

# **PDM UNIVERSITY**

## **Faculty of Life Sciences** **Department of Microbiology** **M.Sc. Microbiology**

**TWO YEAR FULL TIME PROGRAMME**



**PDM UNIVERSITY BAHADURGARH**  
**DELHI- NCR**



*Note: Syllabi applicable for students seeking admission in the M.Sc. Microbiology  
Course from the academic year 2018*

## Details of Course: M.Sc. Microbiology

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### Course Structure Credits (Theory + Practical)

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Core Courses (14 Papers)	14 x 04 = 56
Core Course Practicals	12 x 02 = 24
Dissertation (Experimental, Presentation and Viva-Voce)	01 x 16 = 16
PPT (Pre Placement Training)	0 x 0 = 00

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**Total Credits = 96**

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**M.Sc. Microbiology**  
**Department of Microbiology**  
**Faculty of Life Sciences, PDMU**

**PROGRAMME STRUCTURE**

Sem	Module Code	Module Type	Module Name	Marks			Credits
				Internal	External	Total	
<b>1<sup>st</sup> Sem</b>	MICR5101	Core I	Diversity of Prokaryotic and Eukaryotic Microbes	50	100	150	4
	MICR5102	Core I (P)	Diversity of Prokaryotic and Eukaryotic Microbes Lab	25	50	75	2
	MICR5103	Core II	Microbial Physiology and Metabolism	50	100	150	4
	MICR5104	Core II (P)	Microbial Physiology and Metabolism Lab	25	50	75	2
	MICR5105	Core III	Immunology	50	100	150	4
	MICR5106	Core III (P)	Immunology Lab	25	50	75	2
	MICR5107	Core IV	Virology	50	100	150	4
	MICR5108	Core IV (P)	Virology Lab	25	50	75	2
			<b>Total</b>	<b>300</b>	<b>600</b>	<b>900</b>	<b>24</b>
<b>2<sup>nd</sup> Sem</b>	MICR5109	Core V	Microbial Pathogenicity	50	100	150	4
	MICR5110	Core V (P)	Microbial Pathogenicity Lab	25	50	75	2
	MICR5111	Core VI	Environmental Microbiology	50	100	150	4
	MICR5112	Core VI (P)	Environmental Microbiology Lab	25	50	75	2
	MICR5113	Core VII	Plant - Pathogen Interaction	50	100	150	4
	MICR5114	Core VII (P)	Plant - Pathogen Interaction Lab	25	50	75	2
	MICR5115	Core VIII	Enzyme and Techniques in Biochemistry	50	100	150	4
	MICR5116	Core VIII (P)	Enzyme and Techniques in Biochemistry Lab	25	50	75	2
			<b>Total</b>	<b>300</b>	<b>600</b>	<b>900</b>	<b>24</b>
<b>3<sup>rd</sup> Sem</b>	MICR6101	Core IX	Molecular Biology	50	100	150	4
	MICR6102	Core IX (P)	Molecular Biology Lab	25	50	75	2
	MICR6103	Core X	Recombinant DNA Technology	50	100	150	4
	MICR6104	Core X (P)	Recombinant DNA Technology Lab	25	50	75	2
	MICR6105	Core XI	Microbial Genetics	50	100	150	4
	MICR6106	Core XI (P)	Microbial Genetics Lab	25	50	75	2
	MICR6107	Core XII	Industrial and Food Microbiology	50	100	150	4
	MICR6108	Core XII (P)	Industrial and Food Microbiology Lab	25	50	75	2
			<b>Total</b>	<b>300</b>	<b>600</b>	<b>900</b>	<b>24</b>
<b>4<sup>th</sup> Sem</b>	MICR6109	Core XIII	Introduction To Bioinformatics	50	100	150	4
	MICR6110	Core XIV	Medical Microbiology	50	100	150	4
	MICR6111	Core	*Dissertation (Experimental, Presentation and Viva-Voce)	400	400	800	16
			PPT (Pre Placement Training)				
			<b>Total</b>	<b>500</b>	<b>600</b>	<b>1100</b>	<b>24</b>
			<b>Grand Total after four semesters</b>	<b>1400</b>	<b>2400</b>	<b>3800</b>	<b>96</b>

