

NATIONAL COLLEGE (AUTONOMOUS), TIRUCHIRAPALLI – 1

M.Sc., MICROBIOLOGY – Course Structure under CBCS

(Applicable to the candidates admitted from the academic year 2013-2014 onwards)

Semester	Paper No.	Title of the Paper	Instr Hrs/ Week	Credit	Exam Hrs.	Marks			Total
						Internal	External		
							W	O	
I	CC I	General Microbiology	6	5	3	25	75		100
	CC II	Bacteriology	6	5	3	25	75		100
	CC III	Immunology	6	5	3	25	75		100
	CC IV P	Lab work in CC-I, II, III & EC-I	6	5	4	25	70	5	100
	EC I	Biochemistry and Enzymology	6	4	3	25	75		100
		Total	30	24					500
II	CC V	Virology	6	5	3	25	75		100
	CC VI	Food and Dairy Microbiology	6	5	3	25	75		100
	CC VII	Genetic Engineering	6	5	3	25	75		100
	CC VIII P	Lab work in CC-IV, V, VI & EC-II	6	5	4	25	70	5	100
	EC II	Phycology, Mycology, Lichenology and Protozoology	6	4	3	25	75		100
		Total	30	24					500
III	CC IX	Pharmaceutical Microbiology	6	5	3	25	75		100
	CC X	Environmental and Agricultural Microbiology	6	5	3	25	75		100
	CC XI P	Lab work in CC-IX, X & EC-III	6	5	4	25	70	5	100
	EC III	Microbial Biotechnology	6	4	3	25	75		100
	EC IV	Plant Diversity	6	4	3	25	75		100
		Total	30	23					500
IV	CC XII	Bioinformatics and Biostatistics	6	5	3	25	75		100
	CC XIII	Research Techniques and Scientific Writing	6	5	4	25	70	5	100
	EC V	IPR, Biosafety and Bioethics	6	4	3	25	75		100
		Project (Dissertation 75 marks & Viva Voice – 25 Marks)	12	5	-	75	-	25	100
		Total	30	19					400
				90					1900

There will be oral test for all practical examinations. The oral test will carry 5 marks in the external component.

GENERAL MICROBIOLOGY – P13MB1**Semester : I****Core Course: I****Instruction Hours/Week: 6****Credit: 5****Unit 1 History of microbiology**

Branches and scope of microbiology. Invention of microscope and discovery of 'animalcules' - Theory of spontaneous generation and biogenesis – the germ theory of disease – Jenner's vaccination - experiments of Pasteur and Tyndall, Koch's Postulates – genetic experiments using microbes.

Unit 2 Microscopy – seeing the unseen

Light Microscopy – Bright field, Dark field, Phase contrast, Fluorescent and Polarization microscopes, Electron Microscopy – TEM & SEM, Confocal Microscopy – Principles and applications.

Unit 3 Microbial Taxonomy - conventional way

Classification of microorganisms Introduction – Contributions of early microbiologists, Classification of microorganisms - Haeckel's three kingdom concept. Whittaker's five kingdom concept. Three domain concept of Carl Woese. Basis of microbial classifications. Introduction to microbial taxonomy – morphological taxonomy, biochemical taxonomy and molecular taxonomy. Numerical taxonomy – basic concepts of taxonomy. Positive and negative aspects of each taxonomical methods. Morphological phylogeny.

Unit 4 Biochemical & molecular taxonomy

Chemotaxonomy - fatty acid, protein finger printing , Isozyme typing, pigments & polyamines. Biochemical phylogeny. Molecular taxonomy – G +C content, DNA – DNA hybridization, Plasmid profiles, rRNA based DNA finger printing methods – other advanced methods. A comparison between conventional and modern approaches in classification.

Unit 5 Microbial Growth and maintenance

Microbial growth - culture media - isolation of pure culture. Growth curve: Diauxy - continuous culture – chemostat – turbidostat - synchronized growth. Measurement of microbial growth – Total cell count method - viable cell count method and biomass determination - dry weight – wet weight – protein – Kjeldhal nitrogen – chlorophyll. Growth phases – kinetics – asynchronous – synchronous - batch – continuous culture. Factors affecting growth (pH, salinity, temperature, light, etc). Microbial growth control - Physical and

chemical methods – sterilization and disinfection. Maintenance and preservation of microorganism.

References:

1. Pelczar M.J, Jr. Chan E.C.S and Krieg N.R. (2004). Microbiology, Tata McGraw Hill Publishing Co.
2. Prescott L.M, Harley J.P and Klein D.A. (2005). 6th edition. Microbiology. Wm.C. Brown Publishers.
3. Julian P. Heath, (2005) Dictionary of Microscopy. Wiley Publications.
4. Salle AJ (1996) Fundamental Principle of Bacteriology [7th Edition] University of California, Los Angeles, Tata McGraw Hill Publishing Company Ltd.,New Delhi.
5. Holt JS, Kreig NR, Sneath PHA, Williams ST (1994) Bergey's Manual of Determinative Bacteriology (9th ed.) William and Wilkins, Baltimore.
6. Tortora, Funke and Case. (2012). Microbiology – An Introduction, Benjamin-Cummings Publications.
- 7.
8. Brendan Wren (Editor), Nick Dorrell (2002) Functional Microbial Genomics (Volume 33) (Methods in Microbiology), Academic Press, UK.
9. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell publishing, USA.
10. Doulgas B. Murphy. (2002) Fundamentals of Light Microscopy and Electronic Imaging.

BACTERIOLOGY – P13MB2

Semester : I

Core Course: II

Instruction Hours/Week: 6

Credit: 5

Unit 1 Morphology, Classification and Ultra structure of bacteria

Morphological types of microbes – Archeobacteria, Gram negative and Gram positive Eubacteria (Monera), eukaryotes (Protista). Ultrastructure and difference of prokaryotic and eukaryotic cells. Bacterial classification – Bergy's manual of systematic bacteriology. Bacterial cell wall: structure and chemical composition – cytoplasmic membrane, protoplasts, spheroplasts, membranous intrusions – membrane transport system, vacuoles and nuclear material – Structure and functions of flagella, cilia, pili, gas vesicles, chlorosomes, carboxyomes, magnetosomes and phycoblasts. Capsule structure and properties. Reserve

food materials – polyhydroxybutyrate, polyphosphate, oil droplets, cyanophycin granules and sulphur inclusions. Cell division, Endospore – Structure and properties.

Unit 2 Nutrition and nutritional types of bacteria

Nutrients – organic – inorganic. autotrophs – heterotrophs – lithotrophs – organotrophs – phototrophs. Autotrophy – anoxygenic – oxygenic photosynthesis. Chemolithotrophy – sulphur – iron – hydrogen – nitrogen oxidation – methanogenesis – bioluminescences - Fixation of carbondioxide – C₃, C₄ pathway - respiratory metabolism –fermentation of carbohydrates – glycolysis – Kreb's cycle – pentose phosphate pathway, the Entner – Doudoroff pathway – homo and hetero lactic fermentations. Metabolism of nitrogenous compounds.

Unit 3 Bacterial nitrogen metabolism

Biological nitrogen fixation (symbiotic and asymbiotic) – nitrogenase enzymes – Oxygen sensitivity - structure and properties – '*nif*' gene – regulation – functions. Assimilation of inorganic nitrogen – nitrification and denitrification– nitrogen cycle.

