J.J. COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS), PUDUKKOTTAI – 622 422
DEPARTMENT OF MICROBIOLOGY
M.Sc. MICROBIOLOGY
Proposed Course Structure under Autonomous Status
Under Choice Based Credit System
(Applicable for the candidates admitted from academic year 2016-2017 onwards)

Sem	*Course Code*	*Course Title*	*Hrs/ Week*	*Credit*	*Total marks*	*Exam Hours*
I	P1RMBCC1	CC1 - General Microbiology	5	5	100	3
	P1RMBCC2	CC2 - General Biochemistry	5	5	100	3
	P1RMBCC3	CC3 - Virology	5	5	100	3
	P1RMBCC4P	CC4 - Practical – I covering CC1, CC2, CC3	5	5	100	6
	P1RMBEC1	EC1 - Biological Techniques	5	3	100	3
	P1RMBEC2	EC2 - Food and Dairy Microbiology	5	3	100	3
		Total	**30**	**26**	**600**	
II	P2RMBCC5	CC5 - Microbial Physiology	5	5	100	3
	P2RMBCC6	CC6 - Agricultural & Environmental Microbiology	5	5	100	3
	P2RMBCC7	CC7 - Microbial Genetics	5	5	100	3
	P2RMBCC8	CC8 – Microbial Biotechnology	5	5	100	3
	P2RMBCC9P	CC9 - Practical – II covering CC5, CC6, CC7 & CC8	5	5	100	6
	P2RMBEC3	EC3 – Molecular Taxonomy & Phylogeny	5	3	100	3
		Total	**30**	**28**	**600**	
III	P3RMBCC10	CC10 – Immunology	5	5	100	3
	P3RMBCC11	CC11 - Medical Microbiology	5	5	100	3
	P3RMBCC12	CC12 - Molecular biology & Genetic Engineering	5	5	100	3
	P3RMBCC13	CC13 - Fermentation Technology	5	5	100	3
	P3RMBCC14P	CC14 - Practical – III covering CC10, CC11, CC12 & CC13	5	5	100	3
	P3RMBEC4	EC4 - Biostatistics & Bioinformatics	5	3	100	3
		Total	**30**	**28**	**600**	
IV	P4RMBPW15	CC15 - Project Work	30	8	100	3
		Total	**30**	**8**	**100**	
Grand Total			**120**	**90**	**1900**	

CC-Core Course / EC – Elective Course / P – Practical / T – Theory, Total Credit – 90 Total Marks – 1900

ELECTIVE COURSES (EC)

I - Biological Techniques
II - Molecular Taxonomy & Phylogeny
III - Food and Dairy Microbiology
IV - Biostatistics and Bioinformatics
V – Nanobiotechnology
VI – Marine Microbiology
VII – Quality Control & IPR
VIII – Herbal Medicine

CC- 1 GENERAL MICROBIOLOGY

Paper Code: P1RMBCC1 **Semester: I**
No. of Credits: 5 **No. of hours per week: 5**

Objectives:

- To know the modern classification system
- To become familiar with structure and function of cellular components
- To get the knowledge of fungal life cycle
- To get the knowledge of algal life cycle
- To prepare the student to involve in various research fields by learning culture collection and preservation methods

Unit I: Classification of micro organism

Definition and systematics, Nomenclatural rules and identification of microbes in the living world classification systems – Haeckel's three kingdoms, Whittaker's five kingdoms approach, Carl Woes three domain system. Major characteristics used in taxonomy – morphological, physiological and metabolic, genetic and molecular. Outline classification of Bergey's manual of systematic bacteriology (2011-2013).

Unit II: Ultra structure Bacteria

Morphological types; structure and composition of cell walls of Gram negative, Gram positive bacteria, halophiles. L-forms and Archaebacteria, capsule types composition and function. Cell membranes in eubacteria, archaebacteria and cyanobacteria – membrane functions, periplasmic space. Structure and function of flagella, cilia and pili, gas vesicles, chlorosomes, carboxysomes, magnetosomes and phycobilisomes. Reserve food materials – polyhydroxybutyrate, polyphosphates, cyanophycin and sulphur inclusions. Nuclear material – bacterial chromosomes and bacterial plasmids.

Unit III: Fungi

Cell wall – chemical composition and functions, membranes and their functions, nutritional strategies of fungi .Structure and life cycle of fungi – Ascomycetes (Aspergillus), Deuteromycetes (Candia), Zygomycetes (Mucor), Basidomyces (Agaricus).

Unit IV: Algae and protozoans

Structure of algal cells – classification – reproduction and characteristics of Chlorophyta (Green algae), Chrysophyta (Golden Brown and Yellow), Green algae, Diatoms, Euglenophyta (Euglenoids). Rhodophyta (Red algae), Cyanophyta, Xanthophyta – Brief account of Protozoans.

Unit V: Culture collection and preservation

Culture collection methods-aerobic and anaerobic culture collection and basic identification methods. Preservation methods of microbes for storage and microscopy studies , culture collections centers – ATCC and MTCC. Physical, chemical methods for controlling microorganisms. A note on fossil microorganism.

Text Books:

1. Pelczar Jr,M.J.Chan, E.C.S. and Kreig,N.R. (1993). Microbiology, Mc,Graw Hill.Inc, New York (All units covered).
2. Prescott,L.M. Harley,J.P. and Klein, D.A.(2003). Microbiology (5^{th} edition) McGraw Hill, New York (All units covered).
3. Madigan,M.T. Martinko,J.M and Parker,J..Brock, T.D.(1997). Biology of Microorganism(8^{th} edition). Prentice Hall International lnc, London (All units covered).
4. Geeta Sumbali and Merhrotra R.S. (2009).Principles of Microbiology.Tata McGraw Hill Education private Limited.
5. Sambamurty A.V.S.S(2005).Text Book of Algae .I.K.International Pvt Ltd.

Reference Books:

1. Alexopoulus, C.J. and Mims,C.W.(1993). Introductory Mycology (3th edition) . Wiley Eastern Ltd, New Delhi..
2. Elizabeth Moore- Landecker.(1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, lnc London.
3. 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.
4. John Webster (1993). Introduction to Fungi (2th edition) . Cambridge University Press, Cambridge.
5. Salle, A.J.(1996). Fundamental principles of Bacteriology ,(7th edition).Tata McGraw- Hill publishing company Ltd, NewDelhi.

CC 2: GENERAL BIOCHEMISTRY

Paper Code: P1RMBCC2 **Semester: I**

No. of Credits: 5 **No. of hours per week: 5**

OBJECTIVE:

- To have a detailed knowledge about the structure and function of biomolecules
- To know the properties of biomolecules.
- To understand the importance of biomolecules

Unit-1 Carbohydrates,

pH, pKa . acid, base . biological buffer system . Water- Principles of thermodynamics. Carbohydrates: Nomenclature, classification, structure, chemical and physical properties of carbohydrates. Metabolisms:glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway.

Unit-2 Lipids:

Nomenclature, classification, structure, chemical and physical properties of fatty acids. Metabolisms: biosynthesis of fatty acids, triglycerols, phospholipids, glycol lipids. Cholesterol biosynthesis, bile acids and salt formation. Eicosanoids, sphingolipids and steroid hormones.

Unit- 3 Amino acids and Protein:

Nomenclature, Classification, structure, chemical and physical properties of amino acids and proteins. Metabolisms: Biosynthesis of amino acids. Degradation of proteins, nitrogen metabolisms and carbon skeleton of amino acids. Over all in born error metabolisms.

Unit . 4 Nucleic acids:

Nomenclature, Classification, structure, chemical and physical properties of purine and pyrimidines. In de novo and salvage synthesis of purines, pyrimidine bases, nucleosides and nucleotides. Catabolisms of purines and pyrimidines bases. Synthetic analogues of nitrogenous bases.

Unit- 5 Bioenergetics and Biological oxidation:

Electron transport chain, oxidative phosphorylation, glycolysis, citric acid cycle, cori.s cycle, glyoxalate pathway. Oxidation of fatty acids- mitochondrial and peroxisomal ß-oxidation, á and ù oxidation, oxidation of unsaturated and odd chain fatty acids, ketone bodies. Photosynthesis, urea cycle, hormonal regulation of fatty acids and carbohydrates metabolisms.