\* Dissertation shall begin in Semester 3 (Part II)

# **SEMESTER SYSTEM COURSE DETAILS**

## **M.Sc. MICROBIOLOGY**

**DEPARTMENT OF MICROBIOLOGY  
FACULTY OF LIFE SCIENCES  
PDM UNIVERSITY, BAHADURGARH**

## MICR5101

### DIVERSITY OF PROKARYOTIC AND EUKARYOTIC MICROBES

(4 credits Theory + 2 credits Practical = 6 credits)

**Archaea:** Systematics, and occurrence, diversity, characteristic features, significance and potential applications (eg. biochips, methane generation, ultrafiltration membranes, production of PHB and PHA, desulphurization of coal and crude oil, bioleaching of metals, enzymes, compatible solutes and others) of different groups of archaeobacteria (Crenarchaeota, Euarchaeota, Korarchaeota, Nanoarchaeota).

**Bacteria:** Conventional and molecular systematics, and general discussion on the occurrence, diversity, characteristic features, significance and potential applications of various groups of bacteria according to Bergey's Manual of Systematic Bacteriology.

**Fungal Systematics and diversity:** Implications of molecular and biochemical methods including rDNA analysis, RFLP, RAPD and other fingerprinting techniques, fatty acids, polysaccharides and lipids and role of secondary metabolites in systematics.

**Fungal endophytes of tropical plants and their applications:** Endophytic fungi, colonization and adaptation of endophytes. Endophytes as latent pathogens and biocontrol agents.

**Mycorrhizal fungi:** Diversity of endo and ecto mycorrhizal fungi. Biology of arbuscular mycorrhizal fungi: signaling, penetration and colonization inside roots, culturing and benefits, recent advances in the field of mycorrhiza.

**Agriculturally important toxigenic fungi:** Biodiversity, Chemical and biological characterization of toxic metabolites, toxigenic fungi in sustainable agriculture with special emphasis on biopesticides.

**Secondary metabolites from fungi:** Terpenes, Non-ribosomal peptides, hydrophobins, peptaibols, indole alkaloids, detailed emphasis on polyketides.

**Genomics and Biodiversity of yeast:** Gene duplication leading to adaptation and biodiversity, functional evolution, diversity in central metabolism, case of aerobiosis/anaerobiosis, changes in regulatory circuits for adaptation to new environments and physiology.

**Antagonistic interactions in yeasts:** Mycocinogeny and diversity of mycogenic yeast strains, characteristics of mycocins, mode of action, genetic basis of mycocinogeny, important mycocins, applications of antagonistic yeasts.

**Biotechnological applications of yeasts:** Yeasts as producers of bioactive molecules such as pigments, lipids, organic acids and EPS, yeasts as probiotics, yeasts in bioremediation, yeasts in alcoholic fermentations.

**Algal diversity from morphology to molecules:** Importance of algae in production of algal pigments, biofuels, hydrogen production, important bioactive molecules, role of algae in sustainable environment.

## **STUDY MATERIALS:**

1. The Prokaryotes. A handbook on the biology of bacteria: ecophysiology, isolation, identification, applications. Volumes I-IV by Balows, A., Trüper, H. G., Dworkin, M., Harder, W., Schleifer, K. H. Springer-Verlag, New York; 1992
2. Bacterial Systematics, by Logan, A., Niall A. Logan, Wiley-blackwell; 1994
3. Principles of Microbiology by R.M. Atlas , Mosby publishers, St. Louis; 1995
4. Brock Biology of Microorganisms (12<sup>th</sup> edition) by Madigan and John M. Martinko, Paul V. Dunlap, David P. Clark Benjamin Cummings; 2008.
5. Microbiology : An Introduction by Gerard J Tortora, Berdell R Funke, Christine L Case Benjamin-Cummings Publishing Company ; 2008.
6. Fundamentals of the fungi by Elizabeth Moore, Fourth edition, Benjamin Cummings; Landecker; 1996.
7. Mycotechnology: Present status and future prospects. Edited by Mahendra Rai. I.K., International Publishing House Pvt. Ltd.; 2007.
8. The Yeast Handbook: Biodiversity and Ecophysiology of yeasts by Carlos A. Rosa and Gabor Peter. Springer- Verlag Berlin Heidelberg; 2006.
9. Algae: Anatomy, Biochemistry and Biotechnology by Laura Barsanti and Paolo Gualtieri. Taylor and Francis Group, LLC; 2006.