Unit 4: Bacterial genetics and application

Phenotypic changes due to environmental changes – types of mutations – factors inducing mutations – repair mechanisms against mutations – mutation rate – designation of bacterial mutants – bacterial recombination – bacterial conjugation – transduction – specialized transduction – the *lac* operon - *E. coli* in genetic engineering – Genome mapping - Bacteria in extreme environments - Application of bacteria in industries, agriculture and plant biotechnology.

Unit 5 Medical Bacteriology

Early discovery of pathogenic microorganisms. Classification of medically important microorganisms; Normal microbial flora of human body and their interaction. Major bacterial infections of human (*Mycobacterium tuberculosis*, *Helicobacter pylori*, *Salmonella*, Enterobacteriaceae, *Vibrio cholerae* and *Treponema pallidum*) and bacterial zoonotic diseases (Anthrax, Brucellosis, Psittacosis and Tularemia).

Reference:

- 1 Pelczar M.J, Jr. Chan E.C.S and Krieg N.R. (2004). Microbiology, Tata McGraw Hill Publishing Co.
2. Prescott L.M, Harley J.P and Klein D.A. (2005). 6th edition. Microbiology. Wm.C. Brown Publishers.
- 2 Brook TD, Madigan M.T, (1994). Biology of Microorganisms. Prentice Hall Int. Inc.
- 3 Tortora, Funke and Case. (2012). Microbiology – An Introduction, 11th Edition. Benjamin-Cummings Publications.
- 4 R. Ananthanarayanan and CK Jayaram Panicker (1997) Text of Microbiology, Orient Longman.
- 5 Salle AJ (1996) Fundamental Principle of Bacteriology [7th Edition] University of California, Los Angeles, Tata McGraw Hill Publishing Company Ltd.,New Delhi.
- 6 White D. (1995) The Physiology and Biochemistry of Prokaryotes Oxford University Press, Oxford.
7. Fritz H. Kayser, Kurt A. Bienz. (2005). Medical Microbiology.
8. Patrick R. Murray, Ken S. Rosenthal, Michael A. Pfaller. (2008) Medical Microbiology. 6th Edition. Elsevier Publications.

IMMUNOLOGY – P13MB3

Semester : I

Core Course: III

Instruction Hours/Week: 6

Credit: 5

Unit 1 History of Immunology

Historical perspective – Early discoveries (Edward Jenner, Robert Koch, Louis Pasteur, Metchnikoff) and theories – Recent discoveries and advancements. Innate and adoptive immune response in protection. Status of immune system in invertebrates and vertebrates with reference to diversity, diversity (hematopoiesis) and efficiency of cells, and molecules, anatomical organization - Functional and structural evolution of immunoglobulin.

Unit 2 Immune response and its regulation

Immune system in humans - Organs involved and immune response. Negative regulation - Immunological tolerance, Mechanisms of tolerance induction, T cell mediated suppression of immune response. Regulation of immune responses by: antigen, antigen-antibody complexes,

Network theory and its experimental evidence. Regulation of complement system – Classical and alternative pathway. Immunodeficiency conditions.

Unit 3: Cytokines and T-cell receptors

Types and general properties of cytokines and chemokines, characteristics of cytokine receptors and antagonists. Source and effect of Tumor necrosis factors and Interferons. Role of IL-1 in immune activation and pyrogenesis. Immunoregulatory role of cytokines (in particular IL-4, IFN- and TNF-). Cytokines in therapy and disease, Super antigens and septic shock syndrome. *T-Cell Receptor*: Structure and types - and TCR, Diversity of TCR (gene organization and rearrangements), T cell accessory membrane molecules (CD and adhesion molecules), Role in immune activation: TCR-CD3 complex and signal transduction pathways.

Unit 4 Tumor immunology

Tumor immunology: Cellular transformations during neoplastic growth, Classification of tumors based on histological, physiological, biochemical and immunological properties, Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease). Escape mechanisms of tumor from host defense, Host immune response to tumor – Effector mechanisms, Immuno-surveillance theory. Diagnosis of tumors – biochemical and immunological tumor markers Approaches in cancer immunotherapy - Immunomodulation (definition and concept), Immune adjuvant and tumor vaccine therapy, Biological Response Modifiers (BRMs) and their application in cancer therapy and in other diseases.

Unit 5 Immunodiagnostics and experimental immunology

Precipitation techniques, agglutination techniques, radiology in immunotechniques, Enzyme-Linked immunosorbent assay (ELISA), Western blotting, immunofluorescence, Flowcytometry and immunoelectron microscopy. Infectious diseases - immune system in AIDS, transplantation immunology, cancer and the immune system. *In vitro* systems – kinetics of antigen antibody reactions, hemolytic plaque assay, ELISA, ELISPOT assay, functional assays for phagocytosis. *In vivo* systems – Experimental animals in immunology research (Inbred animal strains, transgenic animals), Animal models for autoimmunity and AIDS.

References:

1. Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt. (2006) Essentials of Immunology. Blackwell Scientific Publishers, London.

2. Kuby Immunology, Sixth Edition by Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. (2006) W.H. Freeman and Co. New York.
3. C. D. Elgert. (1996) Immunology - Understanding of Immune System. Wiley - Liss, New York.
4. William E. Paul. (2012) Fundamentals of Immunology. 7th Edition.
5. Kenneth Murphy. (2011) Janeway's Immunobiology (Immunobiology: The Immune System)
6. Immunobiology: The Immune System in Health and Disease. 3rd Edition by Travers.
7. Noel R. Rose, Chief Editor: Robert G. Hamilton and Barbara Detrick (Eds.) (2002) Manual of Clinical Laboratory and Immunology 6th Edition. ASM Publications.
8. Pocket Guide to Clinical Microbiology. 2nd Edition. (1998) Patrick R. Murray, ASM Publications.

PRACTICAL I : Lab work in CC-I, II, III and EC I – P13MB4P

Semester : I

Core Course: IV

Instruction Hours/Week: 6

Credit: 5

1. Media preparation- Sterilization.
2. Culture transfer techniques- Isolation of pure cultures.
3. Observation of microbial diversity from natural sources.
4. Bacterial staining (Simple- Negative- Gram's- Capsule- Acid fast- Spore)
5. Bacterial growth curve.
6. Bacterial identification by staining, Biochemical and molecular (16s rRNA gene sequence) characteristics (based on Bergey's manual).
7. Antimicrobial Sensitivity test: Kirby Bauer Method.
8. Extracellular activities of micro organisms (Amylase, Protease and gelatinase).
9. Quantitative estimation of total carbohydrates.
10. Quantitative estimation of proteins by Folin-Lowry / Biuret method.11.
11. Microbial preservation – Lyophilization method.

Immunology

12. Separation of serum
 - a. Agglutination technique
 - i. ABO blood grouping and Rh typing
 - ii. ASO (antistreptolysin-O) test – latex agglutination
 - iii. Hemagglutination (IHA & RPHA)

- b. Precipitation techniques
 - i. Ouchterlony's double immunodiffusion
 - ii. Staining of immno precipitation slides
 - iii. Single radial immunodiffusion
 - iv. Counter current immunoelectrophoresis
 - v. Rocket immunoelectrophortesis.
- 13. Immunoassays
 - a. Dot ELISA (Enzyme Linked Immuno Sorbent assay)
 - b. Radioimmunoassay – Basis
 - c. Immunoflouescene assay – Basis
- 14. Isolation of lymphocytes from human blood sample.
- 15. Animal Experiment – Basis and computer based-demonstration.

