and radiation. Measuring bacterial growth- Spectrophotometric method, microscopic counting, serial dilution and viable cell count, MPN, and filtration technique. Bacterial reproduction-fission, budding and endospore formation.

## **Unit-4**

**10 h**

**Economic importance of bacteria:** A brief account on the economic importance of bacteria in Agriculture-Nitrogen fixing organisms; ecological importance-bioremediation and biopesticides; Industrial importance- source of antibiotics, production of recombinant proteins- growth factors, hormones, vaccines etc. Normal flora in the GIT and their advantages.

**Antibacterial agents:** Mode of action of antibiotics and chemotherapeutic drugs. Antibiograms. Antibiotic sensitivity assays- disc method; replica plating technique; Ames test; Antibiotic resistance in bacteria-various factors that contribute to the development of resistance, Bacterial quorum sensing, Biofilms.

**Recommended Text Books:**

1. Prescott, Harley and Klein- Microbiology-5<sup>th</sup> edition; Publisher: McGraw Hill science 2002.
2. Jacquelyn G. Black-Microbiology Principles and Explorations-6<sup>th</sup> edition; Publisher:John Wiley & Sons, Inc. 2004.

**Suggested Reading:**

1. Robert W. Bauman -Microbiology Brief edition, Publisher: Benjamin Cummings, 2004.
2. Gerard J. Tortora, Berdell, R. Funke, Christine L. Case, , Microbiology: An Introduction.8<sup>th</sup> edition Hardcover: 944 pages, Publisher: Benjamin Cummings. 2004.
3. Kenneth J. Ryan,C. George Ray, John C. Sherris, Sherris Medical Microbiology : An Introduction to Infectious Diseases , Hardcover: 992 pages, Publisher: McGraw-Hill Professional, 2003.
4. John G. Holt, Bergey's Manual of Determinative Bacteriology. Lippincott Williams & Wilkins, 1993.

# MYCOLOGY

**Course Code: MB 452**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This paper deals with recognizing fungi as model systems in biological sciences, applications of modern research techniques, agricultural and industrial concerns, and increased awareness of various ecological and phylogenetic issues by understanding their distribution, occurrence, structure, and classification. All have helped to an explosion of knowledge relating to fungi with a traditional base.*

## **Unit-1**

**10 h**

Historical perspectives – history and significance of mycology in the scientific development. General characteristics of fungi - Structure and organization of fungi – The fungal body and cells, Colony, communication and signaling. Cell differentiation and reproduction. Reproduction in fungi - Vegetative, asexual and sexual reproduction in fungi with special reference to their significance.

## **Unit-2**

**8 h**

Taxonomy – Criteria for classification. Traditional, Chemo and molecular taxonomy and their significance. Myxomycetes, Ascomycetes, Basidiomycetes and imperfect fungi. Ecology (Fungal Lifestyle)- the way they make their living, Distribution of yeasts and fungi.

## **Unit-3**

**10 h**

Nutrition and metabolism in fungi – nutritional requirement of fungi, saprophytic, parasitic, obligatory and facultative. Culture media for fungi, Natural substrates of fungi. Biotrophic semi-biotrophic and necrotrophic mode of growth. Fungal-microbe interaction, fungal - plant interactions – symbiotic and antagonistic interactions.

## **Unit-4**

**10 h**

Endophytic fungi - symbiotic and opportunistic associations, co evolution and loss of reproductive structures, Secondary metabolite production, toxins – importance, toxicity to herbivores and insects. Use of endophytic fungi as biocontrol agents against plant diseases, insect herbivores. Mycorrhizal associations – endo and ecto mycorrhiza.

## **Unit- 5**

**10 h**

Significance of fungi in human and livestock health - symbiotic fungi, toxigenic fungi and mycotoxins, pathogenic fungi; Significance of yeasts and fungi in agricultural production – symbiotic fungi, fungi in improving plant productivity, toxigenic fungi and mycotoxins, plant pathogenic fungi, fungi in biocontrol; Significance of fungi in biotechnology and industrial production; Fungal metabolites and their economic significance – mycotoxins, medicinal uses of fungi (antibiotics), food additives, alcohol, vinegar, enzymes, biopesticides. Fungi as food – mushrooms, Mushroom poisoning.

### **Recommended Text Books:**

1. Ainsworth (2009), Introduction to the History of Mycology, Cambridge University Press
2. Mehrotra RS and KR Aneja. An Introduction to Mycology, New Age Publishers
3. P. D. Sharma (2005), Fungi and Allied Organisms. Alpha Science International Publishers.

### **Suggested Reading:**

1. The Fungi: An Advanced treatise I-IV volumes (Ed) Ainsworth & Sussman; Academic Press.
2. Steven L. Stephenson and Henry Stempfen (1994), Myxomycetes: A handbook of slime molds, Timber Press Publishers.
3. Alexopoulos, Mims, and Blackwell, 1996. Introductory Mycology (4th Ed), John Wiley and Sons, N.Y.
4. Bennett, J. W., and M. Klich. 2003. Mycotoxins. Clin. Microbiol. Rev. 16:497-516.
5. P. D. Sharma (2006), Plant Pathology. Alpha Science International Publishers.
6. Steven L. Stephenson (2010), The Kingdom Fungi: The Biology of Mushrooms, molds and lichens.



# VIROLOGY

**Course Code: MB 453**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*Virology syllabus is structured from basic virology to the advanced techniques in virology. This paper provides an insight into the history, ultra structure and diagnosis of virus. Various groups of virus and their detail study is the main feature of this syllabus apart from the recent advances in the virology like antivirals & their mode of action, Antisense RNA, siRNA, ribozymes and in silico approaches for drug designing. Emerging virus and challenges also included in the course structure for better understanding of the upto date developments in the field of virology.*

## **Unit-1**

**10 h**

**Concept and scope of virology:** Foundations of virology: Virus prehistory, discovery of viruses. Definitive properties of viruses: Morphology, Ultra structure, Chemical composition - proteins, nucleic acids, and enzymes. Classification and nomenclature of viruses; Trends in virology; Evolutionary importance of viruses. Epidemiology of Virus infection. Principles of diagnosis of virology.

## **Unit-2**

**10 h**

**Diagnostic virology:** Biological activity of viruses, Physical, chemical and structural components of viruses, Visualization and enumeration of virus particles, Detection of viruses: physical, biological, immunological and molecular methods. Cultivation of viruses in embryonated eggs, laboratory animals and cell cultures. Serological methods – haemagglutinin and HAI, complement fixation, immunofluorescence methods, ELISA and RIA: Physical, chemical and molecular methods- protein, radioactive tracers, electron microscopy, nucleic acid - PCR based assays, flowcytometry and immunohistochemistry. Infectivity assays for phages and plant viruses. Characterization of viral product expressed in the infected cells. Isolation and purification of viruses.

## **Unit-3**

**10 h**

**Study of virus:** Morphology, ultra structure, chemical composition and replication of: Group I – T2 Bacteriophage, Group II – Banana bunchy top virus, Group III – Reovirus, Group IV- TMV, Group V – Rhabdovirus, Group VI – HIV, Group VII – HBV. Sub-viral particles: Discovery, Structure, Classification, replication and diseases caused by Satellite, Satellites virus, Virusoids, Viroids and Prions. Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms. Oncogenesis: oncogenic viruses, viral transformation by activation of cellular signal transduction pathways, viral transformation via cell cycle control pathways.

**Applied virology:** General aspects of plant and animal viral diseases. Introduction to viral vaccines, preparation of vaccines, new vaccine technology; antiviral drugs, antiviral gene therapy, antiviral libraries, antiretrovirals—mechanism of action and drug resistance. Modern approaches of virus control: Antisense RNA, siRNA, ribozymes, in silico approaches for drug designing. T-phages, Cyanophages, Baculovirus.

**Unit- 5****9 h**

**Emerging virus and challenges:** Mechanism of host cell damage- Host cell ‘shut off’, apoptosis, necrosis, alteration of signaling pathways. Viruses and the future: Promises and problems. Emerging diseases, sources and causes of emergent virus diseases. Prospectus using medical technology to eliminate specific viral and other infectious diseases. Silver lining: viruses as therapeutic agents, viruses for gene delivery, viruses to destroy other viruses. Importance of studying modern virology.