Text Books:

1. Sathyanarayana,U ,Charapani,C.(2010).Biochemistry. Books and allied (P) Ltd
2. Deb,A.C., (1989). Fundamentals of Biochemistry (3rd Edition). New central agency.
3. Jain, J.L., (2005). Fundamentals of Biochemistry (6th Edition), S.Chand Publications
4. Ashokan .P. (2006) Enzymes .Chinna Publications
5. Freifelder, D. (1996) Molecular Biology, II Edition, Narosa Publishing House, New Delhi.

Reference:
1.David E. Metzler. And Carol M. Metzler (2001). Biochemistry-The chemical reactions of living cells- Vol1&2.(2nd edition).Harcourt/Academic press, Newyork.
2.Donald Voet and Judith G. Voet (1995). Biochemistry – Second Edition. John Willey and Sons, Inc.
3. Leninger,A.L., Nelson, D.L., Cox, M.M., (1993). Principles of Biochemisry,(2nd Edition).CBS Publishers,
4.Geofferey, L and Zubay (1998). Biochemsitry. (Fourth Edition) Wm. C. Brown Publishers.
5.Stryer, L. (1995). Biochemistry. 4th Ed. W.H. Freeman and Company, New York

CC-3 VIROLOGY

Paper Code: P1RMBCC3 **Semester: I**
No. of Credits: 5 **No. of hours per week: 5**

Objectives

- To understand the characteristics/ properties of viruses which make them unique microbial pathogens
- To examine the structure and composition of viruses
- Understand the classification of viruses
- Findout the replication strategies of viruses

Unit I: General Virology

Brief outline on discovery of viruses, nomenclature and classification of viruses; Distinctive properties of viruses; morphology & ultrastructure. Capsids and their arrangements - types of envelopes and their composition-viral genome, their types and structures. Brief account of Cyanophages, phycophages, mycophages and Insect viruses. Viroids, prions – Viral related agents.

Unit II: General Methods of Diagnosis and Serology

Cultivation of viruses in embryonated eggs, experimental animals, and cell cultures. Primary & secondary cell cultures and monolayer cell cultures; cell strains, cell lines and transgenic systems. Serological methods – haemagglutination & HAI; complement fixation; immunofluorescence methods, ELISA and radioimmunoassays. Assay of viruses– physical and chemical methods (protein, nucleic acid, radioactivity tracers, electron microscopy). Infective assay (plaque method, end point method).

Unit III: Bacterial Viruses

Bacteriophage - structural organization - Lytic cycle - DNA replication - eclipse phase -phage production - burst size; lysogenic cycle. Brief details on M13, Mu, T4, Lambda and P1.

Unit IV: Plant Viruses

Classification and nomenclature; effects of viruses on plants; RNA viruses- TMV, Cowpea, CMV, Mosaic viruses, Bromo mosaic viruses, Satellite viruses. Double stranded DNA viruses – CaMV, Single stranded DNA viruses –Gemini virus. Transmission and of plant viruses (with vectors) - insects,nematodes, fungi – (without vectors) contact, seed and pollens. Common viral diseases of crop plants - names of diseases, pathogens and symptoms only - paddy, cotton, tomato and sugar cane.

Unit V: Animal Viruses

Classification and nomenclature of animal human viruses. Epidemiology, life cycle, pathogenicity, diagnosis, prevention and treatment of RNA Viruses - Picorna, Orthomyxo, Paramyxo, Rhabdo, Rota, HIV - Oncogenic viruses. DNA viruses; Pox, Herpes, Adeno, SV 40; Hepatitis viruses. Viral vaccines (including DNA Vaccines with examples) interferons, and antiviral drugs.

Text Books:

1. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall,Englewood Cliff, New Jersey.
2. Amitha Biswas(2007). An Introduction to viruses.Vikas Publishers
3. Maloy, S.R, Cronan Jr. J.E, Freifelder, D. (1998). Microbial genetics. Jones and Bartlett publishers.
4. Saravanan,P.(2006).Virology. MJP Publishers

5. Roger Hull (2002). Mathews' Plant Virology.(4thEdition).Academic press-A Harcourt Science and technology company,Newyork.

Reference Books:

1. Flint, S.J., Enquist, L.W., Krung, R. Racaniello, VR. and Skalka, A.M. (2000). Principles of Virology, Molecular Biology, pathogenesis and control, ASM Press, Washinton D.C.
2. Alan J.Cann (1997). Principles of Molecular virology.(2nd edition). Academic press,California.
3. Ann Giudici Fettner (1990). The Science of Viruses. Quill William Marrow,Newyork.
4. Nicklin,J.Greame-Cook.and Killington, R. (2003). Instant Notes in Microbiology.(2nd edition).Viva Books private limited,NewDelhi.
5. Robert I.Krasner (2002). The microbial challenge:Human Microbe Interactions.American society for Microbiology,Washington.
6. Tom Parker, Leslie, M. and Collie, H. (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition).

Core Course IV (CC)
Practical I
General Microbiology, General Biochemisty & Virology

General Microbiology

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 microbes – Micrometry and Dryweight.
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, Actinobacteria, Fungi and Protozoans.
9. Staining methods: Simple, Negative, Acid fast, Gram staining , Spore, Capsule, Lactophenol cotton blue staining - Fungal slide culture

General Biochemistry

1. Preparation of Buffer; (Tris, phosphate, acetate buffer). Acid-Base titration – pKa value Determination.
2. Verification of Beer-Lambert's law using coloured solution (CuSO4).
3. Preparation of standard graph for the following and estimating the concentration in a microbial sample (i) carbohydrate – anthrone method (ii) Protein - Lowry's method and Nucleic acid – DNA (diphenylamine method), RNA (Orcinol method).
4. Separation of aminoacids by paper chromatography and identification of aminoacid.
5. Separation of proteins by polyacrylamide gel electrophoresis and determination of molecular weight of unknown protein.

Virology

1. Isolation and characterization of bacteriophage and cyanophage from natural resources.
2. Phage titration – T4 or Lambda or M13.
3. Determination of lysogeny using Lambda Phage or Staphylococcal indicator systems.
4. Study of virus infected plant samples – animal tissue culture – chick embryo fibroblast culture preparation (Demonstration).
5. Transmision method – mechanical.

References:

1. Wilson, K. and Walker, J. (2000). Practical Biochemistry, 5th Edition, Cambridge University Press.
2. Cappuccino and James, G (1996) Microbiology a laboratory manual, Addison Wesley Publishing Company Inc. 4th edition, England, California.

3. David R. Brooke. Bergey's Manual of Systematic Bacteriology (Vol. I), Eastern Halz, Springer Publication.
4. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994) Methods of General and Molecular Bacteriology, Ed. American Society for Microbiology, Washington D.C.
5. James T. Stanley, Marvin P. Bryant. Bergey's Manual of Systematic Bacteriology (Vol.II), Nobert Fleming Springer Publishers.
6. Wilson K. Walker (1995). Practical Biochemistry, Principles and Techniques, Cambridge University Press.
7. Gerhardt, P., Murray, R.G., Crood, W.A. and Kreig, N.R. (1994) Methods for general and molecular bacteriology, ASM, Washington D.C.
8. Jeanne Dejkstra, Ces.P.de Jager (1998) Practical plant virology, Springer Verlag, Lab Manual, Berlin, Heidel Berg, New York.
9. Miller, J.H. (1992) A short course in bacterial genetics, Cold Spring Harbor.

EC -1 BIOLOGICAL TECHNIQUES

Paper Code: P1RMBEC1 **Semester: I**
No. of Credits: 3 **No. of hours per week: 6**

Objectives:

- To have a detailed knowledge about the instruments
- To understand the importance of instruments in industries
- To develop the instrumentation skills among the students

Unit I: Microscopy and Related Techniques

Light Microscopy : Microscopic optics, components of microscopes. Basic principles and types of Bright field, Dark field, Phase contrast. Fluorescence, Polarization and confocal microscopes and their applications. Immunofluorescence – *In situ* hybridization. Electron Microscopy – Principle, Techniques and applications of Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM). Photomicrography and Video micrography.