ELECTIVE COURSE I : BIOCHEMISTRY AND ENZYMOLOGY - P13MB5E

Semester : I

Elective Course: I

Instruction Hours/Week: 6

Credit: 4

Unit 1: Introduction to Biomolecules and their interactions

Structure of atoms, molecules and chemical bonds. Basic aspects - entropy - enthalpy - electron carrier - artificial electron donors - inhibitors - uncouplers - energy bond - Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

Unit 2: Chemistry of proteins and nucleic acid

Structural features of amino acids, classification of amino acids, amino acids as buffers, chemical reactions of amino acids, peptide linkage, partial double bond nature of peptides, 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. Chemistry of Nucleic acid: Structure of bases, nucleosides, nucleotides, phospho-diester linkages, 5' phosphate, 3'hydroxyl polarity of nucleic acids, tautomeric forms of bases and their implication in pairing of bases, structure of DNA, Tm value, structure of t-RNA, r-RNA, and m-RNA, peptide nucleic acid (PNA).

Unit 3 Chemistry of Carbohydrate, lipid, vitamins and hormones

Carbohydrate: Mono, di oligosaccharides and polysaccharides, with examples, reducing and non-reducing sugars, sugar anomers, sugar epimers, sugar derivatives such as sugar alcohols, amino sugars, sugar acids, deoxy sugars. *Lipids*: Classification of lipids according to chemical structure, fatty acids, saturated, unsaturated, branched, nomenclature, system structure and function of triglycerides, phospholipids, sphingolipids, terpenes, prostaglandins, waxes, steroids. Definition and nomenclature of vitamins– biological availability – assessment of vitamins in nutritional status – vitamins B1, B12, K, E and niacin – Protein and peptide hormones – auxins, gibberellins and abscisic acid.

Unit – 4 Properties of Enzymes

Classification of enzymes. Different structural conformations of enzyme proteins. Enzymes as biocatalysts, catalytic power, activation energy, substrate specificity, active site, theories of mechanisms of enzyme action. Mechanism of action of lysozyme, chymotrypsin and ribonuclease. Monomeric, Oligomeric and multienzyme complex, isozymes and allosteric enzymes. Extremozymes - thermostable, solventogenic and non- aqueous enzymes. Ribozymes (Leadzymes) and abzymes.

Unit – 5 Enzyme kinetics

Importance of enzyme kinetics, factors affecting rates of enzyme mediated reactions (pH, temperature, substrate concentration, enzyme concentration and reaction time). Derivation of Michaelis - Menton equation and its significance in enzyme kinetic studies. Lineweaver-Burke plot, Haldane-Briggs relationship, sigmoidal kinetics steady state kinetics and transient phases of enzyme reaction.

Reference:

1. White D. (2011) *The Physiology and Biochemistry of Prokaryotes*, Oxford University Press, Oxford.
2. Nelson D.L. and Cox, M.M. (2001). *Lehninger Principles of Biochemistry*, 3rd edition, Mac Millan Eworth Publishers.
3. Nelson D.L. and Cox, M.M. (2001). *Lehninger Principles of Biochemistry*, 3rd edition, Mac Millan Eworth Publishers.
4. David, A. Bender (2003). *Nutritional biochemistry of vitamins*, 516pp. Cambridge.
5. Lewin, B. (2000) *Genes VII*. Oxford University Press.

6. Gerald Litwack. (2001) Vitamins and hormones, Academic Press.
7. Freidberg EC, Walker GC, Siede W. (1995) DNA Repair and Mutagenesis, ASM Press.
8. John L. Tymoczko, Jeremy M. Berg and Lubert Stryer. (2011) Biochemistry: A Short Course, 2nd Edition.
9. Voet D. and Voet J. (2010) Biochemistry, 4th edition, John Wiley and Sons Inc.
10. Principles of Enzyme Kinetics. (1976). By Athel Cornish - Bowden. Butterworth and Co.
11. Enzyme Kinetics by Paul Engel. (1977). John Wiley and Sons. Inc., New York.

VIROLOGY – P13MB6

Semester : II

Core Course: V

Instruction Hours/Week: 6

Credit: 5

Unit 1 Introduction to Virology

Brief outline on discovery of viruses, nomenclature and classification of viruses; distinctive properties of viruses; morphology & ultrastructure; viral genome, their types and structures; virus related agents (viroids, prions). Importance and scope of virology.

Unit 2 General Methods of Diagnosis and Serology

Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures; serological methods - haemagglutination; complement fixation; immunofluorescence methods, ELISA and Radioimmunoassays; assay of viruses - physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy)- Infectivity assay (plaque method, end point method).

Unit 3 Microbial Viruses

Bacteriophage structural organization; life cycle; Details on M13, Mu, T3, T4, and Lambda P1, cyanophages, mycophages, phycophages, protozoan viruses, – their ultra structure, features and propagation.

Unit 4 Plant Viruses

Classification and effects of viruses on plants; Symptomatology; common virus diseases of plants: paddy, cotton, tomato, and sugarcane;; life cycle; type species of plant viruses like TMV, Cauliflower mosaic virus and Potato virus X, paddy viruses, banana viruses- banana bunch top virus (BBTV), banana streak virus (BSV), transmission of plant viruses; diagnostics in

seeds and diseased plants; prevention of crop loss due to virus infection, virus-free planting material; vector control.

Unit 5 Animal Viruses

Classification of animal human viruses; epidemiology, life cycle, diagnosis, prevention and treatment of RNA Viruses Picorna, Ortho myxo, Paramyxo, Hepatitis virus, Toga and other arthropod viruses, Rhabdo, Rota, HIV and other Oncogenic viruses; DNA viruses; Pox, Herpes. Adena, SV 40; Hepatitis viruses, H1N1 virus, dengue fever virus, chikungunia virus, birdflu virus. Viral vaccines (conventional vaccines, genetic recombinant vaccines, newer generation vaccines including DNA Vaccines with examples) interferons, and antiviral drugs.

Reference:

1. Alan J.Cann. (2011) Principles of Molecular virology.(5thd edition). Academic press,California.
2. Maloy, S.R, Cronan Jr. J.E, Freifelder, D. . Microbial genetics. Jones and Bartlett publishers. Nicklin,J.Greame-Cook.and Killington, R. (2003). Instant Notes in Microbiology.(2nd edition).Viva Books private limited,NewDelhi.
3. Robert I.Krasner (2002). The microbial challenge:Human Microbe Interactions.American society for Microbiology,Washington.
4. Roger Hull (2002). Mathews' Plant Virology.(4thEdition).Academic press-A Harcourt Science and technology company, Newyork.
5. Flint, S.J., Enquist, L.W., Krung, R. Racaniello, VR. and Skalka, A.M. (2000). Principle of Virology, Molecular Biology, pathogenesis and control, ASM Press, Washinton D.C.
6. Ann Giudici Fettner. (1990) The Science of Viruses.Quill William Marrow,Newyork.
7. Dimmock NJ, Primrose SB. (1987) Introduction to Modern Virolog. Blackwell Scientific Publications, Oxford

FOOD AND DAIRY MICROBIOLOGY – P13MB7

Semester : II

Core Course: VI

Instruction Hours/Week: 6

Credit: 5

Unit 1 Food Microbiology

Introduction- Importance of food microbiology- Types of microorganisms in food spoilage, Source of contamination- Factors influencing microbial growth in food. Food preservations:

principles- methods of preservations-Physical and chemical methods – Radiations, UV, Gamma and microwave, temperature, Chemical and naturally occurring antimicrobials
Biosensors in food industry.