**Recommended Text Books:**

1. Fields Virology Vol 1 and 2. B.N. Fields, D.M. Knipe, P.M. Howley, R.M. Chanock, J.L. Melnick, T.P. Monath, B. Roizman, and S.E. Straus, eds.), 3rd Edition. Lippincott-Raven, Philadelphia, PA.
2. Basic Virology Edward K. Wagner, Martinez J. Hewlett, David C. Bloom, David Camerini.
3. Virology: Principles and Applications John Carter, Venetia Saunders.
4. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Racaniello, A. M. Skalka.
5. Virology Methods Manual. Brian W.J. Mahy (Editor), Hillar O. Kangro (Editor). Elsevier Science & Technology Books.
6. Methods and Techniques in Virology. Pierre Payment, Trudel (Editor). Publisher: Marcel Dekker.
7. Black JG, 2002 Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York.
8. Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5<sup>th</sup> edn. Blackwell publishing, USA.

**Suggested Reading:**

1. Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C.
2. Wagner, E.K. and Hewlett, M.J. 1999. Basic Virology. Blackwell Science. Inc.

**Course Code: MB 454**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce gene cloning and strategies of rDNA technology. This paper provides an insight into the vectors and techniques in rDNA technology. The techniques are elaborated with PCR, hybridization, cDNA library construction and gene transfer. The legal and ethical issues are covered to understand the applications and consequent issues of GMOs.*

## **Unit-1**

**10 h**

**Introduction-** History of nucleic acid, role of genes inside the cell, genetic code, genetic elements that control gene expression. **Enzymes in recombinant DNA technology-** DNA polymerase, reverse transcriptase, restriction endonucleases, polynucleotide kinase, terminal deoxynucleotidyl transferase, DNase, Methylase, phosphatases, ligases RNase and their mode of action. **Vectors in recombinant DNA technology** Introduction to cloning vectors, biology and features of vectors, types of vector - plasmids, cosmids, phages, BAC and YAC and viruses.

## **Unit- 2**

**10 h**

**Nucleic acid amplification and hybridization Techniques** - Polymerase chain reaction (PCR) and its applications, variations in PCR and applications, methods of nucleic acid detection, methods of nucleic acid hybridization, sequencing methods, probes and target sequences, Southern blotting, Northern blotting, in situ hybridization, nucleic acid mutagenesis *in vivo* and *in vitro*.

## **Unit-3**

**8 h**

**Construction of DNA library-** Construction of genomic and cDNA libraries, Screening libraries with gene probes, colony hybridization, plaque hybridization, screening by gain of function, immunological screening.

## **Unit- 4**

**10 h**

**Gene transfer techniques-** Gene transfer techniques in microbes, animals and plants - transformation, electroporation, microprojectile system, liposome mediated gene transfer, DNA/calcium phosphate co-precipitate method, genegun, transfection with phage vectors etc. Agrobacterium based gene transfer in plants - Ti plasmid: structure and functions, Ti plasmid based vectors. Chloroplast transformation.

## **Unit-5**

**10 h**

**Applications and legal issues-** Applications of recombinant DNA technology in Agriculture, Veterinary, Industry, Forensic science and Medicine. Gene mapping-restriction mapping, RFLP, RAPD, AFLP. Engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies etc. Transgenic organisms from mice to rice, Human genetic engineering and Gene therapy- methods of gene therapy, gene therapy in

treatment of diseases, Stem cell therapy, Future of stem cell therapy. Science and the constitution- ethical, legal and environmental issues.

**Recommended Text Books:**

1. Sandy Primose (2006). Principles of Gene Manipulation and Genomics. 7th Ed., Blackwell Publishers.
2. Brown T.A. (2010). Gene Cloning and DNA analysis. 6th Edition, Wiley-Blackwell.

**Suggested Reading:**

1. David E Newton. (2010). DNA technology. ABC-CLIO, LLC
2. Beiquan Mou and Ralph Scorza. (2011). Transgenic Horticultural Crops: Challenges and Oppurtunities. CRC press.
3. Thomas F. Budinger and Miriam D. Budinger. (2006). Ethics of Emerging Technologies: Scientific Facts and Moral Challenges. John Wiley and Sons Inc.
4. Pete Shanks. (2005). Human Genetic engineering. Avalon publishing groups.
5. Glick BR and Pasternak JJ (2003). Molecular Biotechnology, 2<sup>nd</sup> EditioN, ASM press.
6. Peter J Russels (1997). Genetics. 5<sup>th</sup> Ed. Benjamin-Cummings Publishing Co.
7. David Frifielder, Stanley R.Maloy. (1994). Molecular Biology and Microbial genetics. 2<sup>nd</sup> Edition, Jones and Brlett Publishers.

# TECHNIQUES IN MICROBIOLOGY

**Course code: MB 455**

**Total number of Lecture hours: 48**

**Total number of Credits: 03**

*This course aims to introduce various techniques and instrumentation methods required for the study of microorganisms. This paper provides understating on techniques and methods of microscopy, spectroscopy, chromatography and electrophoresis. Recent advances in DNA sequencing methods are covered to understand microbial genomes in the progressive semester.*

## **Unit- 1**

**10 h**

**Microscopy-** Principles and applications, simple, compound, phase-contrast and fluorescent microscopes. Electron microscopy: SEM and TEM, Confocal laser scanning microscopy. **Centrifugation Techniques:** Principles, type of centrifuges, buoyant and density gradient centrifugation, ultracentrifuges.

## **Unit- 2**

**10 h**

**Spectroscopy** - Electromagnetic spectrum, Beer Lambert's Law. Photometry, UV/VIS Spectrophotometry, Infrared spectroscopy, Atomicabsorption spectroscopy, ESR and H and C NMR spectroscopy. Mass spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy, principle, instrumentation and application of MALDI-ToF.

## **Unit- 3**

**8 h**

**Chromatography** - Introduction and types of chromatography, paper, thin layer, gas, partition, Gel permeation, ion-exchange, HP-TLC, HPLC, FPLC and affinity chromatography and instrumentation. Applications of Chromatographic techniques in Microbiology.

## **Unit- 4**

**10 h**

**Electrophoresis and Blotting techniques** - Paper and gel electrophoresis, PAGE (native and SDS), Agarose gel electrophoresis, PFGE, Blotting- Southern, Western and Northern blotting, Immunoblotting, **Labelling and Detection methods** - Nature and types of radiations, preparation of labelled biological samples. Detection and measurement of radioactivity, GM counter, Scintillation counter, Autoradiography, Flow cytometry. Safety measures in handling radioisotopes. RIA, non radiolabelling.

## **Unit- 5**

**10 h**

**DNA sequencing methods** - Major landmarks in DNA sequencing - Maxam-Gilbert sequencing, Chain-termination methods, Advanced methods and *de novo* sequencing, Shotgun sequencing, Next-generation methods, Massively Parallel Signature Sequencing (MPSS), Polony sequencing, 454 pyrosequencing, Illumina (Solexa) sequencing, SOLiD sequencing, Ion semiconductor sequencing, DNA nanoball sequencing, Heliscope single molecule sequencing, Single molecule real time (SMRT) sequencing.

### **Recommended Text Books:**

1. Wilson & Walker. Principles and Techniques in Practical Biochemistry. 5th ed. Cambridge Univ. Press, 2000.
2. Alcomo, I.E. 2001. Fundamentals of Microbiology. VI Edition, Jones and Bartlett Publishers, Sudbury, Massachusetts.

### **Suggested Reading:**

1. Freifelder D. M. Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd ed., W.H. Freeman, 1982.
2. Becker, W. M., Kleinsmith, L.J. and Hardin, J. 2000. The world of the Cell. IVth Edition. Benjamin/ Cummings.
3. Perry, J.J., Staley, J.T. and Lory, S. 2002. Microbial Life. Sinauer Associates, Publishers, Sunderland, Massachusetts.
4. Schaechter, M. Ingraham, J.L. and Neidhardt, F.C. 2006. Microbe. ASM Press, Washington.
5. Sullia, S.B. and Shantharam,S. 2000. General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd.
6. Tortora, G.J., Funke, B.R. and Case C.L. 2004. Microbiology-An Introduction. Benjamin Cummings. San Francisco.
7. Murphy D. B. Fundamental of Light Microscopy & Electron Imaging. 1st ed. Wiley-Liss, 2001.

# MARINE MICROBIOLOGY

**Course Code: MB 471**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*The world's oceans are experiencing unprecedented stresses due to human impacts such as increased nutrient runoff, over-fishing, and increased emissions of greenhouse gases that are causing pervasive changes in ocean chemistry and temperature. The basic knowledge and tools to predict how these changes will affect critical ocean ecosystems upon which society relies for many important functions. This paper is designed introduce the students to understand microbial processes and dynamics of marine environment.*

## **Unit 1**

**10 h**

Introduction to Microbial Oceanography – marine ecosystem: benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop - marine microbial communities - phytoplankton, protozoa, bacteria, fungi, and virus. Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association.