## MICR5103

### MICROBIAL PHYSIOLOGY AND METABOLISM

(4 credits Theory + 2 credits Practical = 6 credits)

**Growth and cell division:** Measurement of growth, growth physiology, cell division, growth yields, growth kinetics, steady state growth and continuous growth.

**Solute Transport:** Primary and Secondary transport: Introduction, Kinetics, ABC transporters, Phosphotransferase system, Drug export systems, amino acid transport.

**Central Metabolic Pathways and Regulation:** Glycolysis, PPP, ED pathway, Citric acid cycle: Branched TCA and Reverse TCA, glyoxylate cycle. Utilization of sugars other than glucose and complex polysaccharides .

**Nitrogen metabolism:** Metabolism of amino acids: Amino acid biosynthesis and utilisation, lysine and glutamine overproduction, stringent response, polyamine biosynthesis and regulation.

**Metabolism of lipids and hydrocarbons:** Lipid composition of microorganisms, biosynthesis and degradation of lipids, lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation.

**Metabolism of nucleotides:** Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

**Physiological Adaptations and Intercellular signaling:** Introduction to two-component system, regulatory systems during aerobic- anaerobic shifts: Arc, Fnr, Nar, FhlA regulon, response to phosphate supply: The Pho regulon Quorum sensing: A and C signalling system, sporulation in *Bacillus subtilis*, control of competence in *Bacillus subtilis*. Heat-Shock responses pH homeostasis, osmotic homeostasis.

### STUDY MATERIALS:

1. Biochemistry by Geoffrey L. Zubay. Fourth Edition, Addison-Wesley educational publishers Inc., 2008
2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox. Fifth Edition, W.H. Freeman and Company; 2008.
3. Microbial lipids edited by C. Ratledge and SG Wilkinson, second edition, Academic Press; 1988.
4. Microbial Physiology by Albert G. Moat and John W. Foster. Third edition, John Wiley and Sons; 2002
5. The Physiology and Biochemistry of Prokaryotes by David White. Second Edition, Oxford University Press; 2000.

## MICR5105

### IMMUNOLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

**Three fundamental concepts in immunology:** Specificity, discrimination of self from non-self and memory.

**Immune cell receptors:** Detailed structure and development of B cell (Ig) and T cell (TcR) receptors; Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); Markers of suppressor / regulatory cells - CD4<sup>+</sup> CD25<sup>+</sup> Foxp3<sup>+</sup> T<sub>reg</sub>, iNKT

**Genetic organization:** Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2). Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors. Peptide loading and expression of MHC-I and MHC-II molecules; Hybridoma technology and monoclonal antibodies, antibody engineering.

**Immune response and signaling:** Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, IL-6, IL-10, IL-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB.

**Tolerance and autoimmunity:** Central and peripheral tolerance, and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases.

**Immunological disorders and hypersensitivity:** Deficiencies / defects of T cells, B cells, complement and phagocytic cells; Comparative study of Type I-V hypersensitivities with examples.

**Transplantation and tumor immunology:** Alloreactive response; Graft rejection and GVHD; HLA-matching; Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors.

### STUDY MATERIALS:

1. Kuby Immunology by Kindt TJ, Goldsby RA, Osborne BA, Kuby J: 6<sup>th</sup> edition. New York. WH Freeman; 2006.
2. Cellular and Molecular Immunology by Abbas AK, Lichtman AH, Pillai S: Saunders Elsevier; 2007.
3. Immunobiology: The immune system in health and disease by Janeway CA, Travers P, Walport M, Shlomchik MJ: 6<sup>th</sup> edition. New York. Garland Science Publishing; 2005.
4. Medical Microbiology and Immunology by Levinson W, Jawetz E: Lange publication; 2001.
5. Fundamental Immunology by Paul WE: 4<sup>th</sup> edition. New York. Raven Press; 2000.
6. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11<sup>th</sup> edition. Blackwell Publishing/Oxford Univ. Press; 2006.