Unit – 2 Microbiology of food products

Contamination, spoilage and preservation of cereals and cereals products, sugar and sugar products, Vegetables and fruits, meat and meat products – fish and other sea foods, egg and poultry. Role of microorganisms in beverages – tea and coffee fermentations. Single cell proteins-spirulina, mushroom.

Unit – 3 Food borne diseases and quality assurance

Food borne diseases, intoxication and food poisoning – bacterial and non-bacterial food borne diseases: *Shigella*, *Staphylococcus*, *Camphylobacter*, *Listeria*, *Clostridium*, *Escherichia coli* and *Salmonella* infections, Mycotoxins, Protozoan and Viral food borne diseases. Quality standards of food - Government regulatory practices and policies. FDA, EPA, HACCP and ISI. Food sanitation in food manufacture and in the retail trade.

Unit – 4 Industrial Food fermentations

Methods of fermentations and organisms used -bread, wine, beer, vinegar - Production and application of Bakers Yeast- Soy sauce fermentation by Moulds - Fermented Meat – Sausages. Fermented vegetables - Saurkraut, Food and enzymes from microorganisms-single cell protein. Production and Application of microbial enzymes in food industry - amylase and protease. Preservation of fermented food products.

Unit – 5 Dairy Microbiology

Microflora of milk -sources of contamination -methods of minimizing contamination. Milk borne infection –intoxication. Milk preservation methods – pasteurization – sterilization. Fermented dairy products – microbes involved in fermentation -starter lactic acid cultures - butter milk, cream, yoghurt, kafil, kumiss, acidophilous milk and cheese production and its types. Applications of microbial enzymes in dairy industry [Protease, Lipases].

References:

1. Elmer H. Marth, James L. Steele, (2001) Applied Dairy Microbiology, Second Edition, CRC Press.

2. Andrews AT, Varley J. (1994) Biochemistry of milk products. Royal Society of Chemistry.
3. Elmer H. Marth, James Steele. (2001) Applied Dairy Microbiology, CRC Press.
4. Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.
5. Hobbs BC and Roberts D. (1993) Food poisoning and food hygiene, Edward Arnold (A division of Hodder and Stoughton), London.
6. May JM. (1987) Modern Food microbiology, CBS Publishers and distributors, New Delhi.
7. Robinson RK. (1990). The microbiology of milk. Elsevier Applied Science, London.
8. Edward Harth, J.T.Steele. Applied Dairy Microbiology. 1998. Marcel Decker Inc. New York.
9. Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge.

GENETIC ENGINEERING – P13MB8

Semester : II

Core Course: VII

Instruction Hours/Week: 6

Credit: 5

Unit 1 Introduction to molecular biology

Introduction to molecular biology and genetics: - Historical background, nature of genetic material, experimental proof that DNA is the genetic material, different forms of DNA (A, B and Z DNA) properties of DNA, DNA denaturation and renaturation, central dogma, Special types of DNA, satellite DNA and tandem repeats.

Unit 2 DNA and RNA Metabolism

DNA replication: Mechanism of prokaryotic DNA replication, semiconservative model of replication, mechanisms of DNA replication, Discontinuous synthesis of DNA, RNA primer for DNA synthesis, DNA polymerases I, II and III and role of ligases and these mechanism of action and role in DNA replication. Replication of viral DNA rolling circle model; DNA repair; DNA recombination. DNA dependent synthesis of RNA: RNA polymerase in prokaryotes, its molecular composition, role of each component of RNA polymerase, mechanism of transcription, eukaryotic transcription and eukaryotic RNA polymerases.; RNA dependent synthesis of RNA and DNA. Splicing of mRNA: Modification in RNA: 5' CAP formation, 3' end processing, polyadenylation, splicing, editing, nuclear export of mRNA and mRNA stability. Processing of other RNA's, Ribosome formation.

Unit 3 Protein Metabolism, Gene Regulation and Silencing

The genetic code; Prokaryotic and eukaryotic translation, mechanism of initiation, elongation and termination, amino acid activation, inhibitors and post translational modification of proteins. Molecular basis of eukaryotic gene regulation. Gene silencing - Molecular mechanism of antisense molecules Biochemistry of ribozyme, hammer head, hairpin and other ribozymes. Application of antisense and ribozymes in genetic engineering.

Unit – 4 Recombinant DNA technology

Recombinant DNA technology - Basic and applied aspects, Genomics and Proteomics. Core techniques and essential enzymes used in recombination: restriction endonucleases, type I, II, III, recognition sequences, properties, nomenclature, classification of type II endonucleases, their activity. DNA ligase: Properties and specificity, S1 nuclease, BAL 31 nuclease, DNA polymerase, polynucleotide kinase, phosphatase, reverse transcriptase its activity and mode of action. Chemical synthesis of DNA. Restriction digestion, ligation and transformation. Plasmid and viral vector: Properties, incompatibility, isolation and purification techniques, plasmid vectors and their properties, natural vector – pSC101. Artificial vectors - pUC19 and pBR322. Single stranded plasmids, promoter probe vectors, runaway plasmid vectors, shuttle vectors. Bacteriophage lambda (λ) as a vector.

Unit- 5 Specialized cloning strategies, application of PCR and genome mapping

Genomic DNA libraries, chromosome walking and jumping, cDNA libraries, short gun cloning, directed cloning, phage display. Recombinant DNA technology with reference to cloning and production of interferon and insulin. Genetically engineered micro organisms (GEMS) / genetically modified organisms (GMO's). DNA sequencing methods, Sequence assembly. Automated sequencing. Genetic and physical maps, physical mapping and map – based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence *in situ* hybridization for genome analysis, Chromosome microdissection and microcloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal, animal trafficking and poaching: taxonomy, biodiversity and DNA barcoding.

Reference:

1. W.S. Klug, and M.R. Cummings. (2004). Concepts of Genetics. Publisher : Pearson Education
Genome by T.A. Brown. Publisher: John Willey & Sons Inc.
2. Alberts Bruce, Bray Demos, and Watson James D. (2005) Molecular Biology of the Cell.
Publisher : Oxford University Press
3. H. Lodish, A.Berk, S. Zipursky, P. Matsundaira, D. Baltimore and J.E. Barnell. (2000)
Molecular Cell Biology Publisher: W.H. Freeman and Company.
4. J. Sambrook, E.F. Fritsch and T. Maniatis. (2001) Molecular Cloning: A Laboratory Manual.
Publisher: Cold spring Harbor Laboratory Press.
5. Molecular Biology of the Gene by J.D. Watson, A.M. Weiner and N.H. Hopkins. (2007)
Publisher: Addison- Wesley Publishing.
6. Helen Kreuz. (2001) Recombinant DNA and Biotechnology: Guide for Teachers. 2nd Edition.
ASM Publications.
7. S.M. Kingsman and A.J. Kingsman. (2005) Genetic Engineering and Introduction to Gene
Analysis and Exploitation in Eukaryotes. Blackwell Scientific Publications, Oxford.
8. S.B. Primrose. (2001) Molecular Biotechnology, Blackwell Scientific Publishers, Oxford.
4. D.M. Glover and B.D. Hames. (1995) DNA Cloning: A Practical Approach IRL Press, Oxford.
9. Henry A. Erlich (Ed.). (1989) PCR Technology - Principles and Applications for DNA
Amplification. Stockton Press.
10. R.W. Old and S. B. Primrose. (1994) Principles of Gene Manipulations. Blackwell Scientific
Publications.
11. Bernard R. Glick and Jack J. Pastemak. (1998) Molecular Biotechnology: Principles and
Applications of Recombinant DNA. 2nd Edition. ASM Publications.