## **Unit 2**

**10 h**

Dynamics of Marine Microbes - Carbon cycle: Phototrophic microbes, the oceanic carbonate system and global warming - Nitrogen cycle: Nitrogen fixers – Iron limitation – ocean fertilization - phosphorus cycle; Decomposition of organic matter; Bioleaching and biodeterioration of natural and synthetic materials

## **Unit 3**

**9 h**

Microbial products: Microbial interaction Microbes of Biotechnological importance; Primary and secondary metabolites - enzymes, antibiotics, organic acid, toxins, biosurfactants and pigments

## **Unit 4**

**9 h**

Microbes of extreme environments – mechanism of extremophiles – halophiles – halorhodopsin – deep sea microbes – microbes of hydrothermal vents - thermophilic, alkalophilic, asmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles – importance in biotechnology.

## **Unit 5**

**10 h**

Seafood microbiology - normal genera associated with fish, food spoilage, fish & human pathogens; zoonotics – Brief account on aquaculture pathogens - Vibriosis – shrimp diseases – WSSV – MBV etc. Rapid diagnosis of contamination in seafoods and aquaculture products.

### **Recommended Text Books:**

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5<sup>th</sup> Edition, Tata McGraw Hill, 1993.
2. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
3. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006
4. Rheinheimer, G., 1980. Aquatic Microbiology, John Wiley & Sons, pp. 235.
5. Elay, A.R. 1992. Microbial food poisoning. Chapman and Hall, London, 191 pp.
6. Ford, T.E., 1993. Aquatic microbiology. An ecological approach. Blackwell scientific publications, London, 518 pp.
7. Krichman, D.L., 2000. Microbial ecology of the oceans. Wiley – liss, New york, 542 pp
8. Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi.
9. Joseph Selvin and A. S. Ninawe (2009). Shrimp Disease Management. ANE Publishers



# MICROBIAL NANOTECHNOLOGY

**Course Code: MB 472**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This discipline helps to indicate the merger of biological research with various fields of nanotechnology. This technical approach to biology allows scientists to imagine and create systems that can be used for biological research. The most important objectives that are frequently found in nanobiology involve applying nanotools to relevant medical/ biological problems and refining these applications. Developing new tools for the medical and biological fields is another primary objective in nanotechnology. Microbes are playing an important role in the synthesis of nanoparticles. This syllabus would enlighten the students to understand basic concepts and application of nanotechnology*

## **Unit – 1**

**9 h**

Introduction to Nanotechnology: Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanocomposite, nanotubes, nanowires and emergence of bionanotechnology. Characterization of nanoparticles – UV-Vis spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD.

## **Unit – 2**

**9 h**

Microbial nanotechnology –Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

## **Unit – 3**

**9 h**

Preparation of nanobiomaterials – Polymeric scaffolds collagen, Elastins: Mucopolysaccharides, proteoglycans, cellulose and derivatives; Dextrans; Alginates; Pectins; Chitin. Nanoparticles – types, functions – Silver, Gold and Titanium. Physical and chemical properties of nanoparticles.

## **Unit – 4**

**12 h**

Nanoscale applications in biology and medicine: Nanotechnologies for biology and medicine - Micro- and nano- fluidics - Scanning probe microscopy in biology and medicine - Self-assembly of biological molecules. Drug delivery – protein mediated and nanoparticle mediated. Hybrid conjugates of gold nanoparticles – DNA oligomers – use of DNA molecules in nanomechanics and Computing. Nanoparticles as carrier for genetic material. Genetically Modified Organisms (GMO) and applications.

Implications of nanotechnology: Health and safety implications from nanoparticles: Health issues – Environmental issues – Need for regulation – Societal implications: Possible military applications – Potential benefits and risks for developing countries – Intellectual property issues – Criticism of Nanotechnology – Studies on the implications of Nanotechnology.

**Recommended Text Books:**

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool Publishers.
3. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects. CRC Press.
5. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.

**Course Code: MB 473**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course designed to introduce the essential fundamentals of Agriculture Microbiology. This course focuses on the concepts of Agricultural Microbiology such as Soil Environment, Major plant diseases caused by fungi, bacteria and viruses, biopesticides & biofertilizers and plant microbe-interactions.*

## **Unit-1**

**10 h**

Soil Environment- Microorganisms, soil structure, soil profile, Physico-chemical conditions, Microbial composition, sampling techniques, role of Microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins). Bio-geo chemical cycles – Carbon cycle, Nitrogen cycle – Nitrogen fixation, nitrification, de-nitrification, sulphur, iron and phosphorus cycles. Rhizosphere – Rhizosphere Microorganisms, Siderophores. PGPM-Plant growth promoting microorganisms. plant-microbe beneficial interactions. Mechanisms of plant growth promotion.

## **UNIT-2**

**10 h**

Major plant disease symptoms caused by fungi, bacteria and viruses. Plant diseases – Principles, symptoms and control measures of the following diseases: Fungal – Tikka, red rot of sugarcane, *Fusarium* wilts (red gram and cotton), *Sclerotium rolfsii* and *Macrophomina phaseolina* (collar rot disease, charcoal rot). Bacterial – Blight of rice, citrus canker, *Xanthomonas* (black rot). Viral and mycoplasmal – Bud necrosis of groundnut, citrus mosaic, little leaf of brinjal, tomato leaf curl. Principles of plant disease control. Protection - Diseases of field, vegetable, orchard and plantation crops of India and their control; causes and classification of plant diseases; principles of plant disease control biological control of diseases.

## **UNIT-3**

**10 h**

Biofertilizers – Introduction, biofertilizers using nitrogen fixing microbes – phosphate solubilization- Rhizobium, Azatobacter, Azospirillum, Azolla; Anabaena Symbiosis, blue green algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculation of *Rhizobium*, *Azotobacter*, *Azospirillum*, *Azolla* and cyanobacteria, Carrier-based inoculants, methods of application, quality control, agronomic importance. Application methods for different biofertilizers.

## **UNIT-4**

**9 h**

Biopesticides – *Bacillus thuringiensis*, *B. sphaericus*, *B. popilliae*, *Pseudomonas syringae*. Biocontrol- Microbial control of plant pathogens- Trichoderma. Useful genes from microorganisms for agriculture (herbicide resistant, Bt, viral). Biological Control – Use of Baculovirus, NPV virus, protozoa & fungi in biological control.

## **UNIT-5**

**9 h**

Molecular plant microbe-interactions: Cell signalling, Quorum sensing, and Biofilm formation. Invasion of plant tissue:- resistance mechanisms against attack by plant pathogens.

Molecular detection of pathogens. Integrated pest management-concepts and components; host plant resistance-biological control of insect pests; Recycling of agricultural wastes - Microbiology and biochemistry of biogas, bioethanol and other value added products. Mushroom cultivation and Vermicomposting.

**Recommended Text Books:**

1. Dirk J, Elias V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
2. Agricultural Microbiology by G.Rangaswamy and Bagyaraj, Prentice Hall India.
3. Bio-fertilizers in Agriculture and Forestry, 1995, by N.S. Subba Rao.
4. Microbes For Sustainable Agriculture by K.V.B.R. Tilak, K.K. Pal, Rinku Dey
5. Soil Microbiology and Plant Growth, 1995, by N.S. Subba Rao.
6. Plant Growth and Health Promoting Bacteria by Dinesh K. Maheshwari
7. Plant-microbe interactions, Volume 1 by Gary Stacey and Noel T. Keen
8. Biological control of crop diseases Volume 89 of Books in soils, plants, and the environment by S. S. Gnanamanickam
9. Plant-microbe interactions and biological control Volume 63 of Books in soils, plants, and the environment by Greg J. Boland, L. David Kuykendall

# MYCOTOXICOLOGY AND PLANT PATHOLOGY

**Course Code: MB 474**

**Total Number of Lecture hours: 48**

**Total Number of credits: 03**

*This course provides the learner some of the significant developments in the area of Plant Pathology and material on specific microbial diseases in plants, how plants defend themselves against pathogens, with impetus to fungal diseases and development of mechanisms to produce disease-resistant plants. This becomes important mainly because of the current development of plant pathology as a science and its potential future impact on plant disease control.*

## **Unit- 1**

**8 h**

**Plants and Disease:** The concept of disease in plants, History of Plant Pathology, Early significant plant diseases, Plant Pathology in the 20<sup>th</sup> century, Types of Plant diseases, Losses caused by plant diseases, Plant Pathology- today and future.