Unit II: Analytical Techniques

Spectroscopic methods – UV-Visible, Atomic Absorption and Atomic Emission Spectroscopy. Spectroflurimetry, Luminometry. X- ray spectroscopy. Centrifugation – Principles and types centrifugation. Electroanalytical methods – electrolytic – Potentiometric, conductimetric, coulometric & voltametric analysis. Biosensors. Radioactive Analysis : Principles of radioactivity, GM counter & LS counter.

Unit III: Principles & Applications of Chromatographic Techniques :

Principles of chromatography, Thin layer chromatography, Adsorption – Ion exchange and gel permeation – affinity chromotography for separation of compounds GC and HPLC methods.

Unit IV: Electrophoresis Techniques

Electropohoretic techniques – protein – nucleic acid – immuno – two dimensional electrophoresis. Isoelectric focusing, silver staining.Capillary electrophoresis, Native-PAGE.

Unit V: Molecular Biological Techniques

Isolation of chromosomal and plasmid DNA. Polymerase chain reaction – isolation of specific genes using PCR. Restriction digestion and Phosphatase treatment of cloning vectors. Cloning techniques – separation and quantification of DNA, gene transfer mechanisms – chemical and electroporation. Methods of detection of clones – Nucleic acid transfer by blotting, Hybridization plaque, colony hybridization. Histochemical detection of β -galactosidase, antibody screening including colour development reaction.

Text Books:

1. Veerakumari (2005). MJP Publishers.
2. Palaivelu.P (2002) Analytical Biochemistry, MKU University.

3. B.Sivakumar (2005). Bioseperatons - Principles and Techniques.Prentice-Hall of India Pvt.ltd.
4. P.Asokan (2002). Analytical Biochemistry. Chinna Publications.
5. Dubey, R.C. (2006). Text book of Biotechnology. Chand and company (P)Ltd.

Reference books:

1. P Sambrrok, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd eidition, Vol. 1,2,3) Cold Spring Laboratory Press, New York. Ress
2. Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press.
3. John G. Webster. (2004). Bioinstrumentation. University of Wisconsin, John Wiley & Sons, Inc.
4. Wilson, K. and Walker.J (2005). Practical Biochemistry Principles and Techniques,6th edition, Cambridge University/
5. Holme.J and Peck.H (1993). Analytical Biochemistry 2nd edition. Longman Scientific and Technical.

EC – 3 FOOD & DAIRY MICROBIOLOGY

Paper Code: P2RMBEC3 **Semester: II**
No. of Credits: 3 **No. of hours per week: 4**

Objectives

- Identify factors essential for the growth of microorganisms
- Relate the requirements for bacterial growth to the definition of potentially hazardous food
- Fermentation is the controlled action of selected microbes to alter the texture of foods
- Discuss the types of illness associated with food poisoning
- List the types of food preservations

Unit I: Introduction

Importance of food and dairy microbiology- Types of microorganisms in Food Spoilage - source of contamination- Factors influencing microbial growth in food - extrinsic and intrinsic factors – pH, temperature, moisture, oxygen reduction potential.

Unit II: Food fermentations

Methods of fermentations and organisms used - Cheese, bread, wine, beer. Fermented vegetables – Cabbage, cucumber, olives. Food and enzymes from microorganisms - single cell protein. Production of amylase and protease.

Unit III: Contamination, spoilage and preservation

Cereals and cereals products, sugar and sugar products, vegetables and fruits, meat and meat products – fish and othe sea foods, egg and poultry – dairy and fermentative products (ice cream, yoghurt, kefir, kumiss and acidophilous milk), cheese production and its types.

Unit IV: Food borne diseases

Intoxication and food poisoning – *Staphylococcus*, *Clostridium*, *Escherichia coli* and *Salmonella* infections, Hepatitis, Amoebiosis and Mycotoxins. Bacterial and fungal exo and endotoxins.

Unit V: Principles and methods of food preservation

Methods of preservations-Physical and chemical methods, food sanitations. Milk preservation methods – pasteurization. Good manufacturing practices (GMP) - hazard analysis, critical control points and personnel hygiene. Food sanitation in food manufacture and in the retail trade; Food control agencies and its regulations

Book of Studies:

1. Frazier and Westhoff, DC. 1988. Food Microbiology. TATA McGraw Hill Publishing Company LTD., New Delhi
2. Adams, M.R and Moss, MO. 1995. Food Microniology. The Royal Society of Chemistry, Cambridge
3. Banwart GJ. 1989, Basic food microbiology, Chapman & Hall, New York.
4. Sivasankar B. 2005. Food Processing and preservation, Prentice-Hall of India Pvt.Ltd.
5. James M.Jay. 2003. Modern Food Microbiology, 4th edition, CBS Publishers and distributers

Book of Reference:

1. Andrews AT, Varley J. 1994. Biochemistry of milk products. Royal Society of Chemistry.
2. Robinson RK. 1990. The microbiology of milk. Elsevier Applied Science, London.
3. Ramanathan N. 2009.A Textbook of Food Microbiology, OM Sakthi pathipagam
4. Shirly J. VanGarde, Margy Woodburn. 2005. Food Preservation and Safety, Surabhi Publications.
5. Pelczer Jr,M.J.Chan, E.C.S. and Kreig,N.R. (1993). Microbiology, Mc,Graw Hill.Inc, New York.

CC-5 MICROBIAL PHYSIOLOGY

Paper Code: P2RMBCC5 **Semester: II**
No. of Credits: 5 **No. of hours per week: 5**

Objectives:

- To understand of the basic functions of a cell
- To know the dynamics of microbial growth
- To understand the autotrophic nature of microbes
- To familiarize with the knowledge of energy production
- To be aware of how physiology is applicable in industries

Unit I - Cell structure and function

Cell structure and function - Biosynthesis of peptidoglycan - outer membrane, teichoic acid – Exopolysaccharides; cytoplasmic membrane, pili, fimbriae, S-layer, cell inclusions. Transport mechanisms – active, passive, facilitated diffusions – uni, sym, antiports. Iron uptake - Pinocytosis and Phagocytosis. Electron carries – artificial electron donors – inhibitors – uncouplers – energy bond.

Unit II - Microbial growth

Microbial growth - Phases of growth – growth curve – measurement of growth – calculations of growth rate – generation time – Batch, Continuous and synchronous growth – induction of synchronous growth, synchrony index – factors affecting growth – pH, temperature, substrate and osmotic condition. Survival at extreme environments – starvation – adaptative mechanisms in thermophilic, alkalophilic, osmophilic and psychrophilic. Bioluminescence - mechanism – advantages.

Unit III - Microbial pigments

Microbial pigments - Autotrophs - cyanobacteria - photosynthetic bacteria and green algae – heterotrophs – bacteria, fungi, myxotrophs. Brief account of photosynthetic and accessory pigments – chlorophyll – fluorescences, phosphoroscenses - bacteriochlorophyll – rhodopsin – carotenoids – phycobiliproteins;

Unit IV – Energy production

Carbon assimilation Carbohydrates – anabolism – autotrophy – oxygenic – anoxygenic Photosynthesis – autotrophic generation of ATP; fixation of CO2 – Calvin cycle – C3 – C4 pathways. Respiratory metabolism – Embden MayerHoff parnas pathway – Enter Doudroff pathway – glyoxalate pathway – Krebs cycle – oxidative and substrate level phosphorylation – reverse TCA cycle – gluconeogenesis – Fermentation of carbohydrates – homo and heterolactic fermentations.

Unit V - Spore Physiology

Spore Physiology: Types, endospores and other persistent forms, Classification of endospore forming bacteria, spore formation, Initiation process of sporulation. genes with reference to *Bacillus subtilis*. Other persistent forms: Cyst, Exospores and Myxospores.

Text Books:

1. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). Microbiology.(5th edition).McGraw-Hill company, New York
2. Moat, A.G., Foster, J.W. and Spector, M. P (2002). Microbial Physiology (4th Edition). John Wiley & Sons, New York
3. Hans G. Schlegel (1995) General Microbiology, Seventh edition, Cambridge University Press
4. S.Sundarajan (2003). Microbial Physiology, 1st edition, Annol Publications.
5. Pelczar, Jr, M.J.Chan, E.C.S and Kreig, N.R. (1993). Microbiology, Mc.Graw Hill.Inc, New York.