PRACTICAL COURSE FOR CC V, VI, VII and EC II – P13MB9P

Semester : II

Core Course: VIII

Instruction Hours/Week: 6

Credit: 5

.Virology:

1. Isolation and characterization of bacteriophage from natural sources.
2. Preparation of bacteriophage stock – basis and demonstration.
3. Phage Titration - T4 and M13 - Basis
4. Burst size determination - A one step growth curve of bacteriophage T4 - Basis

5. Determination of lysogeny by using Lambda phage - Basis
6. Study of virus infected plant samples
7. Thermal characterization, Longevity *in vitro* - Dilution end point - Basis
8. Animal Virus Propagation - Egg inoculation - Demonstration.
9. Field visit.
10. Demonstration of Koch's postulates.

Genetic engineering

10. Total soluble protein isolation, Polyacrylamide Gel Electrophoresis.
11. Isolation of genomic DNA (bacterial).
12. Visualization of isolated genomic DNA by agarose gel electrophoresis.
13. Isolation of plasmid DNA & restriction digestion
14. Bacterial transformation – blue white colony selection technique.
15. Amplification of DNA by PCR & RAPD.

Food and Dairy Microbiology

16. Production and estimation of lactic acid by *Lactobacillus* Sp. Or *Streptococcus* Sp.
17. Sauerkraut fermentation - Basis.
18. Isolation of food poisoning bacteria from contaminated foods, Dairy products.
19. Extraction and detection of aflatoxin for infected foods - Basis.
20. Preservation of potato/onion by UV radiation.
21. Production of fermented milk by *Lactobacillus* sp.
22. Field visit.

Mycology, phycology, Lichenology and Protozoology

23. Isolation and growth of fungi.
24. Staining and microscopic examination of fungi
25. Isolation and microscopic identification of algae, lichen and protozoa from natural sources.

ELECTIVE COURSE II: PHYCOLOGY MYCOLOGY, LICHENOLOGY AND PROTOZOLOGY – P13MB10E

Semester : II

Elective Course: II

Instruction Hours/Week: 6

Credit: 4

Unit 1 Phycology

Introduction – algae as primary producers – Characteristics: morphology, algal pigments and motility - Distribution of algae, classification of algae by Fitch, algal nutrition, algal thallus, algal reproduction, green algae, diatoms, euglenoids, *Rhodophyta*, *Pyrrophyta*, Algal ecology and algal biotechnology, Marine algae, sea weeds and their applications - Commercial

products from algae – algae as food – algal diseases - Life Cycles of *Chlamydomonas*, *Oscillatoria*, *Volvox*, *Spirogyra*, *Laminaria*, and *Batrachospermum*.

Unit 2 Introduction to mycology

Historical introduction to mycology structure and cell differentiation, Classification of fungi, Evolutionary tendencies in lower fungi. Saprophytic fungi, fungal genetics, resistance and virulence. A brief account of fungal cell structure, nutrition, reproduction and representative life cycles of some fungi - *Synchytrium*, *Perenospora*, *Albugo*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Ustilago* and *Puccinia*; Fungi in plant diseases and its economic importance – fungi and nematodes – fungi as parasites of insects.

Unit 3 Fungal reproduction, ecology and diseases

Heterothalms, sexual behavior in fungi, Physiological specialization, phylogeny of fungi - Fungi as insect symbiont. Mycorrhiza - Plants as an environment for fungal growth. Fungus plant conformation. Effects of pathogenic fungal infestation on host plant physiology - Physiology and structure of symbiotic fungi, host-symbiont interactions, their effects on host growth and their agricultural applications. Fungal diseases - Mycoses (systemic and subcutaneous), Candidiasis, Pneumocystis, blastomycoses, dermatomycoses and other diseases.

Unit 4 Lichenology: Morphology, diversity, reproduction, symbiotic nature, chemical interactions and traditional & commercial uses.

Unit 5 Protozoology

Introduction – classification– ecology of protozoa : free-living and symbiotic – importance of protozoa – morphology: intracellular structures and locomotor organelles – Reproduction of protozoa: asexual and sexual, regeneration - Parasitic protozoans - Antiparasitic Agents, Intestinal and Urogenital Protozoa, Blood and Tissue Protozoa. Causative agents and pathogenesis of Protozoan Diseases – amoebiasis, malaria, trypanosomiasis and leishmaniasis- major infectious nematodes of human, animal and plant.

Reference:

1. Pelczar M.J, Jr. Chan E.C.S and Krieg N.R. (2001). Microbiology, Tata McGraw Hill Publishing Co.

2. Prescott L.M, Harley J.P and Klein D.A. (2005). 6th edition. Microbiology. Wm.C. Brown Publishers.
- 3 Mehrotra RS and Aneja KR (1990) An Introduction to Mycology, New Age International Publishers.
- 4 Alexopoulos CJ and Mims CW 1979. Introduction to Mycology (3rd Ed.) Wiley Eastern Ltd, New Delhi.
5. Jawetz, Melnick and Adelberg (2001) Medical Microbiology. McGraw Hill Medical Publication division.
6. David Greenwood, Richard Slack and John Peutherer (2000) Medical Microbiology. 15th edition, Church Hill Living stone Publication.
7. K.D Chatterjee (2007) Medical Parasitology (2007).
8. Cathleen park Talaro. (2005) Foundations in Microbiology. 6th edition, McGraw Hill Medical Publication division.
9. Harley, J. P. (2007) Microbiology Lab Manual 7th edition McGraw Hill Medical Publication division.
10. Hale, M.E. Jr. Biology of Lichens, Edward Arnits, Maryland.

PHARMACEUTICAL MICROBIOLOGY – P13MB11

Semester : III

Core Course: IX

Instruction Hours/Week: 6

Credit: 5

Unit 1: Introduction

Historical perspective – Paul Ehrlich's postulates, Case studies of development of drug such as sulpham drugs, arsenicals. Current approaches to drug discovery: Rational Drug design, receptor / target concept in drug designing, bioinformatics tools in drug designing - molecular docking.

Unit 2 Advances in Drug discovery

Introduction to pharmacogenomics, Combinatorial chemistry, High Throughput Screening. Phases of drug discovery: Bioprospecting, Principles of Extraction, Purification and Characterization of bioactive molecules from natural resources, Lead discovery, Lead compound optimization, Candidate drug selection.

Unit 3: Preclinical development of drug discovery

Safety profile of drugs (Pyrogenicity, Toxicity –hepato, - nephro, -cardio and -neurotoxicity). Toxicological evaluation of drug: LD50, Acute, subacute and chronic toxicity. Mutagenicity (Ames test, micronucleus test), Carcinogenicity and Teratogenicity. Drug interactions, Drug metabolism – activation / inhibition of drug *in vivo*, adverse drug reactions.

Unit 4. Clinical development of biologicals

Regulatory authorities for introduction of medicines in market – Role of Food and Drug Administration, FDA guidelines for drugs / biologicals, Validation (GMP, GLP, GCP, etc.). . Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials – Objectives, Conduct of trials, Outcome of trials. . Delivery systems – formulations, targeted drug delivery, Sustained release of drugs. . Drug distribution in body, bio-availability and pharmacokinetic studies.