## **Unit- 2**

**10 h**

**Parasitism and Disease Development:** Parasitism and Pathogenicity, Host range of pathogens, Development of disease in plants, Stages in disease development: The disease cycle- Inoculation, Pre-penetration phenomena, Penetration, Infection, Dissemination of the pathogen, Relationship between disease cycles and epidemics.

## **Unit- 3**

**10 h**

**Genetics of Plant Disease:** Introduction, Genes and disease, Types of plant resistance to pathogens, The nature of resistance to disease- Pathogenicity genes in plant pathogens, Genes controlling: a) Degradation of cuticle and cell wall, b) Production of secondary metabolites-fungal toxins; Resistance (R) genes of plants.

## **Unit- 4**

**10 h**

**Plant Diseases caused by Fungi:** General Characteristics of plant pathogenic fungi- Morphology, Reproduction, Ecology & Dissemination; Symptoms caused by fungi on plants, General characteristics of diseases caused by Myxomycetes, Chytridiomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes.

## **Unit- 5**

**10 h**

**Control of Plant Diseases:** Methods that exclude the pathogen from the host- Quarantines and Inspections, Crop certification, Evasion or avoidance of pathogen, use of pathogen free propagating material, pathogen-free seed, pathogen-free vegetative propagating materials.

Methods that eradicate or reduce pathogen inoculum; Disease control by immunization/ improving host resistance; Direct protection of plants from pathogens; Integrated control of plant diseases.

### **Recommended Text Books:**

1. George N. Agrios. 2005. Plant Pathology, 5<sup>th</sup> Edition, Academic Press.
2. Schumann, G.L. 2006. Essential Plant Pathology. APS Press.
3. Sharma, P.D. 2006. Plant Pathology.
4. Hewitt, H. G. 1999. Fungicides in crop protection.
5. David S. Ingram and Robertson, N. F. 1999. Plant Disease. Collins Publishers.

## II-Semester Lab Courses

### **BACTERIOLOGY LAB**

**Course Code: MB 491**

**Total Number of Credits: 01**

1. Introduction to good laboratory practices and sterilization techniques & Preparation of different nutrient media-Liquid and Solid media-minimal, complex and differential media
2. Isolation of bacteria from air, water, soil
3. Morphological characteristics of bacteria-Staining techniques – simple and Gram's staining Endospore staining, Flagella staining and Capsule staining
4. Bacterial culture techniques-Liquid broth culture & Pure culture techniques-serial dilution technique, Pour plate, spread plate, streak plate techniques.
5. Measurement of bacterial population by turbidimetry and colony counting by serial dilution of samples
6. Bacterial growth curve
7. Antibiotic sensitivity tests-disc method
8. Preservation of pure cultures: slant preparation, water stock, glycerol stock
9. Biochemical tests for bacterial identification
10. Detection of bacterial pathogens by PCR method.

### **MYCOLOGY LAB**

**Course Code: MB 492**

**Total Number of Credits: 01**

1. Methods of isolation and identification of fungi by traditional methods.
2. Preparation of pure culture and preservation of culture.
3. Isolation and identification of endophytic fungi from plants.
4. Observation and identification of mycorrhiza.
5. Isolation and identification of fungi from seeds.
6. Study of soil fungi from varied geographical origins.
7. Isolation of antibacterial/ antimycotic compounds from fungi.
8. Staining and observation of plant pathogenic fungi.
9. Study of asexual reproduction in *Saccharomyces*.

## **VIROLOGY LAB**

**Course Code: MB 493**

**Total Number of Credits: 01**

1. Isolation of bacteriophages from sewage
2. Estimation of virus yields - plaque assay
3. Routes of inoculations in embryonated eggs
4. Haemagglutination test
5. Hemagglutination inhibition assay
6. Biocontrol assay on insect larvae using NPV
7. ELISA test
8. Study of virus infected plant material.
9. One step growth curve of bacteriophage by Burst size determination.
10. Demonstration of identification of arthropod vectors of viral transmission

## **TECHNIQUES IN MOLECULAR CLONING LAB**

**Course Code: MB 494**

**Total Number of Credits: 01**

1. Isolation of Genomic DNA and quantification.
2. Isolation of Plasmid and quantification.
3. Preparation of Vector and Insert by restriction digestion.
4. Preparation of competent cells using  $\text{CaCl}_2$ .
5. Ligation reaction of restriction digested Vector and Insert.
6. Transformation of recombinant DNA.
7. PCR amplification of gene of interest.
8. Isolation of RNA and quantification.
9. Reverse transcriptase PCR.
10. Restriction Fragment Length Polymorphism (RFLP) analysis
11. Quantitative Real Time –PCR(Demonstration)



## **INSTRUMENTATION TECHNIQUES LAB**

**Course Code: MB 495**

**Total Number of Credits: 01**

1. Study of simple and compound microscopes, their handling including oil immersion objective.
2. Absorption spectra- UV-Visible.
3. Paper Chromatography of amino acids, carbohydrates, nucleic acids.
4. Ion exchange chromatography.
5. SDS Gel electrophoresis.
6. Agarose Gel electrophoresis
7. PCR technique
8. Quantitative Real time-PCR (Demonstration)
9. Scanning Electron Microscope (Demonstration)
10. Western Blot

# MEDICAL MICROBIOLOGY

**Course Code: MBT 501**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course deals with importance of the microorganisms in human health. The basic concepts and medical terms will be explained along with information related to biosafety levels. Modes of transmission, host-pathogen interactions will be discussed in detail. Students will study important diseases by body system with reference to the etiology, pathogenesis, treatment, diagnosis and prevention.*

## **Unit- 1**

**8 h**

Important developments in medical microbiology: Normal flora of human body, opportunistic infections; Host-parasite interactions. Nosocomial infections and their control. General concepts for clinical specimen collection and biosafety levels.

## **Unit- 2**

**10 h**

**Epidemiology:** Concept of epidemic, endemic and pandemic, acute, chronic, morbidity, mortality, prevalence, incidence, Reservoirs, Carriers. Stages of Disease Progression. Modes of transmission; vector, vehicle transmission, portal of entry. Mechanisms of microbial resistance to host cellular and humoral defenses. *Molecular basis of microbial pathogenicity.* Molecular Koch's postulates, Pathogenicity Islands, bacterial toxins. *Active and Passive Immunization:* different types of vaccine live attenuated, killed, subunit, recombinant DNA vaccine. *Antimicrobial Agents:* Multi-drug Resistance, Generation of antibiotics, Mechanism of Action of: Streptomycin, Griseofulvin.

## **Unit- 3**

**10 h**

**Infections of Skin:** Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Bacterial: *Staphylococcus; Streptococcus, Pseudomonas*; Viral: Chicken Pox, Measles, Fungal: Cutaneous and Subcutaneous Mycoses Protozoal: *Leishmania*. Infections of *Gastrointestinal System:* Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Bacterial: *Salmonella, Shigella, E. coli*, Viral: Hepatitis, Protozoal: *Entamoeba*,

## **Unit- 4**

**10 h**

**Infections of Nervous System:** Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Meningitis, *Bacterial:* Tetanus, Botulinum, Leprosy. *Viral:* Rabies, Protozoal: African Sleeping sickness, *Systemic Infections:* Etiology, Pathogenesis, Laboratory diagnosis, prophylaxis and treatment of Bacterial: Brucellosis, RMSF, Protozoal: Malaria



# FOOD MICROBIOLOGY

**Course Code: MB 502**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*The Food Microbiology paper would enable students to learn about the epidemiology of food-borne diseases and the pathogens. Also, the study would equip them to study various methods of pathogen detection available along with understanding the beneficial and harmful effects of microbes in the food industry. Food Safety standards are also highlighted.*

## **Unit- 1**

**10 h**

**Historical Perspective and Scope of Microbiology in relation to food-** Importance and significance of microorganisms in food. Factors – Intrinsic and Extrinsic parameters - affecting the growth of microorganisms in food. Food borne diseases- Bacterial food borne diseases- (Staphylococcal intoxicification, Botulism, Salmonellosis, Shigellosis, EPEC Diarrhoea, *Clostridium Perfringens* gastroenteritis, *Bacillus cereus* gastroenteritis; Food-borne fungi- Mycotoxins- Aflatoxicosis, Deoxynivalenol, Mycotoxicosis, Ergotism. Food Borne Viral Pathogens- (Norwalk virus, Reovirus, Rotavirus, Adenovirus, Parvovirus, Hepatitis A Virus) Food Borne Animal Parasites- Protozoa – Giardiasis, Amebiasis, Toxoplasmosis, Cryptosporidiosis. Cysticercosis/ Taeniasis; Roundworm – Trichinosis, Anisakiasis.