References:

1. Caldwell, D.R. (1995). Microbial Physiology and metabolism, Wm. C. Brown, Publishers, USA
2. Salle,A.J. (1996). Fundamental principles of Bacteriology(7th edition).Tata McGraw-Hill publishing company limited, NewDelhi.
3. White, D. (1995). The physiology and biochemistry of Prokaryotes, Oxford University, Press, Oxford, New York.
4. Rabert Poole, K. (2007) Advances in Microbial Physiology, Volume 53 Elsevier Science & Technology

CC-6 AGRICULTURAL & ENVIRONMENTAL MICROBIOLOGY

Paper Code: P2RMBCC6 **Semester: II**
No. of Credits: 5 **No. of hours per week: 5**

Objectives:

- To know the various interaction and role of microbes in improving soil fertility.
- To become familiar with some important Indian crop diseases
- To inculcate the spread of air born and water born diseases
- To Acquire the knowledge of Aquatic ecosystem
- To know the solid and liquid waste management

Unit I: Soil Microbiology

Interactions among soil microorganisms - mutalism, - commensalism – amensalism – synergism - parasitism – predation -competition. Microbial interactions between plants – rhizosphere - phyllosphere - mycorrhizae - symbiotic association in root nodules. Biofertilizers – VAM, *Rhizobium, Frankia, Azospirillum, Azotobacter* cyanobacteria and Azolla.

Unit II: Plant diseases and its control

Some bacterial diseases of agricultural crops. Plant diseases, pathogens and symptoms and control measures with reference to paddy, cotton, maize, tomato, citrus,mango, potato. Plant protection – phenolics –phytoalexins and related compounds. Bioinsecticides – viral, bacterial and fungal- a brief note.

Unit III: Biogeochemical cycles & Air microbiology

Soil microbes and fertility of soil. Roles of microbes in biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur.soli microbes and fertility of soil. Aerobiology – a brief introduction - droplet nuclei – aerosols - air borne transmission of microbes and diseases; assessment of air quality.

Unit IV : Aquatic microbiology

Aquatic microbiology - factors that affect microbial growth – temperature – pressure – light – salinity - turbidity – pH -inorganic and organic constituents. Aquatic habitats - freshwater - lakes, ponds and streams; marine habitats - estuaries, deep sea, hydrothermal vents, saltpans, coral reefs and mangroves and their microbial communities; zonation – food chain and food web. Role of microorganisms in the productivity.

Unit V: Waste treatment

Types of wastes - characterization of solid and liquid wastes. Treatment of solid wastes – incination composting, vermiform composting, sillage, pyrolysis, saccharification. Treatment of liquid wastes – primary and secondary treatment; anaerobic (methanogenesis) -aerobic - trickling, activated sludge, oxidation pond.

Text Books

1. Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition Benjamin/Cummings Publishing Company, California.
2. Subba Rao N .S (1995) Soil microorganisms and plant growth. Oxford and IBH publishing co. pvt. Ltd. New Delhi
3. Joseph, C. Daniel.(1999). Environmental Aspect of Microbiology(2nd Edition). Bright sun publication
4. Rengasawamy ,G., Bagyaraj, D.J. (2001) Agricultural Microbiology.Prentice.Hall of India (P) Ltd

5. Sharma, P.D. (2009). Environmental Microbiology. Narosa Publication
6. Aneja, K.R., Jain and Raman Aneja (2008). A text book of basic and applied microbiology. 1st edition. New Age Publications.

Reference Books

1. Dirk, J. Elasas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil icrobiology, Marcel Dekker INC, New York, HongKong.
2. Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and bio treatment – Longman Scientific Technical.
3. Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. New York.
4. Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health association.
5. Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C.
6. Patricia Cunning (1995). Official Methods of Analysis, Vol. I and II, 16th Edition, Arlington, Virginia, USA.

CC-7 MICROBIAL GENETICS

Paper Code: P2RMBCC7 **Semester: II**
No. of Credits: 5 **No. of hours per week: 4**

Objectives:

- To understand of the basic concepts of genetics
- To know the organization of microbial genetics
- To understand the central dogma of molecular biology
- To familiarize with the knowledge of gene regulation

Unit I: Microbial Genetics

Microbial Genetics: Definition and scope of Genetics. Pre-Mendelian genetics concepts – Performation, Epigenesis, Inheritance of acquired characters, Germplasm theory. Hereditary and Environment, Genotype and Phenotype, Clones, Pure-lines and Inbred lines. Microbes as tools for genetic studies.

Unit II: Bacterial Genetics

Bacterial Genetics: Organization of genetic material in bacteria, Gene transfer mechanisms: Conjugation, Transformation and Transduction. Recombination in bacteria. Natural transformation systems- *Streptococcus pneumonia* and *Haemophilus influenzae*.. Transfection and forced competence. Bacterial Conjugation: Properties of the F plasmid, F+ x F - mating, F' x F- conjugation.

Transduction: Generalized and specialized transduction.

Unit III: Viral Genetics

Viral Genetics: General characteristics of viral genome, T4 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 IV: Transcription and Translation

Transcription – initiation, elongation – termination. Synthesis of mRNA in prokaryotes and eukaryotes. Synthesis of rRNA and tRNA. RNA processing – capping and polyadenylation. Genetic code, Translation – initiation, elongation and termination. Signal sequences and protein transport.

Unit V: Regulation of gene expression

Regulation of gene expression: operon concept, catabolic repression instability of bacterial RNA, positive and negative regulation, inducers and corepressors. Negative regulation - *E. coli* lac operon; positive regulation- *E.coli* ara operon; regulation by attenuation his and trp operons. DNA binding sites on DNA, Global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA syntheses.

Text Books

1. David Frifelder,(2008).Microbial Genetics, Narosa PublishingHouse ,New Delhi.

2. Old RS and Primrose,S.B.(1989).Principles of gene Manipulation,4th edition.Black Well Scientific Publication.London.
3. Nancy Trun & Jasmine Trampy (2004). Fundamental of Bacterial Genetics (2004). 1st edition. Blackwell publishing company.
4. C.B.Powar (2003). Gene Regulation.1st edition. Himalaya publication.
5. S.Sambamurthy (2007). Molecular Genetics. Jones and Bartlett Publishers.

Reference Books

1. Darnell.J .,1995.Molecular Cell Biology, Scientific American Books, USA.
2. Weaver.R.F., Philip.P.W.1989, Genetics, WMC Brown Publishing, USA.
3. Lodish H., Baltimore D., Berk ,A., Zipsary S.L., Matsudaira P., Darnell J.(1995).Molecular Cell Biology .Scientific American Books.
4. Antony J F., Griffiths, Gilbert WM., Wewontin R C., Miller J H., (2000(Modern GeneticAnalysis, Integrating Genes and Genomes, 2nd edition, W H
5. Gardner E.J., Simmons M J., Snustad D.p.(1991).Principless of Genetics .John Wiley and Sons.
6. Lewin B. (2008).GenesVIII 8th edition.Oxford University. Pratice Hall publications.
7. Watson JD,Hopkins NH,Roberts JW,Steitz JA,Weiner AM .(1998).Molecular Biology of the Gene , 4th edition.Benjamin /Cummings Publishing Company.
8. Daniel L.Harti and W.Jones (2001). Genetics. 5th edition. Jones & Bartlett publications.

CC -8 MICROBIAL BIOTECHNOLOGY

Paper Code: P4RMBCC13 **Semester: IV**
No. of Credits: 5 **No. of hours per week: 6**

Objectives:

- To be aware of microbial production of enzymes
- To familiarize with the knowledge of microbial products like SCP
- To know the eco-friendly alternatives using microbes
- To understand transgenic models
- To understand the recycling and reuse of wastes

Unit I:Enzyme technology

Introduction- Biotechnology – Definition – History – Scope. Microbial production of enzymes- Protease- Pectinase- Lipase. Industrial application of microbial enzymes- Therapeutic- Manipulative- Analytical uses. Immobilization of enzymes and its application. Ribozymes- Abzymes- Synzymes.

Unit II: Microbial Products

Biotechnological potential of microalgae – Food – Feed - Colourant – Fuel - Pharmaceutically valuable compounds. SCP (Bacteria and Yeast). Mushroom cultivation . Health care products- Insulin- Somatotrophin- Somatostatin- Interferon- Blood clotting factor VII- Vaccines. Production of IAA- Giberellin- Auxin

Unit III: Biofuel, Biosensors & Biochips

Definitions- Bioethanol production-application. Biodisel production-application. Biogas production-application. Bio Hydrogen production - application. Biosensors –Types- Application. Biochips– Types- Application.