Unit 5. Mechanisms of virulence

A step wise process of infection – Crossing physical, chemical and biological barriers, Colonization, association, adhesion and Invasion of host tissue and toxigenesis.with details account of virulence factors – Adhesins (pili, capsule, hemagglutinins), Invasins (Fibrinolysins, hyaluronidase, hemolysins, hypal extensions), Evasins (catalase, coagulase, Siderophores, Leucocidins, Kinins), Biofilm formation. Toxins (diphtheria, cholera, tetanus toxins and endotoxins of Gram negative bacteria – mode of action and *in vivo* and *in vitro* assay systems). Mechanisms of bacterial resistance to host cellular (phagocytosis) and humoral defenses. Molecular basis of bacterial pathogenicity – cytoskeletal modulation of host cell, virulence genes and pathogenicity islands.

References:

1. Agarwal S. S. and Paridhavi M., (2007), Herbal Drug Technology, Universities Press (India) Pvt. Ltd
2. Bentley's Textbook of Pharmaceutics, Editor E. A. Rawlins, 8th Ed. (2002), BAilliere Tindall, London.

3. Chatwal G. P. (2003) Biopharmasceutics and Pharmacokinetics, Himalaya Publishing House, Mumbai.
4. Chorghade Mukund S., (2006), Drug discovery and development Volume I: Drug discovery, Wiley-Interscience, John Wiley and Sons Inc. USA.
5. Dale Maureen M, John C. Foreman and Tai-Pang D. Fan, (2004), Text book of Immunopathology, 3rd Ed., Blackwell Scientific Publication, London.
9. Dewick Paul M., (2002), Medicinal natural products: A biosynthetic approach, 2nd Ed., John Wiley and Sons
11. Woods D. E., (2002), The use of animal infection models to study the pathogenesis of melioidosis and glanders, Trends Microbiol, 10(11):483-5.
12. Mark J. Pallen¹ & Brendan W. Wren, (2007), Bacterial pathogenomics, Nature Rev. 449|18: 835-842.
13. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) Pharmacology, 4th Ed., Nirali Prakashan.
14. Lorian.V., (1986), Antibiotics in laboratory medicine, 2nd Ed, Williams & Wilkins Publication
15. Mannfred A. Holliger, (2008), Introduction to pharmacology, 3rd Ed., CRC Press
16. Walsh Gary, (2003), Biopharmaceuticals Biochemistry And Biotechnology, 2nd Ed.,John Wiley & Sons Ltd, England
17. Vyas S. P and Dixit V. R. (2002), Pharmaceutical Biotechnology, CBS Publishers and Distributors, New Delhi

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY – P13MB12

Semester : III

Core Course: X

Instruction Hours/Week: 6

Credit: 5

Unit1 Aerobiology and aquatic microbiology

Droplet nuclei, aerosol, assessment of air quality, - solid - liquid - impingement methods. - Brief account of air borne transmission of microbes - viruses - bacteria and fungi, their diseases and preventive measures. Water ecosystems - upwelling - eutrophication - food chain. Microbial assessment of water quality - water purification. Marine environment – -benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop – marine microbial community. Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, asmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles. Marine Microbial Diseases. Production and applications of

marine microbial products – pigments – Astaxanthin, carotene – enzyme – antibiotics – polysaccharide.

Unit 2 Soil Microbiology and Ecological Role of Microbes

Classification of soils - physical and chemical characteristics, microflora of various soil types (bacteria and nematodes in relevance to soil types) - Biogeochemical cycles and the organisms, - carbon nitrogen - phosphorus and sulphur, Major bacteria and fungi of soil. Biodegradation of recalcitrant compounds - lignin - pesticides; bioaccumulation of metals and detoxification - biopesticides; biodeterioration of paper - leather, wood, textiles - metal corrosion - mode of deterioration organisms involved - its disadvantages - mode of prevention. GMO and their impact.

Unit 3 Waste treatment and microbial processes

Wastes - types - solid and liquid wastes characterization - solid - liquid; treatments - physical, chemical, biological- aerobic - anaerobic - primary - secondary - tertiary; solid waste treatment - saccharification - gasification - composting, Utilization of solid wastes - food (SCP, mushroom, yeast): fuel (ethanol, methane) fertilizer (composting), liquid waste treatment - trickling - activated sludge - oxidation pond - oxidation ditch. Subterranean microbes and bioremediation.

Unit-4 Plant microbe interaction and its Role in Agriculture

Types of interaction (Symbiosis, parasitism, mutualism, commensalisms, saprophytism, necrotrophism etc), Plant and microbial surface organization, concept of rhizosphere, non rhizosphere, mycorrhizosphere - ectomycorrhiza, endomycorrhiza, vesicular arbuscular mycorrhiza - application- rhizoplane and phyllosphere. Microbial plant diseases: disease development, plant defense mechanisms DIMBO and DIMBOA, cultivar dependent and independent resistance, disease forecasting, disease control (disease escaping), cultural, chemical and biocontrol.

Unit-5 Concepts of sustainable agriculture.

Traditional agricultural practice and organic farming; Biofertilizers: symbiotic and non-symbiotic microorganisms –Mass production and maintenance of biofertilizers - *Rhizobium*, *Azospirillum*, and *Azotobacter*, *Phosphobacteria*, *Frankia*, AMF and BGA. Out line of biopesticide, bioinsecticides, bioherbicides and its application to the agriculture. Plant resistance R genes, Induction of R-genes by bacteria – BT cotton and its global impact - Implications for biotechnology.

Reference:

1. Raina M. Maier, Ian L. Pepper, Charles, P. Gerba (2006). Environmental Micrology, Academic press.

2. Pelczar M.J, Jr. Chan E.C.S and Krieg N.R. (2001). Microbiology, Tata McGraw Hill Publishing Co.
3. Scheper, T. (2005). Advances in Biochemical Engineering/Biotechnology-Marine Biotechnology I. Springer.
4. Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993) Pollution: Ecology and Biotreatment. 1993. Longman Scientific Technical.
5. MK. Rai. (2005) Handbook of Microbial biofertilizers. Food Products Press, New York.
6. Stanier, P.R., Ingraham., Wheelis, M.L and Painter, P.R. (1990) The microbial world. Prentice. Hall of India Private Limited, New Delhi.
7. Jamesh W. Nybakker (2001). Marine Biology, Benjamin Cummings
8. Shimshon Belkin and Rita R. Colwell (2005). Ocean and Health: Pathogens in the marine environment. Springer.
9. Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.
10. Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi.
11. Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, HongKong.13.
12. KG Mukerji, C. Manoharachary & J. Singh (2006). Microbial Activity in the Rhizosphere (Soil Biology Series), Published by Springer-Verlag, Germany, Editors:
13. Varma A and Hock B., (2001) Mycorrhiza: Structure, Function, Molecular Biology and Biotechnology. Publisher: Springer-Verlag, Germany.

PRACTICAL – III (Lab work in CC-IX, X & EC-III) - P13MB13P

Semester : III

Core Course: XI

Instruction Hours/Week: 6

Credit: 5

Pharmaceutical Microbiology

1. Collection and transport of clinical specimens for microbiological examinations.
2. Screening of antimicrobial agents from natural sources against given bacteria.
3. Bioassay of chloremphenicol by plate assay method or turbidimetric Assay method.
4. Treatment of bacterial cells with cetrimide, phenol and detection of Leaky substances such as potassium ions, aminoacids, due to cytoplasmic membrane damage – demonstration and basis.
5. To determine MIC, LD 50 of Beta-lactum/aminoglycoside/ tetracycline/ansamycins.
6. Sterility testing.

7. Sampling of pharmaceuticals for microbial contamination and load (syrups, suspensions, creams and ointments, ophthalmic preparations).