## MICR5107

### VIROLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

#### **Section A: Animal Viruses**

**Classification, Morphology and Chemistry of Viruses:** Virus evolution and classification, properties of viruses, virus structure

**Working with viruses:** Techniques for visualisation and enumeration of viral particles, measuring biological activity of viruses, assays for virus estimation and manipulation, characterization of viral products expressed in infected cells, Diagnostic virology, Physical and chemical manipulation of viruses.

**Virus replication Strategies:** Principal events involved in replication: Adsorption, penetration, uncoating nucleic acid and protein synthesis, intracellular trafficking, assembly, maturation and release, viral-host interaction, Host response to viral infection.

**Replication patterns of specific viruses:** Replicative strategies employed by animal DNA viruses. Replicative strategies employed by animal RNA viruses. Identification of virus prototypes associated with different virus replication schemes; Details on important viruses namely Herpesvirus, Poliovirus, Influenza virus, VSV, SV40 and Adeno Virus, Poxviruses, Hepatitis Viruses, coronaviruses, Retroviruses.

**Subviral pathogens:** HDV, Prions, Viroids

**Pathogenesis of viral infection:** Stages of infection, Patterns of some viral diseases-epidemiology, transmission, infection, symptoms, risk, transformation and oncogenesis, emerging viruses.

**Anti-viral strategies-prevention and control of viral diseases:** Host specific and nonspecific defense mechanisms involved in resistance to and recovery from virus infections. Role of interferon in viral infections. Contributions of various host defense mechanisms in viral infections; Viral Chemotherapy: Nucleoside analogs, reverse transcriptase inhibitors, protease inhibitors, History of vaccines especially smallpox and polio. New methods: subunit vaccines, anti-idiotypic and DNA vaccines.

#### **Section B: plant and microbial viruses**

**History and development of plant virology, cryptograms, and classification of plant viruses and viroids:** Brief history of virology highlighting the significant contributions of scientists to the development of plant virology; significance of plant virology and modern classification of plant viruses and viroids according to ICTV; and cryptograms of various plant viruses and virus groups

**Propagation, purification, characterization and identification and genomics of plant viruses:** General methods of propagation of plant viruses; purification of plant viruses using centrifugation, chromatography and electrophoresis techniques, their assay and comparison of the sensitivity of assay methods; methods employed in identification of plant viruses and structural and functional genomics

**Symptoms of plant virus diseases, transmission of plant viruses, viral and viroid diseases and their control:** General discussion on symptoms caused by viruses and viroids in diseased

economically important trees and agricultural crops, and their control including development of virus disease resistant transgenetics

**Microbial viruses:** Diversity, classification, characteristics and applications of bacteriophages, and general account on algal, fungal and protozoan viruses.

### **STUDY MATERIALS:**

1. Principles of Virology: Molecular Biology, Pathogenesis and Control of Animal Viruses by S.J. Flint, L.W. Enquist, V.R. Racaniello, and A.M. Skalka 2<sup>nd</sup> edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5<sup>th</sup> edition, Blackwell Publishing, 2005
3. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3<sup>rd</sup> edition, Blackwell Publishing, 2007.
4. Principles of Molecular Virology by Alan J. Cann, 3<sup>rd</sup> edition, Elsevier Academic Press, 2001.
5. Plant Virology by Roger Hull, 4<sup>th</sup> edition, Academic press, 2002.