Unit IV: Transgenic plants & animals

Development of Transgenic plants an animals - resistant to herbicide- insects-bacteria- virus and fungus. Transgenic rice, edible vaccine,bioplastic. Transgenic animals - ethical implications on transgenic animals

Unit V: Bioremediation

Microbes involved in biodegradation - Microbial degradation of phenolics – metals – sewage nutrients (phosphate and nitrate) – hydrocarbons – xenobiotic compounds, bioaugmentation – bioaccumulation – biomagnification. microbial leaching of ores – oil extraction. Microbial deterioration of materials – paper – leather – wood – paint – textiles – paint – metal corrosion.

Text books

1. Singh, B. D .(2006).Biotechnology. Kalyani Publication.
2. Dubey, R.C. (2006). Text book of Biotechnology. Chand and company (P)Ltd

3. Trevan ,M.D, Boffey, S. Coulding K. H., Stanburry.P. (1990). Biotechnology the basic principles-Tata McGraw Hill edition.
4. Sathyanarayana, U (2008). Biotechnology. Books and allied (P) Ltd
5. Pradipta Kumar , Mohapatra (2006).Text Book of Environmental Biotechnology. I.K .International

References

1. Das, H.K., (2007).Text Book of Biotechnology. Wiley India (P) Ltd
2. Ramwat ,K.G.,Shaily Goyal (2009).Comprehensive Biotechnology. Chand and company (P)Ltd
3. Wiiliam J,Thieman ,Michael, A., Palladino (2009). Introduction to Biotechnology. Dorling Kindersley (India) Private Limited
4. Philose, P.M. (2006).A Text Book of Biotechnology. Dominant Publishers and Distributors.
5. Ramdass, P., Meerarani, S (2002).Text book of Animal Biotechnology. Library of congres cataloguing in Publishing in Data.

Core Course 9 (CC)
Practical II
Microbial Physiology, Agricultural & Environmental Microbiology and Microbial Genetics

Microbial Physiology

1. Bacterial growth curve – Turbidity
2. Biochemical tests:
   a) Carbohydrate fermentation test
   b)IMViC Test
   c) Urease
   d) Catalase
   e) Oxidase

Agricultural & Environmental Microbiology

1. Isolation and enumeration of soil microorganisms (fungi, bacteria and actinobacteria).
2. Staining of vesicular Arbuscular mycorrhizae from plant.
3. Isolation and culturing of *Rhizobium* from root nodules.
4. Study of the following diseases:
   a) Tobacco mosaic;
   b) Bacterial blight of paddy;
   c) Downy mildew of bajra;
   d) Powdery mildew of cucurbits;
   e) Head smut of sorghum;
   f) Red rot of sugar cane.
5. Isolation and identification of air-borne bio-particles using Andersen sampler.
6. Determination of DO of polluted/pond water.
7. Determination of BOD of polluted/pond water.
8. Determination of COD of polluted/pond water.
9. Assessment of water quality by MPN technique.

Microbial Genetics

1. Isolation of antibiotic resistant microbes
2. Induction of mutation by ultra-violet radiation and chemical mutagens – NTG, MNNG.
3. Transformation (competent cell preparation) and Transduction using P1.
4. Auxotrophic mutant isolation

References:

1. Atlas Ronald.M. Bartha and Richard (1987). Microbial Ecology 2nd edition. Benjamin/Cummings Publishing company
2. Dirk, J.Elasas, V, Trevors, J.T., Wellington, E.M.H. (1970). Modern soil microbiology, Marcel Dekker INC, New York.

3. Ec Eldowney, S, Hardman D.J, Waite, S. (1993). Pollution Ecology and Biotreatment – Longman Scientific Publishers
4. Mitchel, R. (1992). Environmental Microbiology. Wiley-John Wiley and Sons. Inc Publications New York.
5. Clescri, L.S., Greenberg, A.E and Eaton, A.D. (1998). Standard Methods for examination of water and waste water, 20th edition, American Public Health Association.

EC-2 MOLECULAR TAXONOMY AND PHYLOGENY
Paper Code: P4RMBEC3 **Semester: III**
No. of Credits: 3 **No. of hours per week: 4**

Objectives:

- To be aware of taxonomical positions of microbes
- To understand the use of different biochemical techniques used in taxonomy
- To focus on the identification of microbes in research level
- To know the sequence analysis
- To apply molecular phylogeny in taxonomy

Unit I: Microbial Taxonomy

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 II: 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, RFLP, RAPD, STRR & LTRR, REP –PCR, rRNA based DNA finger printing methods

Unit III: 16S rRNA based finger printing

Types of rRNA – 23S rRNA, 16S rRNA & 5S rRNA. Importance of 16SrRNA inmicrobial identification and taxonomy. Methods of 16S rRNA / rDNA fingerprinting -Isolation of rRNA, RT-PCR, Isolation of DNA, amplification of 16S rDNA using PCR, Cloning, transformation, Blue-white screening, Plasmid isolation, Dot blot/Southern blot hybridization using specific probes Sequencing of 16S rDNA using chain-termination method.

Unit IV: Sequence analysis.

Submission of rDNA sequences in GenBank – Bankit & Sequin guidelines. NCBI, EMBL & DDBJ – retrieving sequences. RNA structure prediction, Restriction enzyme patterns. Ribosomal Database Project - Designing primers & probes. Sequence comparison, alignment and data base searching – Clustal W, FASTA & BLAST. DNA barcoding.

Unit V: Molecular phylogeny.

Introduction to Molecular phylogeny – tree terminology, software programs for making phylogenetic trees – MEGA, Phylib, RAPDistance. Cladogram, additive trees and ultrametric trees, rooted, unrooted trees and tree shapes.

Text Books

1. Bioinformatics (Sequence and genome analysis) (2002) 2nd edition by David W.Mount, CBS publication.UK
2. Genomes by T.A.Brown 1st edition,Bios Scientific publication UK.
3. Gene Biotechnology (2nd Edition) by Joghand, S.N. Himalaya Publishing company, India. 4.
4. Concepts of genetics by William Klug, Micheal R.Cummings. Pearson Education, Delhi

References:

1. Genome Mapping and Sequencing by Ian Dunham (Hardcover - Sep 1, 2003).
2. Brendan Wren (Editor), Nick Dorrell (2002) Functional Microbial Genomics (Volume33) (Methods in Microbiology), Academic Press, UK.
3. Sandy B. Primrose Richard M. Twyman (2005) Principles of Genome Analysis and Genomics, Blackwell Publishing, USA.

4. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell publishing, USA.
5. Principles of Genome Analysis: A Guide to Mapping and Sequencing DNA from Different Organisms by S. B. Primrose (Paperback - Jan 1998)

CC-10 IMMUNOLOGY

Paper Code: P3RMBCC9 **Semester: III**
No. of Credits: 5 **No. of hours per week: 4**

Objectives:

- To understand of the basic functions of Immune system
- To know the properties antigens and antibodies
- To understand the structure and functions of immune cells
- To familiarize with the knowledge of Immunity to infections
- To develop skills in immunotechniques

Unit I: Immune System

Milestones in immunology - evolution of immunology Infection, immunity, types of immunity - innate and adaptive, phagocytosis and extracellular killing, immunity to specific infection,. Anatomy of the lympho - reticular system, primary lymphoid organs - Secondary lymphoid tissues - Hematopoiesis , immuno reactive cells - T & B lymphocytes, macrophages, granulocyte and NK cells, Lymphocyte Traffic.

Unit II: Antigen and Antibody Molecules

Antigen types and its properties, Antigen engineering for better immunogenicity - Use for vaccine development- immunization schedule, whole cell vaccines, recombinant vaccines, DNA vaccines, synthetic peptide, multivalent subunit and anti-idiotype vaccines, Edible vaccines. Antibody structure and function, Classification of immunoglobulins, Antibody engineering – Monoclonal Antibody production - Hybridoma Technology. Antibody for diagnosis, Antibody for therapy.

Unit III: MHC, Cytokines and Complements

Concept of Histocompatibility - Genetic organization of H2 and HLA complexes. Class I and class II MHC molecules, structure and function. Antigen processing and presentation by MHC molecules. Cytokine structure and their receptors - Cytokine therapy, Complements – membrane attack complex – classical and alternate pathway.