## **Unit- 2**

**10 h**

**Detection of foodborne pathogens-** Detection and Enumeration of micro organisms and their products in food- Culture dependent methods- Sample collection and processing, analysis, surface testing, Direct microscopic observation, enumeration and isolation methods; Animal and Cell Culture Models to study foodborne pathogen interaction; Culture independent techniques – Metagenomics, Biosensor based detection of food pathogens, Nucleic-acid based methods- PCR; Immunological methods to detect food-borne pathogens; Molecular Typing and Differentiation of Food-borne Bacterial Pathogens; Analytical methods for microbial metabolites- microbial toxins and metabolites.

## **Unit- 3**

**9 h**

**Food spoilage and Food preservation-** Organisms involved, characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat, poultry and sea foods, milk and milk products, packed and canned foods. Spoilage and defects of fermented foods. Food preservation- High temperature, Low temperature- Significance of psychrophilic microbes in cold-stored and frozen foods, Drying, Chemical, Modified atmosphere, Radiation, other food protection methods and Microbial Resistance.

**Unit- 4****10 h**

**Microbiology of Food fermentations-** Milk, Fermentation, Fermented and Non-fermented Dairy Products. Food fermentations- Manufacture of fermented foods- Meat and fishery products, plant products- Sauerkraut and fermented olives, breads, beverages. Microbial cells as food- SCP, mushroom cultivation. Source and applications of microbial enzymes, antioxidants, biosurfactants, polysaccharides, flavors and colors. Probiotics and their advantages, Genetically modified foods.

**Unit- 5****9 h**

**Food safety and Quality Management Systems-** General principles of food safety risk management, Recent concerns on food safety- Safe food alternatives (Organic foods), Good agricultural Practices (GAP), Food Indicators of water and food safety and quality- Microbiological criteria of foods and their Significance. The HACCP and ISO systems for food safety.

**Recommended Text Books:**

1. Adams, M. R., and M. O. Moss, 1996, Food Microbiology, New Age International (Rt) Ltd., New Delhi.
2. Frazier, W.C. and D.C. Westhoff, 1988, Food Microbiology (Reprint 1995), Tata McGraw Hill Publishing Ltd., New Delhi.
3. James M. Jay., Loessner, M. J., and Golden D. A., 2005, Modern Food Microbiology, Seventh edition.
4. Verma, L.K. and Joshi, V. K., 2000, Post Harvest Technology of Fruits and Vegetables, Tata McGraw Hill Publication.

**Suggested Reading:**

1. Arun K. Bhunia, 2008, Foodborne Microbial Pathogens- Mechanisms and Pathogenesis, Food Science text Series, Springer International, New York, USA.
2. Benwart, G. J., 1987, Basic Food Microbiology, CBS Publishers & Distributors, New Delhi.
3. Deak, T. and L. R. Beuchat, 1996, Hand Book of Food Spoilage Yeasts, CRC Press, New York.
4. Doyle, M. P. and Beuchat, L. R., 2007, Food Microbiology- Fundamentals and Frontiers, ASM Press.
5. Garbutt, J., 1997, Essentials of Food Microbiology, Arnold – International Students edition, London.
6. Marriott, N. G. and Gravani R. B. 2006. Principles of Food Sanitation, Food Science text Series, Springer International, New York, USA.

## APPLIED & INDUSTRIAL MICROBIOLOGY

**Course Code: MB 503**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*The syllabus of applied and industrial microbiology is oriented towards the industrial application of microorganisms and recent microbial products. After studying this paper students will know the applied and industrial aspects of microbiology such as screening of microorganisms, strain improvement, microbial metabolites, fermented microbial products, microbial enzymes, Biofuels using microbes and microbial production of Biopolymers. The recent applications of the microbes for the human welfare are well structured in this paper.*

### **Unit- 1**

**10 h**

**Basics of Industrial Microbiology:** Historical account of microbes in industrial microbiology; sources and characters of industrially important microbes; their isolation, purification and maintenance; Screening of useful strains; primary screening and secondary screening; Strain improvement through random mutation and genetic engineering; types of fermentation and fermenters. Microbial growth kinetics in batch, continuous and fed-batch fermentation process.

### **Unit- 2**

**10 h**

**Microbial production of metabolites:** Microbial production of Primary and secondary metabolites. Commercial production of antibiotics with special reference to penicillin, streptomycin and their derivatives. Microbial transformations: steroids and alkaloids production. Large scale production of recombinant molecules interferon, human proteins-insulin, somatostatin, vaccines and anticancer agents.

### **Unit- 3**

**10 h**

**Fermented Microbial products:** Microbiology and production of alcoholic beverages; Malt beverages, distilled beverages, wine and champagne; Commercial production of organic acids like acetic, lactic, citric, and gluconic acids; Commercial production of important amino acids (glutamic acid, lysine and tryptophan), and vitamins (riboflavin and vitamin A).

### **Unit- 4**

**9 h**

**Microbial enzymes:** Immobilization of microbial enzymes and whole cells and their applications in industries; Industrial enzymes production; Cellulases, Xylanases, Pectinases, Amylases, Lipases and Proteases and their applications. Enzymes involved in microbial biocatalysis/transformations.

**Biofuels & Biopolymers:** Biofuels (ethanol and methane) from organic residues; fuels from algae; Mushroom cultivation; other microbial products - Biopolymers and EPS, Bioplastics, Biosurfactants, effluent treatment, SCP.

**Recommended Text Books:**

1. Nduka Okafor (2007). *Modern Industrial Microbiology and Biotechnology*. 1<sup>st</sup> Edition: Science Publishers.
2. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2002). *Industrial Microbiology: An Introduction*. Blackwell Science Publishers.

**Suggested Reading:**

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation.
2. Reed. G. (1999). Prescott and Dunn's Industrial Microbiology. CBS Publishers.
3. Demain, A. L. (2001). Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
4. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker &S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.
3. Richard H. Baltz, Julian E. Davies, and Arnold L. Demain (2010). Manual of Industrial Microbiology and Biotechnology. 3<sup>rd</sup> Edition, ASM Press.
4. Daniel Forciniti (2008). Industrial Bioseparations: Principles and Practice. 1<sup>st</sup> Edition, Wiley-Blackwell.
5. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA.,2007.

# ENVIRONMENTAL MICROBIOLOGY

**Course Code: MB 504**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*Environmental Microbiology is historic as well as eminently modern. The activities of the microorganisms at large in nature/ environment is considered in this paper. Microbes play far more important roles in nature than their small sizes would suggest. In order to evaluate the roles of microorganisms in ecosystems, it is essential to understand the precise natural habitats and how their activities can be explored.*

## **Unit- 1**

**10 h**

**Microbial ecology:** Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession. Ecological pyramid, energy flow, food chain, food webs and their dynamism, stability and complexity of ecosystem. Interactions between microbes and organisms at other trophic levels: commensalism, mutualism, parasitism and predation with examples. **Microbial communities:** Microenvironment and niche, communities in soil, water, air. Biofilms, microbial mats and their significance.

## **Unit- 2**

**8 h**

**Soil Microbiology:** Soil microbes and soil fertility, microorganisms in soil processes carbon, nitrogen and sulphur cycle Nitrogen fixation: Biochemistry of Nitrogen fixation - mechanism of nitrogenase - hydrogenase - Assay of nitrogen fixation - physiology of legume root nodule, leghaemoglobin - Synthesis, Genes involved in nitrogen fixation.

## **Unit- 3**

**10 h**

**Aquatic Microbiology:** The aquatic environment - major environmental conditions influencing microflora. Distribution of microorganisms in the aquatic environments - freshwater environment, estuaries and marine environment. Microbiology of drinking water, water pollution, purification of water for human consumption. Assessment of microbial status in water and waste water. Wastewater characteristics, Effluent treatment processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).

## **Unit- 4**

**10 h**

**Plant-microbial interaction:** Introduction, concepts and scope of agricultural microbiology, Interrelationships between plants and microorganisms, Rhizosphere and phyllosphere microorganisms and their interactions with plants. Plant pathogens (bacterial and fungal) Mechanisms of plant pathogenicity, symptoms of plant diseases, transmission of plant diseases. Signalling events in pathogenesis and resistance to pathogens. Molecular basis of plant disease control along with cultural practices, chemical and biological control.



Microbial control of insects. Beneficial association between plant and microorganisms (association of plants with cyanobacteria, actinomycetes and fungus).