**MICR5102, MICR5104, MICR5106, MICR5108**  
**PRACTICALS**  
**(Based on theory papers)**

1. Isolation of bacteria from various samples by enrichment techniques and their identification by conventional biochemical and molecular methods as well as by BIOLOG system
2. To evaluate antimicrobial chemical agents by log reduction method.
3. To identify and study the important taxa of algae and fungi.
4. Evaluation of bacterial growth in liquid media: Diauxic growth curve.
5. Enrichment and isolation of members of Rhodospirillaceae : Analysis of photopigments.
6. Induction of  $\beta$ -galactosidase in *E.coli*.
7. Sugar transport in yeast
8. Endospore formation in *Bacillus subtilis*: Requirements for germination and out growth of spores, correlation between sporulation and protease activity.
9. Study of dimorphism in yeast.
10. Physiology of microcyclic conidiation in fungi.
11. Study of physiological parameters of poly-hydroxyl alkanoates accumulation in bacteria.
12. Measurement of superoxide dismutase activity in bacteria under different physiological conditions.
15. Study of enzyme kinetics.
16. Protein purification using various column chromatography, SDS-PAGE and NATIVE PAGE analysis and pI determination.
17. Estimation of infectivity titre of a virus sample using Plaque assay.
18. Production of a purified virus stock and its quantitation.
19. Determination of size of a virus.
20. Detection of viral antibodies in given sample using agglutination assay.
21. Determination of specificity of anti-viral response by agglutination-inhibition assay.
22. Growth of animal cells in culture medium.
23. Determination of viral titre following infection of animal cells in culture.
24. Study of virus infected plant material.
25. To perform immunoelectrophoresis.
26. To perform radial immunodiffusion assay.
27. To perform rocket immunoelectrophoresis.

28. To stain a tissue by immunohistochemical reaction
29. To study quantitative precipitation assay
30. To perform dot-ELISA.
31. To perform latex agglutination test
32. To perform western blotting.
33. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

## MICR5109

### MICROBIAL PATHOGENICITY

(4 credits Theory + 2 credits Practical = 6 credits)

**Classical view of microbial pathogenicity:** Define pathogenicity and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD<sub>50</sub>, ID<sub>50</sub>, TCID<sub>50</sub>. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative / obligate intracellular pathogens.

**Molecular microbial pathogenicity:** Molecular Koch's postulates, multiplicity of virulence features, coordinated regulation of virulence genes, two component signal transduction systems and environmental regulation of virulence determinants, antigenic variation; clonal and panmictic nature of microbial pathogens, type 1-IV secretion systems, biofilms and quorum sensing.

**Emerging and re-emerging pathogens:** Illustrate emerging and re-emerging pathogens using *V. cholerae* O: 139, X-MDR *M. tuberculosis*, *Helicobacter pylori*, Enterohaemorrhagic *E. coli* (EHEC), *Cryptosporidium parvum*, Lyme disease, SARS virus, Bird flu, prions, AIDS, Dengue Hemorrhagic Fever, and *Chlamydiae*, opportunistic fungal pathogens. Mechanisms of emergence of new pathogens: microbial change and adaptation, horizontal gene transfer (HGT), pathogenicity islands (PAI), role of integrons.

**Molecular microbial epidemiology:** Objectives of microbial epidemiology. Biochemical and Immunological tools biotyping, serotyping, phage typing, FAME, Curie Point PyMS, protein profiling, multilocus enzyme electrophoresis (MLEE); Molecular typing: RFLP (ribotyping, IS based), RAPD, 16S-23S IGS, ARDRA, rep (REP, ERIC, BOX)-PCR, PFGE, AFLP, MLST, MVLST, VNTR, SNP, Microarray and whole genome sequence; GIS

**Environmental change and infectious diseases:** Global warming lead increase in vector-borne and water-borne infectious diseases; Impact of increasing urbanization, international travel and trade on infectious diseases.

**Antimicrobial resistance:** Recent concepts – Multidrug efflux pumps, extended spectrum  $\beta$ -lactamases (ESBL), X-MDR *M. tuberculosis*, Methicillin-resistant *S. aureus* (MRSA).

**Newer vaccines:** Recombinant vaccines, subunit vaccines, DNA vaccines, Vaccinia, BCG and HIV– vector based vaccines

**Rapid diagnostic principles:** Nucleic acid probes in diagnostic microbiology, nucleic acid amplification methods, Real-time PCR, diagnostic sequencing and mutation detection, molecular typing methods, array technology.

### STUDY MATERIALS:

1. Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL, Jawetz E, Adelberg EA . 23<sup>rd</sup> edition. Lange Publication. 2004.
2. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2<sup>nd</sup> edition. American Society for Microbiology Press. 2005.
3. Bacterial Pathogenesis: A molecular approach by Salyers AA and Whitt DD eds. American Society for Microbiology Press, Washington, DC USA. 2002.