Unit IV: B and T cell Activation

B cell receptor complex (BCR), B cell activation and maturation, Generation of antibody diversity, Understanding self-nonself discrimination, TH Cell subpopulation, Organisation of T cell receptor, T cell receptors (TCR), APC-Tcell interaction, T cell activation and maturation, Th1 and Th2 cells. Cell mediated effector responses. Lymphocyte Migration and Inflammation, Hypersensitivity reactions - auto immunity.

Unit V: Immunotechnology and its applications

Precipitation techniques, agglutination techniques, radiology in immunotechniqes, 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.

Text Books:

1. Ivan Roitt. Jonathan Brostoff and David Male. (2007). Immunology(7th edition).Elsevier science Ltd., New York
2. Janis Kuby (1994). Immunology. (2nd edition). W.H. Freeman and company,New York.
3. N.V.Shastri (2005). Principles of Immunology.(5^{th} Edition).Himalaya Publishing House, Mumbai.

4. I.Kannan (2007). Immunology. MJP Publishers.
5. S.C.Rastogi (2008). Elements of Immunology. CBS publishers, New Delhi.
6. Lydyard, Whelan and Fanger (2002), Instant notes in Immunology, Bios scientific publishers.

Reference books:

1. Charles A. Janeway,Jr. Paul Travers. Mark Walport and Donald Capra,J.(1999). Immunobiology-The immune system in health and disease.(4th edition).Current Biology Publications, London.
2. Richard A., .Goldsby Thomas J. Kindt and Barbera A. Osborne. (2002). Kuby Immunology.(5th edition).W.H. Freeman and company, New York.
3. Abul K. Abbas. Andrew H. Lichtman and Jordan S.Pober.(1994). Cellular and Molecular Immunology.(2nd edition).W.B. Saunders company, Philadelphia.
4. Ian.R.Tizard (2004). Immunology – An introduction.4th Edition.
5. Joshi & Osama (1998). Immunology (Serology, Hematology), Agro Botanica.

CC-11 MEDICAL MICROBIOLOGY

Paper Code: P3MBCC10 **Semester: III**
No. of Credits: 5 **No. of hours per week: 4**

Objectives:

- To understand of the basic concepts of medical microbiology
- To understand the pathogencity of medically important microbes
- To develop skills in diagnosing microbial infections

Unit-I: Introduction of Medical Microbiology

History of Medical Microbiology, Scope of Medical Microbiology. Normal Microbial flora of healthy human host, Host Microbial interaction – Invasivesness. Infectivity and Pathogenic potentials – Epidemiology of Infectious diseases. Zoonotic diseases. Hospital born infections.

Unit-II : Laboratory Diagnosis

Collection and transport of clinical samples – Urine, Blood, Stool, CSF. Isolation of pathogenic bacteria and fungi from clinical samples like Blood, Urine, Stool and sputum. Assessment of parasitic infection using clinical samples. Antibiotic sensitivity assay, MIC, MBC, IC50 determination

Unit-III: Systematic Medical Bacteriology

Study of bacterial pathogenic diseases of international importance – Pneumonia (*Streptococcus* and *Klebsiella*), Gonorrhoea, Cholera, Diptheria, Tuberclosis, Leprosy, Lyme disease, Meningitis, Syphillis, Gastroenteritis, Typhoid, Anthrax.

Unit-IV: Viral diseases

Study of diseases associated with viruses – swine flu, bird flu, Measels, Mumps, Rubella, Polio, Chicken Pox, small pox, Hepatitis, Dengu, Japanease Enchepalitis, Ebola haemaraggic fever, Rabies, AIDS, Yellow fever.

Unit-V: Mycology & Protozoalogy

Superficial, Cutaneous, Subcutaneous, Systemic and opportunistic Mycoses, Causative agent, Lifecycle, pathogenesis and treatment of following protozoan and helminthic diseases – Amoebiasis, Giardiasis, Malaria, Sleeping sickness, Filariosis and ascariasis.

Text Books:

1. Ananthanarayanan, R and C K Jayaram Panicker. 2009. Textbook of Microbiology, 8th edition, Orient Longman
2. Chakraborty P 1995, A Text book of microbiology, New Central Book Agency Pvt Ltd. Calcutta
3. David Greenwood.Richard C.B Slack and Jhon F.Peuthere.2000.Medical Microbiology 15th edition, ELBS with Churchill Livingston Publi
4. Chatterjee K.D.2007. Medical Microbiology, 7th edition.
5. Prescott, Harley, Klein's. 2007. Microbiology. 7th edition, McGraw Hill Medical Publications Division.

Reference Books:

1. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases2nd edition. Williams and Wilkins, Baltimore.
2. Collee, JG. Duguid JP, Fraser AG, Marimon BP. (1989) Mackie and Mc Cartney Practical Medical Microbiology, 13th Edition. Churchill Livingstone.
3. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition.Blackwell Scientific Publication, Oxford.
4. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7thedition. Edward Arnold. A division of Hodder and Stoughton.
5. Ronald M. Atlas. (1989) Microbiology. Fundamentals and Application

CC-12 MOLECULAR BIOLOGY & GENETIC ENGINEERING

Paper Code: P3RMBCC11 **Semester: III**
No. of Credits: 5 **No. of hours per week: 4**

Objectives:

- To be familiar with gene mutation
- To use vectors in genetic engineering
- To understand enzymes responsible for manipulating the genetic materials
- To know the techniques in genetic engineering
- To understand the functional genomics and applications

Unit I: Gene and Mutation

Gene as a unit of mutation and recombination. Mutagenesis, mutations and mutants – biochemical basis of mutations, spontaneous and induced mutations, isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants. DNA repair mechanism - Excision repair, SOS repair, recombination and mismatch repair.

Unit II: Plasmid and Cloning Vectors

Plasmid features and biology - structural and functional organization, plasmid replication and copy number - stringent and relaxed plasmids, incompatibility of plasmid maintenance. Construction of an ideal vector, co-integrate vectors. Salient features of cloning vectors, restriction enzymes, their classification, mode of action and target sites.Types of cloning vectors: plasmids, cosmids, phasmids, shuttle vectors, BAC, YAC, bacteriophage and other viral vectors.

Unit III: Gene manipulating Enzymes

Enzymes in Genetic Engineering - DNA polymerase, RNA polymerases, Polynucleotide kinase, DNA ligases -Nick translation system, Terminal deoxynucleotidyl transferase,Topoisomerases, Reverse transcriptase, Restriction endonucleases Type I & II. Restriction modification systems.

Unit IV: Techniques of Genetic Engineering

Strategy of recombinant DNA technology – Cloning strategies - Use of linkers, adaptors, homopolymer tails - cDNA cloning and gene libraries. Recombinant selection and screening methods. Expression of cloned genes – problems and solutions. Whole genome analysis - physical method of DNA sequencing - automated sequence; chromosome walking. Methods of introducing recombinant DNA in to bacteria, plants and animals - Ca-mediated transfection, particle bombardment, microinjection, electroporation and lipofection.

Unit V: Functional genomics and Applications of Genetic Engineering

Molecular screening - DNA chips and microarrays - site directed mutagenesis, transgenic animals and gene knockout techniques, cell culture based techniques. Genetic diagnosis - Applications in medical field, transgenic plants, transgenic animals, Recombinant vaccines development. Gene therapy; Molecular basis of genetic diseases, genetic counseling.

Text Books

1. David Frifelder,(1990).Microbial Genetics, Narosa PublishingHouse ,New Delhi.
2. Old RS and Primrose,S.B.(1989).Principles of gene Manipulation,4th edition.Black Well Scientific Publication.London.
3. Lewin B. (2000).GenesVII.Oxford University.
4. Watson JD,Hopkins NH,Roberts JW,Steitz JA,Weiner AM .(1998).Molecular Biology of the Gene , 4th edition. Benjamin /Cummings Publishing Company.