8. Determination of D value, Z value for heat sterilization in pharmaceuticals.

Environmental and Agricultural Microbiology

9. Quantification of microorganisms in air – solid – liquid impingement techniques.

10. Physical, Chemical & Microbial assessment of water. Colour, pH, alkalinity, acidity, COD, BOD, anions and cations.

11. MPN index – presumptive, completed and confirmative tests.

12. Isolation of microflora from different industrial wastes.

13. Degradation of phenols – colorimetric assay.

14. Isolation of N₂ fixing, phosphate solubilizing/mobilizing and siderophore producing microbes.

15. Localization of AMF.

Microbial Biotechnology

16. Isolation of industrially important microorganisms for microbial processes (e.g. - alpha amylase) and improvement of strain.

17. Preparation of enzyme immobilized columns for biotransformation –e.g. yeast cells immobilized in calcium alginate beads.

18. Analysis of enzyme activity from immobilized cells:

a. Comparative enzyme activity of free cells and immobilized cells

b. Effect of gel concentration on enzyme activity

19. Extraction of Citric acid/Lactic acid by salt precipitation.

20. Comparison of ethanol production using various Organic wastes /raw Material [Free cells/ immobilized cells].

21. Hydrogen photoproduction – Microbial based demonstration.

ELECTIVE COURSE – III : MICROBIAL BIOTECHNOLOGY – P13MB14E

Semester - III

Elective course: III

Instruction hrs /week: 6 hrs.

Credit : 4

Unit 1 Introduction to Industrial microbiology

Principles of exploitation of micro-organisms and their products, screening, strain development strategies, immobilisation methods, adsorption; covalent linkages – advantages

and disadvantages, raw materials used in media production, industrial sterilization, fermentation equipment and its uses, types of fermentation-single, batch, continuous, dual or multiple, surface, submerged and solid state fermentation. Biology of industrial microorganisms such as *Streptomyces*, yeasts, *Spirulina* and *Penicillium* – Strain improvement – Culture preservation - Stock culture collection centres – Criteria used for the selection of microorganisms for fermentation.

Unit 2 Bioreactor design and operation:

Designing of bioreactors - Design aspects CSTRs: The dimensional ratios of the outer shell, _operational aspects_ working volume, baffles and impellers_(configuration and types). . Immobilized cell reactors and air-lift reactors – Design and operation. Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa. Agitation - Functions and importance. Flow patterns with different types of impellers. Fermentation broth rheology and agitation – Concept of Newtonian and non-Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynold's number, Power number, Aeration number. Operational modes of bioreactors: Batch, Fed-batch and Continuous processes.

Unit 3 Product based industrial Processes

Upstream, Fermentation and Downstream Processing for the following: 1. Antibiotics (Rifamycin). 2. Microbial enzymes (Chitinase, Glucose Oxidase, Lipase). 3. Exopolysaccharides (Pullulan). 4. Use of immobilized cells / enzymes to produce protease. Animal cell culture technology to produce recombinant vaccines.

Unit 4 Bioenergy from microbes

Bioethanol (microbial production), biobutanol, biogas and biodiesel (microalgae and other microbes) production from microbes – Microbial fuel cell – concept, scope and recent developments – hydrogen photoproduction.

Unit 5 Principles of Validation Process / Method and commercialization

The concept of ISO Certification. Preparation of SOPs. Validation protocols for methods in Quality Control. Process validation. Commercialization - Objectives - market potential - economic measures in plant and equipment - media, heating and cooling; productivity of culturing, recovery costs.

References:

1. Stanbury PF, Whitaker A, Hall SJ. (1995) Principles of Fermentation Technology, Pergamon Press.
2. Demain A.L, Davies J.E. (1999). Manual of Industrial Microbiology & Biotechnology. ASM press.
3. Glick BR, Pasternak JJ (1994) Molecular Biotechnology, ASM press.
4. Mittal D.P. 1999. Indian Patents Law. Taxmann Allied Services (p) Ltd.
5. Sikyta B. (1983) Methods in Industrial Microbiology, Ellis Horwood Limited.
6. David A. Mitchell, Nadia Krieger, Marin Berovic .Solid-State Fermentation Bioreactors: Fundamentals of Design and Operation, Springer.
7. Wulf Crueger, Anneliese Crueger, Thomas D. Brock (1991) Biotechnology: A Textbook of Industrial Microbiology.

ELECTIVE COURSE – IV : PLANT DIVERSITY – P13MB15E

Semester : III

Elective Course: IV

Instruction Hours/Week: 6

Credit: 4

Unit 1 Bryophytes

General characteristics, classification by Watson, Range of vegetative structure, Evolution of gametophytes and sporophytes – Ecological and economic importance of Bryophytes.

Unit 2 Pteridophytes

General characteristics, classification by Reimer, Range of morphology, reproduction and evolution of gametophytes and sporophytes – Heterospory and origin of seed habit.

Module 3 Gymnosperm diversity

General characteristics, classification by Sporne: morphology, anatomy, reproduction and Economic importance.

Unit – 4 Angiosperm diversity

General characteristics, classification by Bentham and Hooker, Modern system of classification. Biosystematics, chemotaxonomy, numerical taxonomy. Herbarium preparation and management.

Unit 5 Economic botany

Economic importance of Food – cereals: *Oryza*, *Triticum* and Maize, Pulses: *Cicer*, *Phasolus* and *Glycine*, Edible oil: sesame, *Helianthus* and *Arachis.*, Fibres: *Gossypium* and *Corchorus*, Forest products: timber, *Tectona*, *Dalbergia*, Medicinal plants: *Ocimum*, *Rauwolfia*, *Phythanthus*, Vegetables: *Solanum tuberosum*, *Allium cepa*, *Lycopersicum esclantum*, Fruits: *Pyrus malus*, *Mangifera indica*, *Musa paradisica*, *Ananus comosus*

Reference:

1. Parihar, N.S. (2002) An introduction to embryophyta – I: Bryophyta. Central Book Depot. Allahabad.
2. Vashishta, B.R. et al (2008) Botany for Degree students. Bryophyta. S.Chand and Co. Ltd. New Delhi.
3. Rashid. A. (1986) an introduction to Pteridophyta. Vani Educational Books, New Delhi.
4. Sharma, O. P. (1990) Text book of Pteridophyta. MacMillan India Ltd. India.
5. Vashshta, P. C. et al., (2008) Botany for Degree students. Pteridophyta. S. Chand and Co. Ltd. New Delhi.
6. Sporne. K.R. (1974) The morphology of Gymnosperm, B.I. Publication, New Delhi.
7. Vashishta, P. C. et al., (2006) Botany for Degree students. Gymnosperms. S. Chand and Co. Ltd. New Delhi.
8. Pandey. B.P. (2007) Economic Botany. S.Chand and Co. Ltd. New Delhi.
9. Sambamurthy, A.V.S.S amd Subramanian, N.S. (1989) A Text Book of Economic Botany. Wiley Eastern Ltd. New Delhi.

BIOINFORMATICS AND BIOSTATISTICS – P13MB16

Semester : IV

Core Course: XII

Instruction Hours/Week: 6

Credit: 5

UNIT – 1 Introduction and Nucleic acid databases

Computer concepts – why Bioinformatics? - structural organization, evolution, Applications in biology. Web browsing. Introduction to Databases – Definition and Types. Nucleic acid databases – Primary and Secondary databases – NCBI, EMBL, DDBJ, RefSeq, OMIM-

Organization, Data Retrieval, Submission, Mining. Sequence alignment: FASTA, BLAST – algorithm & tools. cDNA libraries and ESTs. EST analysis tools- sequence similarity search tools, sequence assembly tools and sequence clustering tools. *In silico* Gene identification – Strategies and tools.