4. Pathogenomics: Genome analysis of pathogenic microbes by Hacker J and Dorbindt U. ed. Wiley-VCH. 2006.
5. Molecular Microbiology: Diagnostic Principles and Practice by Persing DH, Tenover FC, Versalovic J, Tang Y, Unger ER, Relman DA, White TJ eds. American Society for Microbiology Press, 2004.
6. Infectious Disease Epidemiology: Theory and Practice by Nelson KE, Williams CM, Graham NMH eds. An Aspen Publication. 2001.

## MICR5111

### ENVIRONMENTAL MICROBIOLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

#### Section A

1. **Brief history and development of environmental microbiology:** History and development of microbial ecology highlighting significant contributions of microbiologists and emergence of environmental microbiology, and significant applications of microbes in solving environmental pollution problems
2. **Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment:** Understanding microbial diversity in the environment by culture-dependent approaches and their limitations, and by culture-independent molecular approaches (DNA heterogeneity by reannealing denatured environmental DNA, ARDRA, analysis of FAME profiles, measuring metabolic capabilities using BIOLOG microtitre plates, using DNA probes and PCR primers, G+C analysis, slot-blot hybridization of community DNA, and fluorescent *in situ* hybridization of intact cells)
3. **Microbial diversity in normal environments:** Diversity of microbes in terrestrial (agricultural and desert soils), aquatic (fresh water and marine), atmospheric (stratosphere) and animal (cattle, termites, pests such as cockroach and nematodes, and human being) and their potential applications
4. **Microbial diversity in extreme environments:** Occurrence, diversity, adaptations and potential applications of oligotrophs, thermophiles, psychrophiles, barophiles, organic solvent and radiation tolerants, metallophiles, acidophiles, alkaliphiles and halophiles
5. **Global warming:** The source and variety of gases which contribute to global warming, effects of global warming and remedial measures

#### Section B

6. **Lignin degradation:** Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production.
7. **Liquid waste management:** Treatment of sewage (Primary, Secondary and Tertiary treatments) and Treatment of Industrial effluents (distillery, textile, pulp and paper).
8. **Solid waste management:** Waste types & their possible usages, landfill development and composting.
9. **Bioremediation of environmental pollutants:** Petroleum hydrocarbons and pesticides.
10. **Microbes and mineral recovery:** Biobleaching of copper, gold and uranium.

## **STUDY MATERIALS:**

1. Microbial Ecology By Atlas R.M., Bartha R., Benjamin Cummings Publishing Co, Redwood City, CA., 1993.
2. Environmental Microbiology by A.H. Varnam & M.G. Evans, Manson Publishing Ltd., 2000.
3. Manual of Environmental Microbiology by Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
4. Environmental Microbiology by W.D. Grant & P.E. Long, Kluwer Academic Publishers, 1981.
5. Environmental Microbiology by R. Mitchel (2<sup>nd</sup> edition), Wiley-Blackwell, 2009.
6. Microbiology: An environmental Perspective by P. Edmonds, Macmillan, New York, 1978.
7. Environmental Microbiology by Raina Maier, Ian Pepper, & Charles Gerba, Academic Press, 2008.
8. Environmental Microbiology: Principles And Applications by Patrick K. Jjemba, Science Publishing Inc., 2004.
9. Encyclopedia of Microbiology, Six-Volume Set, 1-6 by Moselio Schaechter, Academic press, 2009.
10. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad and A. Singh, I.K. International, 2007.
11. Applied Bioremediation and Phytoremediation by A. Singh and O.P. ward, Springer, 2004.
12. Microbial and Enzymatic Degradation of Wood and Wood components, by K-E.L. Eriksson, R.A. Blanchettee and P. Ander, Springer, 1990.
13. Advances in Applied Bioremediation by A. Singh, R.C. Kuhad and O.P. Ward, Springer, 2009.



## MICR5113

### PLANT – PATHOGEN INTERACTION

(4 credits Theory + 2 credits Practical = 6 credits)

**Concepts and physiology of plant diseases:** What is a disease and what causes disease, pathogenesis, pathogenesis in relation to environment, effect of microbial infections on plant physiology, photosynthesis, respiration, transpiration, translocation.