## Unit- 5

10 h

**Biofertilizers:** Bacterial bio fertilizer: *Rhizobium*, *Azotobacter*- *Azopirillum*, *Acetobacter diazotrophicus* - phosphobacteria and Frankia. Algal fertilizer - Blue green algae, Azolla – Importance. Fungal fertilizers - Mycorrhizae – ecto and endomycorrhiza. Principles of mass production, Quality Control and Field applications. **Bioremediation:** Factors affecting the bioremediation process, Bioremediation of toxic waste sites; Role of microbes; Microbial degradation of environmental pollutants- industrial solvents, pesticides, petroleum hydrocarbons, xenobiotics; Bioremediation practices and technologies.

### Recommended Text Books:

1. Prabhakaran, G. 2004. Introduction to Soil and Agricultural Microbiology, Himalaya Publishing House.
2. George N. Agrios. 2005. Plant Pathology. 5<sup>th</sup> Edition. Academic Press.
3. Hand Book Of Biofertilizers & Vermiculture, Engineers India Research Inc., Jan (2007)-332 pages.
4. Raina M. Maier, Ian A. Pepper and Charles Gerba (2009) Environmental Microbiology (2<sup>nd</sup> edition). Academic Press.
5. Mohapatra P. K. Textbook of Environmental Microbiology. IK International Pvt. Ltd.

### Suggested Reading:

1. Atlas, R. M and Bartha, R (1998) Microbial Ecology – Fundamentals and Applications, Addison, Wesley Longman Inc.
2. Barcelo, P., Rasco-Gaunt, S., Thorpe, C., and Lazzeri, P. (2001) Transformation and gene expression: In Advances in Botanical Research, vol. 34: Biotechnology of Cereals (P. R. Shewry, P. A. Lazzeri, and K. J. Edwards, eds), pp. 59–126. Academic Press, London.
3. Vessey, 2003. Plant growth-promoting *Rhizobacteria* as biofertilizers. Plant and Soil, 255: 571-586.
4. Pepper IL, Gerba CP and Brusseau M (2006) Environmental and Pollution Science, Academic Press, USA

## MICROBIAL GENOMICS

**Course Code: MB 505**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to understand advancement of Microorganisms using culture-independent approaches. Microbial Genomics, Metagenomics and Bioinformatics are new dimensions of approaches in exploring the microbial world. Without these new dimensions, a Microbiology student could not apply his knowledge in research and development activities. Therefore, this course could enable the students to perform analysis and interpretation of microbial phylogeny.*

### **Unit- 1**

**10 h**

**Structural and functional genomics-** definition, historical prospective and strategies. Genome Structure: genome sizes – microbial and organelle genome – genome physical mapping and sequencing – tools in genome analysis; Structural and functional annotations of genes and genomes. An overview of genome projects : human, plant, animal and microbial genomes. Analysis of Human Genome Map repositories: NCBI – Entrez Human genome map viewer, Human Microbiome project – Earth Microbiome project - hologenome theory.

### **Unit- 2**

**10 h**

**Whole genome library:** Need of genome library, methodology, Enzymes used in genome library construction, Vectors for library construction, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Whole genome shotgun sequencing: DNA sequencing theory pair wise and end sequencing, The Institute for Genomic Research (TIGR), Celera Genomics. Hierarchical Shotgun sequencing, Next-generation sequencing and full genome sequencing platforms.

### **Unit- 3**

**9 h**

**Metagenomics** – definition – principles – methods - whole genome shotgun sequencing – pyrosequencing – metagenomic library production – high throughput screening - metgenomics of archeological samples – Sargasso sea project – microbial phylogeography.

### **Unit- 4**

**10 h**

**Taxonomy and phylogeny:** Basic concepts in systematics, taxonomy and phylogeny; molecular evolution; nature of data used in Taxonomy and Phylogeny, Definition and description of phylogenetic trees and various types of trees, Phylogenetic analysis algorithms such as maximum Parsimony, UPGMA, Transformed Distance, Neighbors-Relation, Neighbor- Joining.

## Synthetic microbiology and bioengineering

Introduction to synthetic biology - Metabolomics and synthetic microbiology, predictive model building (metabolomes) - Secondary metabolism and synthetic biology - synthetic bacterium, Mycoplasma laboratorium

### Recommended Text Books:

1. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P Read. New York: Wiley-Liss; 1999.
2. Sudbery, Human Molecular Genetics Prentice Hall, 2002
3. Pasternak, An Introduction to Molecular Human Genetics
4. Strachan and Read, Human Molecular Genetics
5. G. Grandi. 2003, Genomics, proteomics and Vaccines
6. S.B. Primrose, 2004, Genomics : Applications in Human Biology
7. J. Zhou, D.K. Thompson, T. Xu, J.M. Tiedge, 2004, Microbial functional Genomics, Proteomics & Bioinformatics
8. Bioinformatics: Sequence and Genome Analysis by Mount D., 2004 Cold Spring Harbor Laboratory Press, New York.
9. Bioinformatics- a practical guide to the analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellette, B.F., 1998, John Wiley & Sons, UK.

### Suggested Reading:

1. Necia Grant Cooper; (Ed.) 1994. The Human Genome Project; Deciphering the Blueprint of heredity University Science books, CA, USA.
2. Gary zweiger, 2003. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences.. Tata McGraw-Hill Publishers, New Delhi.
3. Dobzhansky, Th. Genetics and Origin of Species. Columbia Unvieristy Press.
4. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
5. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
6. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
7. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London
8. Molecular Evolution: A Phylogenetic Approach (Page, R. D. M. and Holmes, E. C.) 1998; Inferring Phylogenies (Felsenstein, J.) 2004; Phylogenetic Trees Made Easy (Hall, B. G.) 2001; Molecular Systematics (Hills, D. M., Moritz, C. and Mable, B. K.) 1996, 2nd edition.
9. Principles of Genome Analysis: A Guide to Mapping and Sequencing DNA from Different Organisms by S. B. Primrose (Jan 1998)
10. Edwards, A; Caskey, T (1991). "Closure strategies for random DNA sequencing". *Methods: A Companion to Methods in Enzymology* 3 (1): 41–47.
11. Edwards, A; Voss, H.; Rice, P.; Civitello, A.; Stegemann, J.; Schwager, C.; Zimmerman, J.; Erfle, H.; Caskey, T.; Ansorge, W. (1990). "Automated DNA sequencing of the human HPRT locus". *Genomics* 6 (4): 593–608.

# FERMENTATION TECHNOLOGY

**Course Code: MB 521**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*This course aims to introduce technological advancement of fermentation and bioprocess for industrial applications. Microorganisms are capable of growing on a wide range of substrates and can produce a remarkable spectrum of products. This course will enlighten the students on basics of fermentation, metabolic engineering, fermenter design and downstream processing. The economics and IPR of industrial products are introduced to understand commercialization of microbial products.*

## **Unit- 1**

**10 h**

**Introduction to fermentation technology:** Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation. Introduction to fermentation processes, Microbial culture selection for fermentation processes - Fermentation Pathways for Industrial Products: Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by micro organisms; possibility of control of the reactions for the increased formation of useful metabolites. Strain Development - Various techniques of modifying the strains for increased production of industrial products.

## **Unit- 2**

**10 h**

**Fermentation process:** Growth of cultures in the fermenter Importance of media in fermentation, media formulation and modification. Kinetics of growth in batch culture, continuous culture with respect to substrate utilization, specific growth rate, steady state in a chemostat, fed-batch fermentation, yield of biomass, product, calculation for productivity, substrate utilization kinetics. Fermentation process: Inoculum development. Storage of cultures for repeated fermentations, scaling up of process from shake flask to industrial fermentation - cell and enzyme immobilization.

## **Unit- 3**

**9 h**

**Bioreactors:** Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, sterilization of media - cooling and heating devices, probes for online monitoring, computer control of fermentation process-PID, measurement and control of process. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors.

## **Unit- 4**

**9 h**

**Downstream Processing:** Introduction, removal of microbial cells and other solid matters, Filtration: Theory, Batch filters (plate and frame filters, pressure leaf filters), Continuous filters (rotary vacuum, Cross flow filtration); Centrifugation, Cell aggregation and flocculation, Types of centrifuges (basket centrifuges, tubular bowl centrifuge etc); Cell disruption: Physical mechanical methods and chemical methods - solvent extraction of

product; evaporation chromatographic systems for separation and crystallization; drying techniques

## Unit- 5

10 h

**Bioprocess economics** - Bioproduct regulation - General fermentation economics. Intellectual Property Rights (IPR), Patents, Trademarks, Copyrights, Secrets, Patenting of biological materials, international co operation, obligations with patent applications, implication of patenting, current issues, hybridoma technology etc. Patenting of higher plants and animals, transgenic organisms and isolated genes, patenting of genes and DNA sequences.