5. Gardner E.J., Simmons M J., Snustad D.p.(1991).Principless of Genetics .John Wiley and Sons.

Reference Books

1. Darnell.J .,1995.Molecular Cell Biology, Scientific American Books, USA.
2. Weaver.R.F., Philip.P.W.1989, Genetics, WMC Brown Publishing, USA.
3. Lodish H., Baltimore D., Berk ,A., Zipsary S.L., Matsudaira P., Darnell J.(1995).Molecular Cell Biology .Scientific American Books.
4. Antony J F., Griffiths, Gilbert WM., Wewontin R C., Miller J H., (2000(Modern GeneticAnalysis, Integrating Genes and Genomes, 2nd edition, W H

CC-13 FERMENTATION TECHNOLOGY

Paper Code: P3RMBCC12 **Semester: III**
No. of Credits: 5 **No. of hours per week: 4**

Objectives:

- To know how the microbes are used in industries
- To be aware of the strain improvement for industrial purposes
- To know the different types of fermenters and their functions
- To familiar with large scale production of important products
- To understand the patent rights

Unit I – Industrially important microbes and their development

Screening methods for industrial microbes – detection and assay of fermentation products– classification of fermentation types – strain selection and improvement. Mutation and recombinant DNA techniques for strain development.

Unit II – Fermenter – types and function

Fermenters – Basic functions, design and components – asepsis and containment requirements – body construction and temperature control – aeration and agitation systems – sterilization of fermenter, air supply, and medium; aseptic inoculation methods– sampling methods, valve systems – a brief idea on monitoring and control devices and types of fermenters.

Unit III – Large scale fermentation

Fermentation media - Desired qualities - media formulation strategies – economic means of providing energy, carbon - nitrogen - vitamin and mineral sources - role of buffers,precursors, inhibitors, inducers and antifoams,effect of environment (temperature, pH, high nutrient concentration), types of fermentation. Sterilization, kinetics of thermal death of micro-organisms, batch and continuous sterilization.

Unit IV-Downstream processing

Objectives and criteria - foam separation - precipitation methods - filtration devices – chemical and electroflocculation and filter aids - industrial scale centrifugation and cell disruption methods - liquid-liquid extraction - solvent recovery – chromatography - two-phase aqueous extraction – supercritical fluid extraction - ultrafiltration, drying devices, crystallisation and whole broth processing.

Unit V – Industrial products and IPR

Commercial production of penicillin, ethanol, vinegar, vitamin B12, Protease from microbial sources. GATT and IPR, forms of IPR, IPR in India, WTO ACT, Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of Indian patents and , patenting of biological materials.

Text Books:

1. Stanbury P.F.A. Whitaker S.J. Hall, 1995 Principles of Fermentation Techniques 2 ed.
2. Patel A.H. (2006). Industrial Microbiology, Rajiv Beri for MacMillan India Lte., New Delhi
3. Casida,J.R(2009).Industrial Microbiology. New age international (P) Limited.
4. Sateesh M.K,(2008).Bioethics and Biosafety .I.K.International Publishing house Pvt .Ltd.
5. Kalaichelvan, P T. & Arul Pandi (2007) Bioprocess Technology . MJP Publishers, Chennai.

References:

1. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.
2. Glick, B.R. and Pasternak, J.J. (1998). Molecular Biotechnology, II Edition, ASM Press,New York.
3. Tortora, G.J., Fernke, B.R. and Case, C.L. (2001), Microbiology – An Introduction, Benjamin Cummings.
4. Prescott C., Dunn .G,(2002).Industrial Microbiology. Agrobios (India).

Core Course XIV (CC 14)
Practical III
Immunotechnology, Medical Microbiology, Molecular Biology & Genetic Engineering and Fermentation Technology

Immunotechnology

1. Collection of venous blood from human and separation and preservation of serum/plasma
2. Agar gel diffusion – Ouchterlony's method
3. Counter immuno electrophoresis
4. Electrophoresis – serum proteins
5. Blood grouping
6. Latex agglutination test – ASO, RF
7. Widal tube and slide agglutination technique
8. Enzyme Linked Immunosorbent Assay (ELISA)
9. Western blotting

Medical Microbiology

1. Collection and transport of clinical specimens for microbiological examinations
2. Isolation and identification of upper respiratory tract bacterial pathogen – *Streptococcus pyogens/ Klebsiella pneumoniae*
3. Isolation and identification of lower respiratory tract bacterial pathogen – *Pseudomonas aeuroginosa/ Klebsiella pneumonia/S. pneumonia.*
4. Isolation and identification of gastrointestinal bacterial infection – *Salmonella / Shigella /Vibrio*
5. Isolation and identification of urinary tract infection (UTI) – *E. coli & Klebsiellapnemoniae*
6. Isolation and identification of bacteria from the cases Typhoid fever – *Salmonella typhi, S. paratyphi* A & B
7. Isolation of fungal skin pathogens – Trichophytons, Microsporum.Dermatophytes & *Candida*
8. Demonstration of intestinal parasites (trophozoites / cysts / ova) – Saline and iodine wet mount.

Molecular Biology & Genetic Engineering

1. Genomic DNA isolation
2. Plasmid DNA isolation
3. Restriction digestion
4. Transformation of plasmid DNA
5. PCR
6. RAPD Fingerprinting
7. Southern and Northern Blotting

Fermentation technology

1. Production, quantification and characterization of followings:
   i) Alcohol,
   ii) Citric acid,
   iii) Amylase,
   iv) Lipase,
   v) Protease

EC - 4 BIOSTATISTICS AND BIOINFORMATICS

Paper Code: P3RMBEC4 **Semester: III**

No. of Credits: 3 **No. of hours per week: 4**

Objectives:

- To develop skills of the students in the area of probability and statistics
- To know about the various reliability methods
- To learn the basic protocols in computer
- To provide basic idea of bioinformatics databases and application for the students
- To know the basic knowledge of genomics and proteomics

Unit I: Introduction to Bio statistics

Introduction to Bio statistics – Collection of data – Graphical representation, bar diagrams and Pie diagram: Measures of Central tendency: Arithmetic mean, median and mode. Measures of dispersion : Range, Mean Deviation and Standard deviation. Coefficient of Variation – Skewness and Kurtosis.

Unit II: Inferential statistics

Inferential statistics – Probability distributions – Poisson, Binomial and Normaldistributions – Hypothesis testing: Student – t test, Chi-square test, F – test. ANOVA: one way and two way classification – Correlation and Regression.

Unit I: Biology in the computer age

Computational Approaches to Biological questions. Basics of computers – servers,workstations, operating systems, Unix, Linux. World Wide Web. Search engines, findingscientific articles - Pubmed – public biological databases.

Unit II: Genomics

Sequence analysis – Sequencing genomes – sequence assembly – pairwise sequencecomparison - geneome on the web – annotating and analysing genome sequences.Genbank – sequence queries against biological databases – BLAST and FASTA–multifunctional tools for sequence analysis. Multiple sequence alignments, Phylogeneticalignment – profiles and motifs.

Unit III: Proteomics

Protein Databanks - Sequence Databanks- PIR, SWISPROT, TrEMBL, Structural Databases – PDB, SCOP, CATH, SSEP, CADB, Pfam and GDB-biochemical pathway databases-Predicting Proteinstructure and function from sequence – Determination of structure – feature detection – secondary structure prediction – predicting 3 D structure - protein modeling.

Text Books

1. AroraMatham (2004ed).Biostatistics.Himalaya Publication.
2. Jasra P.K. and Gur Deep raj – First edition (2000) Krishna PrakashamPvt.Ltd.
3. Bioinformatics (Sequence and genome analysis) (2002) 2nd edition by David W.Mount, CBS publication.UK.
4. Genomes by T.A.Brown 1stedition,Bios Scientific publication UK.
5. Gene Biotechnology (2nd Edition) byJoghand, S.N. Himalaya Publishing company, India.
6. Concepts of genetics by William Klug, MichealR.Cummings.Pearson Education, Delhi.

References:

1. Genome Mapping and Sequencing by Ian Dunham (Hardcover - Sep 1, 2003).
2. Brendan Wren (Editor), Nick Dorrell (2002) Functional Microbial Genomics (Volume33) (Methods in Microbiology), Academic Press, UK.
3. Sandy B. Primrose Richard M. Twyman (2005) Principles of Genome Analysis and Genomics, Blackwell Publishing, USA.
4. Roderic D. M. Page, Edward C. Holmes (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell publishing, USA.
5. Principles of Genome Analysis: A Guide to Mapping and Sequencing DNA from Different Organisms by S. B. Primrose (Paperback - Jan 1998)

EC – 5 NANOBIOTECHNOLOGY

Paper Code: P4RMBEC5 **Semester: IV**

No. of Credits: 3 **No. of hours per week: 6**

Unit I:

History – bionanotechnology – concept and future prospects – application in Life Sciences. Terminologies – nanotechnology, bionanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles.