UNIT – 2 Protein databases

Protein databases - Primary databases - SWISS-PROT, PIR, MIPS, TrEMBL, NRL-3D, Composite databases- PROSITE, PROFILES, PRINTS, Pfam, BLOCKS, IDENTIFY - Organization, Data Retrieval, Submission, Mining. Protein structural databases: PDB, MMDB – Visualization, Classification (SCOP & CATH). Secondary & Tertiary structure prediction- Methods (Sequence based & *AB INITIO*) & tools.

UNIT – 3 Alignment and Phylogeny

Sequence alignment: Pairwise alignment – Strategies (Local alignment, Global alignment, Ends free space alignment), Methods – Dot plot, Heuristic model, Scoring matrices – PAM, BLOSUM. Multiple alignment – Strategies (SP, Progressive alignment – clustal tools), Phylogenetic analysis: Phylogenetic tree and its significance, Methods of Phylogenetic analysis – Distance methods (UPGMA, NJ, FM), Character based methods (MP, ML), MCMC, GA, SAGA, DCM, HGT. Phylogenetic tree construction and tools. File handling in PERL.

Unit 4 Biostatistics

Introduction and scope. Sampling methods and representation-Tabulation, Graphs, Diagrams, Frequency curves. Measures of Central tendency- Mean, Mode, median, Quartiles & Percentiles. Measures of Dispersion: Range, Quartile deviation, Mean deviation & Standard deviation. Measures of skewness.

Unit – 5 Measures of Relation and Tests of significance

Measures of Relation: Correlation, Regression and Principle component analyses. Tests of significance: Small sample test (Chi-square t test, F test), large sample test (Z test), ANOVA and standard error. Introduction to probability theory and distributions, binomial, exponential, Gaussian and Poisson distribution and normal (only definitions and problems). Computer oriented statistical techniques (Microsoft Excel and SPSS) - Frequency table of single discrete variable, bubble plot, computation of mean, variance and standard Deviations, t test, correlation coefficient.

References:

1. W.J. Ewens, Gregory Grant,(2005). Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology & Health), Springer
2. Bryan Bergeron,(2003).Bioinformatics Computing First Indian Edition, Prentice Hall,
3. Cynthia Gibas & Per Jambeck (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai.
4. HH Rashidi & LK Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
5. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press.
6. Baxevanis AD & Ouellette BEF (2001) Bioinformatics: A practical guide to the analysis of genes and proteins, Wiley Interscience – New York.
7. Arora PN & Malhon PK (1996). Biostatistics Imalaya Publishing House, Mumbai.
8. Stanton A & Clantz, Primer of Biostatistics — The McGraw Hill Inc., New York.

RESEARCH TECHNIQUES AND SCIENTIFIC COMMUNICATION – P13MB17

Semester : IV

Core Course: XIII

Instruction Hours/Week: 6

Credit: 5

Unit 1 Research Concepts and Data Collection

Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, Types of Research; Hypotheses Research Purposes - Research Design - Survey Research - Case Study Research. Sources of Data: Primary Data, Secondary Data; Procedure Questionnaire - Sampling Merits and Demerits - Experiments - Kinds - Procedure; Control Observation - Merits - Demerits - Kinds - Procedure - Sampling Errors - Type-I Error - Type-II Error.

Unit 2 Writing Research proposal

Developing an outline Preamble, the problem, specific aims, background and significance, hypothesis to be tested, study design, setup, measurement procedures, analysis of data, displaying preliminary data in tables, graphs and charts. Report Writing- Prewriting considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.

Unit 3. Scientific communications

Title and abstract for a given text - Choosing and indexing key words from a given paper- Writing the paper based on a given set of instructions to authors. (Any refereed journal may be used for sample '*Instructions to Authors*') - Writing a newspaper report / popular article of a latest research paper - Writing a pedagogical (academic) article on a scientific theme - Critically comment on a manuscript. Drawing appropriate figures on given data, writing footnotes to figures and tables - Preparation of display material (such as scientific posters). Photomicrography, taking photographs of experimental results. Scanning pictures, Making Power Point slide shows.

Unit 4: Bioinstrumentation

Basic laboratory Instruments - Principle and working of pH meter, Laminar-air flow. Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications.

Unit – 5 Chromatographic, Electrophoretic and radio isotopic techniques

Theory, principles and applications of paper, thin layer, gel filtration, ion exchange, affinity, hydrophobic, gas liquid, high pressure/ performance liquid chromatography (HPLC) Basic principles of electrophoresis, theory and application of paper, starch gel, agarose, native and denaturing PAGE, isoelectric focusing. Spectroscopic techniques - theory and applications of UV, Visible, IR, NMR, Fluorescence, Atomic Absorption, CD, ORD, Mass, Raman Spectroscopy. Radioisotopic techniques Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger- Muller and Scintillation counters, autoradiography and its applications. Dosimetry.

Reference:

1. Baxevanis, A.D. & Ouellette, B.F.F. (2001). Bioinformatics: A practical guide to the analysis of genes and proteins – Wiley Interscience – New York.
2. Cynthia Gibas & Per Jambeck (2001) Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai

3. Zar, J.H. (1996). Biostatistical analysis. Prentice Hall, Upper saddle River, New Jersey, USA
4. Jogdand SN (2004) Gene Biotechnology Published by Himalaya Publishing House, Mumbai.
5. John G Webster(2004).Bioinstrumentation .Student edition, John Wiley & sons, Ltd.
6. Keith Wilson& John Walker (2003) Practical Biochemistry Principles & techniques.5th edition,Cambridge university press.
7. Grumani N (2006) Research Methadology for biological sciences.1st Edition , MJP Publishers, A unit of Tamilnadu Book House.

ELECTIVE COURSE V : IPR, BIOSAFETY AND BIOETHICS – P13MB18E

Semester : IV

Elective Course: V

Instruction Hours/Week: 6

Credit: 4

Unit 1 Biosafety - Introduction

Biosafety issues in biotechnology - historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals.

Unit 2 Biosafety Guidelines

Guidelines and regulations (National and International including Cartagena Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of GMOs - Risk - Analysis, Assessment, management and communication.

Unit 3 Bioethics

Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of Animal use. Green peace - Human Rights and Responsibilities.

Unit 4 Intellectual Property Rights

Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of Biotechnological inventions. Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. IPR and WTO regime - Consumer protection and plant genetic resources.

Unit 5 Patents and Patent Laws

Objectives of the patent system - Basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Patent Filing Procedures - National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies.

References:

1. Rajmohan Joshi (Ed.). (2006). Biosafety and Bioethics. Isha Books, Delhi.
2. Jeffrey M. Gimble, (2005) Academia to Biotechnology, Elsevier Academic Press.
3. Senthil Kumar Sadasivam and Mohammed Jaabir M. S. (2008). IPR, Biosafety and Biotechnology Management, Jasen Publications, India.
4. Beier F.K, Crespi R.S and Straus T. (2000) Biotechnology and Patent protection, Oxford and IBH Publishing Co. New Delhi.

PROJECT WORK - P13MBP19

Semester : IV

Project

Instruction Hours/Week: 12

Credit: 5

PROJECT WORK

(Dissertation 75 marks & Viva Voice – 25 Marks)