### **Recommended Text Books:**

1. Principles of Fermentation Technology by Stanbury, P.F., Whitekar A. and Hall. 1995., Pergaman. McNeul and Harvey.
2. Fermentations - A practical approach. IRL.
3. Bioprocess Technology: Fundamentals and Applications. Stockholm KTH.
4. Biochemical Reactors by Atkinson B., Pion, Ltd. London.
5. Biotechnology - A Text Book of Industrial Microbiology by Cruger.
6. Fermentation Biotechnology: Industrial Perspectives by Chand.
7. Biochemical Engineering Fundamentals by Bailey and Ollis, Tata McGraw Hill, N.Y.
8. Biotechnology. Volume 3. Edited by H. J. Rehm and G. Reed. Verlag Chemie. 1983.
9. Advances in Biochemical Engineering by T.K. Bhosh, A.Fiechter and N. Blakebrough. Springer Verlag Publications, New York.
10. Biotechnology- A textbook of Industrial Microbiology by Creuger and Creuger, Sinaeur Associates.
11. Bioprocess Engineering Kinetics, Mass Transport, Reactors, and Gene expressions by Veith, W.F., John Wiley and Sons.
12. Industrial Microbiology by L.E. Casida, Wiley Eastern
13. Bioprocess Engineering: Downstream processing for Biotechnology by Belter, P.A. Cussler, E.L.and Hu, W.S., John Wiley and Sons, N.Y.
14. Separation process in Biotechnolgy by Asenjo, J.A. Eds. Marcel Dekkar, N.Y.
15. Bioprocess Engineering Principles by Doran, Acad. Press, London.
16. Bioreaction Engineering Principles by Nielsen, J. and Villadsen, plenum Press, N.Y.
17. Fermentation, Biocatalysis and bioseparation, Encyclopedia of Bioprocess Technology by Chisti, Y., Vol. 5, John Wiley and Sons, N, Y.
18. Vogel, H.C. and C.L. Todaro, (2005). *Fermentation and Biochemical Engineering Handbook : Principles, Process Design and Equipment*. 2nd Edition, Standard Publishers.

### **Suggested Reading:**

1. Biely, J.E. and Ollis D.F. Bio Chemical Engineering Fundamentals (1986) Megraw Hills.
2. Rehm, H.J. and Reed G (ed), Biotechnology, Vol 1-2, Verlag chemie.
3. Stanbury, P.E. and Whitaker A., Principles of Fermentation Technology (1984) Pergamon Press.

4. Pirt, S.J. Principles of Microbial and Cell Cultivation. Blackwell Scientific Publication, London.
5. Moo-young M. Comprehensive Biotechnology Vol. 1-4 Pergamon Press Oxford.
6. Biotechnological Innovations in Chemical Synthesis. BIOTOL. Publishers / Butterworth
7. Heinemann Industrial Microbiology by G. Reed (Ed), CBS Publishers (AVI Publishing.)
8. Biology of Industrial Microorganisms by A.L. Demain.
9. Genetics and Biotechnology of Industrial Microorganisms by C.I. Hershenberg, S.W.

# GENOME TECHNOLOGY

**Course Code: MB 522**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

## **Unit-1**

**9 h**

An introduction to genetic technology -Enzymes used in genetic engineering- Restriction endonucleases, DNA polymerases, Reverse transcriptase, Ligases, Polynucleotide kinase, Alkaline phosphatase, Nucleases, Klenow fragment, Terminal deoxynucleotidyl transferase, RNase. Vectors for cloning- Plasmids, Bacteriophage , Filamentous phage vectors, Cosmids, Phagemids, YACs. Ligation of DNA fragments with vectors - Homopolymer tailing, Ligation of cohesive termini, Blunt-end ligation, Linker molecules.

## **Unit-2**

**10 h**

Introducing genes into prokaryotes- Natural gene transfer methods-Transformation, transduction, calcium chloride mediated transformation, Transfection with phage vectors. Introducing genes into eukaryotes- Gene transfer by viral transduction, Calcium phosphate mediated transformation; Liposome mediated transformation, Microinjection, Electroporation.

## **Unit-3**

**9 h**

Cloning strategies: Producing genomic libraries in cloning vectors, Genomic libraries in high-capacity vectors, cDNA cloning, Shotgun cloning, Cloning in *E.coli*, Identifying the recombinant DNA and its products- Immunochemical screening, Hybrid arrested translation, Nucleic acid probes.

## **Unit-4**

**10 h**

Prokaryotic expression systems Gene expression based on bacteriophage T7 RNA polymerase, Eukaryotic expression systems- Fused genes, Unfused genes, Secreted proteins, Gene expression by transcription factors- Nfkb, PPAR, Antisense RNA technology- SiRNA, miRNA.

## **Unit-5**

**10 h**

Techniques in genetic technology- Hybridization technique, Southern, Northern-Western blotting techniques, Site directed mutagenesis, Restriction mapping, DNA profiling in forensic science, Chromosome walking, Chromosome jumping, DNA sequencing, PCR. Basic concepts of Intellectual property rights.

### **Recommended Text Books:**

1. Primrose, Principles of Genome analysis. Blackwell Sciences.2003.

2. Watson. Recombinant DNA. Second edition. American Publishers.1992.
3. Sambrook, J., Fritsch, E. F., and T. Maniatis, Molecular Cloning, A Laboratory Manual, Second edition. Cold Spring Harbor Laboratory Press, New York, 1989.
4. Joseph M. Fernandez and James P. Hoeffler. Gene expression systems.Academic Press, 1999.



## CYANOBACTERIOLOGY

**Course Code: MBT523**

**Total number of lecture hours: 42**

**Total number of Credits: 03**

*This course will help the student to understand taxonomy and molecular biology methods of cyanobacteria. The course will give knowledge on function of photosystem of cyanobacteria, the mechanisms of differentiation of heterocysts and hormogonia, molecular regulation of carbon dioxide and nitrogen metabolism and application of cyanobacteria.*

### **Unit 1:**

**8 h**

**Introduction:** Origins of life and photosynthesis, Diversity of cyanobacteria, Fossil history of cyanobacteria The Oceanic Cyanobacterial Picoplankton.

### **Unit 2:**

**8 h**

**Genomics of Cyanobacteria:** Gene transfer to cyanobacteria in lab and in nature, Molecular ecology and environmental genomics of cyanobacteria, comparative genomics of marine cyanobacteria, stress response-regulatory system and regulated genes.

### **Unit 3**

**10 h**

**Molecular Biology of cyanobacteria:** Molecular Biology of Cyanobacteria and Chloroplast Origins and Evolution; Supramolecular Membrane Organization; Phycobilisome and Phycobiliprotein Structures; The Use of Cyanobacteria in the Study of the Structure and Function of Photosystem II and The Cytochrome Complex; Photosystem I in Cyanobacteria; The F-type ATPase in Cyanobacteria: Pivotal Point in the Evolution of a Universal Enzyme.

### **Unit 4**

**8 h**

The Biochemistry and Molecular Regulation of Carbon Dioxide Metabolism in Cyanobacteria, Genetic Analysis of Cyanobacteria, Heterocyst Metabolism and Development, Differentiation of Hormogonia and Relationships with Other Biological Processes;

### **Unit-5**

**8 h**

**Applications:** Mass cultivation of cyanobacteria under outdoor and indoor conditions. Cyanobacteria as a source of fine chemicals: polysaccharides, bioactive molecules, pigments,

antioxidants, lipids and polyunsaturated fatty acids. Cyanobacteria as biofertilizer for paddy cultivation. Hydrogen production by cyanobacteria: Mechanism, progress and prospects.

Text Books:

1. Antonia Herrero and Enrique Flores. The Cyanobacteria: Molecular Biology, Genomics and Evolution, Caister academic press,2008.
2. T. A. Sarma. Handbook of Cyanobacteria, CRC press, 2012.

Reference Books:

1. D.A. Bryant. The Molecular Biology of Cyanobacteria (Advances in Photosynthesis and Respiration) Springer 1995.
2. Samit Ray. Cyanobacteria, New Age International Pvt Ltd Publishers, 2006.
3. Percy M. Gault and Harris J. Marler. Handbook on Cyanobacteria: Biochemistry, Biotechnology and Applications (Bacteriology Research Developments), Nova Science Publishers, Inc 2009.