Unit II:

Types of nanoparticles production – physical, chemical and biological. Microbial synthesis of nanoparticles– Silver, Gold. Characterization of nanoparticles – UV-Vis spectroscopy, Electron Microscopy – HRTEM, SEM, AFM, EDS, XRD.

Unit III:

Advantages of nanoparticles – drug targeting, protein detection, MRI, development of green chemistry – commercial viability of nanoparticles. Disadvantages – health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

Unit IV:

Extraction and purification of microbial enzymes Importance of enzyme purification, different sources of enzymes. Extracellular and intracellular enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using Temperature, salt, solvent, pH, etc.), liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods.

Unit V:

Production and Applications of microbial enzymes -Microbial enzymes in textile, leather, wood industries and detergents. Enzymes in clinical diagnostics. Immobilization of microbial enzymes Methods *viz.* adsorption, covalent bonding, entrapment & membrane confinement and their analytical, therapeutic & industrial applications. Properties of immobilized enzymes.

Text Books

1. Glick. B, R and Pasternak J. J (2001)Molecular biotechnology. ASM press,Washington.(Unit III)
2. Nanotechnology Fundamentals and applications I.K.International Publishing House Pvt.Ltd,Neu Delhi.(Unit I and III)
3. Wilson, K. and Walker (1995). Practical Biochemistry Principles and Techniques, Cambridge University (Unit II)
4. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication(Unit I to III).
5. Schmid et al (2006).Nanotechnology assessment and perspectives. Springer International.

Reference Books

1. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan &Claypool Publishers.
2. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systemsand Biopolymer-based Nanostructures. Horizon Scientific Press.
3. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects.CRC Press.
4. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.
5. Methods in Enzymology. Volume 22 - Enzyme purification and related techniques. Edited by William B. Jakoby. Academic Press, New York.
6. Biotechnology. Volume 7 A - Enzymes in Biotechnology. 1983 Edited by H. J. Rehm and G. Reed. Verlag Chemie. Hand Book of Enzyme Biotechnology by Wiseman.

EC – 6 MARINE MICROBIOLOGY

Paper Code: P4RMBEC6 **Semester: IV**
No. of Credits: 3 **No. of hours per week: 4**

Unit: I Marine Microbial disserts

Marine environment – benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop – marine microbial community – plankton, bacteria, fungi, protozoa.

Unit II: Marine Extremophiles

Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, asmophilic and barophilic, psychrophilic microorganisms – hyperthermophiles and halophiles – importance of extremophiles in biotechnology.

Unit III: Symbiotic microbes

Microbe-microbe interactions – Lichens, antagonistic interactions – amensalism, mycoparasitism – Animal-microbe interaction – Ectosymbiosis of Protozoa, Ruminant symbiosis – Plant-microbe interaction – *Rhizobium, Mycorrhizae, Anabaena* – sponge.

Unit IV: Marine Microbial Disease

Marine food borne pathogens & Water borne pathogens – *Aeromonas, Vibrio, Salmonella, Pseudomonas, Leptospira, Corneybacter, black band disease in corals.*

Unit V: Marine Microbial Biotechnology

Production and applications of marine microbial products – pigments – Astaxanthin, β carotene – enzyme – antibiotics – polysaccharide – sea food preservation methods.

References:

1. Prescott, L.M., Harley J.P. Klein (1999). Microbiology, WCB, Mc Grow Hill Publications
2. Raina M. Maier, Ian L. Pepper, Charles, P. Gerba (2006). Environmental Micrology, Academic press.
3. Jamesh W. Nybakker (2001). Marine Biology, Benjamin Cummings
4. Shimshon Belkin and Rita R. Colwell (2005). Ocean and Health: Pathogens in the marine environment. Springer.
5. Scheper, T. (2005). Advances in Biochemical Engineering/Biotechnology-Marine Biotechnology I. Springer
6. Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi

EC – 7 QUALITY CONTROL & IPR

Paper Code: P4RMBEC7 **Semester: IV**
No. of Credits: 3 **No. of hours per week: 4**

Unit I: Bioethics

Legalty, morality and ethics, the principles of bioethics, autonomy, human rights, beneficience, privacy justice equality .

Unit II: Biosafety

Concept and issues, rational and subjective perceptions of risks and benefits – relationship between risk hazard, exposure, and safe gaurds – biosafety concerns at the level of individuals, institutions, society, region, country and the world – Lab associated infections.

Unit III: Biosafety Assessment (BSA)

Biosafety assessment in biotechnology – biosafety during industrial production of GMOs – microbes, plants and animals. Planned introduction of genetically modified organisms and pharmaceutical products fromGMOs such as drug-vaccines – biomolecules. Biosafety guidelines in India.

Unit IV: Quality control

Quality control in food process technology – WHO standards – Quality control in dairy products, drugs and beverages – Quality control for potable water.

Unit V: IPR

GATT and IPR, forms of IPR, IPR in India, WTO Act, Convention on Biodiversity (CBD), Patent Co-operation Treaty (PCT), forms of patents and patentability, process of patenting, Indian and international agencies involved in IPR & patenting, Global scenario of patents and India's position, patenting of biological material, GLP, GMP.

Text books

1. Ignacimuthu. S (2009).Bioethics. Narosa Publishing house
2. Singh B. D (2006).Biotechnology.KalyaniPublication.
3. Shaleesha .A (2008).Bioethics. Wisdom Biotechnology
4. Sateesh M.K, (2008).Bioethics and Biosafety .I.K.International Publishing house (P) Ltd
5. Sathyanarayana, U (2008).Biotechnology.Books and allied (P) Ltd

References:

1. Frederic H. Erbisch, Karim M. Maredia (2004). Intellectual Property Rights in Agricultural Biotechnology, CABI Publisher.
2. Mittal D.P. (1999). Indian Patents Law. Taxmann Allied Services (p) Ltd.
3. Christian Lenk, Nils Hoppe, Roberto Andorno (2007). Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology, Ashgate Publisher (p) Ltd.
4. Felix Thiele, Richard E. Ashcroft (2005). Bioethics in a Small World. Springer.
5. John Bryant (2002) Bioethics for Scientists. John Wiley and Sons Publisher.

EC – 8 HERBAL MEDICINE

Paper Code: P4RMBEC8 **Semester: IV**

No. of Credits: 3 **No. of hours per week: 4**

Unit I: Terminologies

Terminologies- Definitions- Cassification of medicinal plants based on their effects with special reference to India. Economic value of herbs and herbal drugs, Diversity of Indian and World producingmedicinal plants, standardization and preservation of herbal drugs.

Unit II: Allergens

Allergens - types – sources - active principles - Chemical nature - cell modifiers – lecitins - mutagens, teratogens - Allergic reactions with examples. Drugs acting on brain and nervous system - Rheumatic arthritis - physcoactive drugs - Depressants, Stimulants, hallucinogens - sources, effects, basic mechanism of action

Unit III: Cardiovascular diseases

Cardiovascular diseases - blood pressure - cardiac drugs of plant origins - alkaloids, anticoagulants - basic mechanism. Pulmonary / respiratory disorders – asthma – bronchitis - common cold – allergy - Remedy from plants

Unit IV: Drugs for urinogenital disorders

Drugs for urinogenital disorders - roots of *Withania somnifera* - memory stimulants - *Centella asiatica* - Drugs for dissolving kidney stones- *Musa paradisica* (pseudostem) – Antiinflammatory drugs – *Cardiospermum*- Anticancer drugs – *Catharanthus roseus*

Unit V: Drug adulteration

Drug adulteration, identification and substitutions, identification, cultivation and micropropagation of herbals, biotechnological exploitation, Databases on herbals and herbal drugs.

Text Books

1. Kumar, N.C.(1993). An Introduction to Medical botany and Pharmacognosy. Emkay Publications, New Delhi
2. Rao, A.P.(1999).Herbs that Heal. Diamond Pocket Books (P) Ltd., New Delhi