**Course Code: MB 524**

**Total Number of Lecture hours: 48**

**Total Number of Credits: 03**

*Drug Design and Discovery course introduce the basic principles of modern drug design, discovery and development. The course deals with the different source of drug with specific focus on microbial source, drug development and manufacturing process. The course will have more focus on detection, selection, and validation of new antibacterial targets, vaccines and the use of gene technology in pharmaceutical industry.*

## **Unit-1**

**9 h**

**Introduction-** History of drug design, Current approaches and philosophies in drug design, Molecular mechanisms of diseases and drug action with examples. Pharmaceutical products, Pharmaceuticals of microbial origin (macrolides, ansamycins, Peptide and other antibiotics) animal origin (sex hormones androgens, Oestrogens, Progesterone and progestogens etc), plant origin (Alkaloids Atropine and scopolamine Morphine and cocaine Additional plant alkaloids)

## **Unit -2**

**10 h**

**Sources of Drugs-** Microbial drugs, Plants as a source of drugs, E. coli as a source of recombinant therapeutic proteins. Expression of recombinant proteins in yeasts, animal cell culture systems. Additional production systems: Fungal production systems, Transgenic animals, Transgenic plants and Insect cell-based systems. Rational drug design and Combinatorial approaches to drug discovery.

## **Unit -3**

**10 h**

**Drug development process-** Impact of genomics and related technologies upon drug discovery: Gene chips, Proteomics, Structural genomics and Pharmacogenetics.

**Drug manufacturing process-** Guides to good manufacturing practice, Production of final product - Cell banking systems, Upstream processing, Microbial cell fermentation, Mammalian cell culture systems, Downstream processing, Final product formulation, Freeze-drying, Labelling and packing

## **Unit-4**

**10 h**

**Vaccines and adjuvant-** Traditional vaccine preparations, attenuated, dead or inactivated bacteria, Attenuated and inactivated viral vaccines, Toxoids, antigen-based and other vaccine preparations. Impact of genetic engineering on vaccine technology. Peptide vaccines Vaccine vectors. Development of an AIDS vaccine, Difficulties associated with vaccine development, AIDS vaccines in clinical trials, Cancer vaccines, Recombinant veterinary vaccines. Adjuvant technology: Adjuvant mode of action, Mineral-based adjuvants ,Oil-based emulsion adjuvants Bacteria/bacterial products as adjuvants

**Nucleic acid as drugs-** Gene therapy: Basic approach to gene therapy, Vectors used in gene therapy -Retroviral vectors, Additional viral-based vectors, Manufacture of viral vectors, Non-viral vectors. Gene therapy and genetic disease, cancer, Gene therapy and AIDS. Gene-based vaccines.

**Recommended Text Books:**

1. Povl Krogsgaard-Larsen, Ulf Madsen and Kristian Stromgaard. Textbook of Drug Design and Discovery, Fourth Edition, CRC press, 2009.
2. Thomas J. Dougherty and Steven J. Projan. Microbial Genomics and Drug Discovery, Taylor and Francis, 2003.

**Reference Books:**

1. Kenneth M. Merz, Dagmar Ringe and Charles H. Reynolds. Drug Design: Structure- and Ligand-Based Approaches, Cambridge University press, 2010.
2. Tommy Liljefors, Povl Krogsgaard-Larsen and Ulf Madsen. Textbook of Drug Design and Discovery, Third Edition, Taylor and Francis, 2002
3. David B. Weiner and William V. Williams. Biological Approaches to Rational Drug Design (Handbooks in Pharmacology and Toxicology) CRC press, 1994,
4. Gary Wlsh, Biopharmaceuticals, Biochemistry and Biotechnology, Wiley. 1998.

### III-Semester Lab Courses

#### **MEDICAL MICROBIOLOGY LAB**

**Course Code: MB 541**

**Total Number of Credits: 01**

1. Study of normal micro-biota of mouth; isolation, identification and preservation of microorganisms
2. Study of normal micro-biota of skin; isolation identification and preservation of microorganisms
3. Identification and Biochemical tests of respiratory tract bacterial pathogen (using avirulent strain of MTCC Culture of – *Streptococci/ Klebsiella pneumoniae*).
4. Identification and Biochemical tests of gastrointestinal bacterial infection (using avirulent strain of MTCC Culture of) – *Salmonella / Shigella sps*.
5. Laboratory examination and identification and biochemical tests of pus specimens (using avirulent strain of MTCC Culture) for *Staphylococcus aureus, Streptococcus pyogenes and Pseudomonas aeruginosa*.
6. Laboratory examination of sputum: Collection of sputum. Microbiological examination of sputum for pus cells and predominant bacteria. Ziehl-Neelsen staining to detect the presence of *Mycobacterium*. (using avirulent strain of MTCC Culture).

#### **FOOD MICROBIOLOGY LAB**

**Course Code: MB 542**

**Total Number of Credits: 01**

1. Examination of microbial load in soft drinks, ice creams, packaged and canned foods.
2. Isolation and identification of food poisoning bacteria from contaminated foods, dairy products.
3. Isolation and identification of food spoilage fungi from foods.
4. Isolation, extraction and detection of aflatoxin from foods.
5. Production and estimation of lactic acid by *Lactobacillus Sp. / Streptococcus Sp*.
6. Role of microbes in fermented foods- Bread making, Sauerkraut.
7. Detection of number of bacteria in milk by standard plate count (SPC).
8. Determination of quality of milk sample by methylene blue reductase test.
9. Assessment of water quality by Multiple Tube Fermentation Test.

## **APPLIED & INDUSTRIAL MICROBIOLOGY LAB**

**Course Code: MB 543**

**Total Number of Credits: 01**

1. Bioassay of nicotinic acid
2. Production of Ethanol by Yeast.
3. Isolation of amylase producing microorganisms from soil
4. Isolation of protease producing microorganisms from soil
5. Isolation of lipase producing microorganisms from soil
6. Production and extraction of thuricides.
7. Laboratory scale production of biofertilizers.
8. Production, quantification and extraction of Citric acid
9. Demonstration: Reactor Studies: Batch, fed-batch, and continuous flow reactor analysis and residence time distribution.
10. Demonstration: Down-stream Processing Lab
11. Determination of the specific growth rate a bacterium in submerged fermentations.
12. Production of wine from grape juice.
13. Preparation of fermented food products-curd, cheese and alcohols.
14. Isolation and characterization of plant growth promoting bacteria.

## **ENVIRONMENTAL MICROBIOLOGY LAB**

**Course Code: MB 544**

**Total Number of Credits: 01**

1. Isolation and Identification of Symbiotic Nitrogen-fixing bacteria from soil.
2. Splash liberation of fungal spores from diseased tissue.
3. Seed health testing by using Standard Blotter Method.
4. Estimation of total phenols in healthy and diseased plant tissues.
5. Degradation of cellulose by cellulolytic fungi (*Chaetomium* species).
6. Associative and Antagonistic relationships among soil microorganisms.
7. Microbial management of organic wastes.
8. Degradation of oil by microorganisms
9. Isolation of hydrocarbon and heavy metal tolerant microorganisms
10. Production and analysis of Poly Hydrxy butyrates (PHB)

## MICROBIAL GENOMICS LAB

**Course Code: MB 545**

**Total Number of Credits: 01**

1. Isolation HMW DNA
2. DNA Cloning and Expression in *E. coli* cells
3. End repairing and cloning in fosmid/BAC
4. Restriction analysis
5. Polymerase chain reaction-Gradient
6. RT-PCR (demo)
7. 2-D gel electrophoresis (demo)
8. 16S typing
9. Mega software
10. Entrez Human genome map viewer

# **Project/Dissertation**

**Course Code: MB 599**

**Total Number of Credits: 6**



## Annexure

### Equipments Essential for M.Sc., Microbiology Practical course

1. Electronic Balance
2. Autoclave
3. Hot air oven
4. Laminar air flow
5. Refrigerator
6. Distillation unit
7. CO<sub>2</sub> Incubator
8. Incubator
9. Microscopes (Light, Zoom-stereo, fluorescent and photographic)
10. Spectrophotometer
11. Centrifuge
12. Gel Electrophoresis
13. Water Bath
14. Table top centrifuge
15. Shaker Incubator
16. Thermal cycler (PCR)
17. Fluorescent Microscope
18. Refrigerated water bath
19. Milli Q System
20. Orbital Incubator Shaker
21. Micro balance
22. Refrigerated Centrifuge
23. Gel Documentation System
24. Fermentor
25. Electrophoresis Units
26. Inverted Microscope
27. Ice-making machine
28. Lyophilizer
29. Sonicator
30. Vacuum concentrator
31. Inverted Microscope