**Biochemical basis of plant diseases:** Enzymes and toxins in plant diseases, phytoalexins.

**Some important plant diseases and their etiological studies:** Crown gall, symptoms of viral diseases and their control, diseases of some important cereals, vegetables and crops.

**Genetical basis of plant diseases:** Genetics of host-pathogen interactions, resistance genes, resistance mechanism in plants.

**Disease control:** Principles of plant disease control, physical and chemical methods of disease control, biocontrol, biocontrol agents - concepts and practices, fungal agents, *Trichoderma* as biocontrol agent, biocontrol agents – uses and practical constraints.

**Molecular approach:** Molecular diagnosis, transgenic approach for plant protection, futuristic vision of molecular diagnosis, applications and constraints.

**Disease forecasting:** History and important milestones in disease control, disease forecasting and its relevance in Indian farming.

### STUDY MATERIALS:

1. Plant pathology by George N. Agrios: 4<sup>th</sup> ed., Academic press, New York, 1969.
2. Plant pathology by R.S. Mehrotra: Tata McGraw –Hill publishing company limited. New Delhi.
3. Bacterial plant pathology, cell and molecular aspects by David C. Sigee, Cambridge University Press, 1993.
4. Molecular plant pathology by M. Dickinson: BIOS Scientific Publishers, London, 2003.
5. The essentials of Viruses, Vectors and Plant diseases by A.N. Basu & B.K. Giri: Wiley Eastern Limited, 1993.
6. Biocontrol of Plant Diseases (Vol. I) by K.G. Mukerji & K.L. Garg: CRC Press, Inc., Boca Raton, Florida, 1988.
7. Molecular Biology of Filamentous Fungi by U. Stahl & P. Tudzyski: VCH Verlagsgesellschaft mbH, D-6940 Weinheim (Federal Republic of Germany), 1992.

## MICR5115

### ENZYME AND TECHNIQUES IN BIOCHEMISTRY

(4 credits Theory + 2 credit Practical = 6 credits)

#### Enzymes

1. Enzymology- Introduction, General characteristics of enzymes, Activation energy, Coupled reactions, active site and its importance, Factors influencing catalytic efficiency.
2. Enzyme kinetics, Rapid Equilibrium, Henry-Nucgaekkus-Menten's equations, Steady State approach, significance of  $K_m$ , Haldane equation, Velocity vital Substrate concentration curves.
3. Methods of plotting enzyme kinetics data-Lineweaver-Burk, Hanes-Woolf, Woolf-Augustinsson-Hofstee, Eadsie-Scatchard; Advantages and disadvantages of the methods, Comparisons and applications; Integrated form of the Henry-Michaelis-Menten equation.
4. Equilibrium dialysis, Scatchard plot for equilibrium binding, Effect of pH on enzyme stability and activity, Effect of temperature on enzyme stability, Arrhenius equation.
5. Formation of E.S covalent intermediates, transient kinetics, flow techniques (continuous, stopped, quenched), Temp-Jump.
6. General mechanistic principles: Role of proximity effect, bound distortion, multistep catalysis, bi-functional catalysis and solvent effects.
7. Regulation of enzyme activity: Feedback inhibition, reversible covalent modification, irreversible covalent modification, allosteric concept, Aspartate transcarbamylase, ligand-protein interaction, scatchard plot, Hill plot, cooperativity index, Models for allostery (MWC, KNF), Half site reactivity.
8. Enzyme Inhibition, Models and types of inhibition.
9. Applied enzymology: Application of enzymes in analytical labs. (clinical and industrial), enzymes as industrial catalysts, Immobilized enzymes, enzyme electrodes, assay of enzyme activities for diagnostic purposes, abzymes, recent developments.

#### Techniques

1. X-ray Crystallography
2. Chemiluminescence & Phosphorescence
3. Hydrodynamic methods, Centrifugation Sedimentation, partial specific volume and diffusion co-efficient, Viscosity.
4. Protein purification & Chromatography: Gel filtration, ion-exchange, hydrophobic interaction chromatography, hydroxyapatite and affinity chromatography, FPLC HPLC.
5. Molecular spectroscopy, IR, ESR, FRET, Biomolecular fluorescence complementation assay.
6. Mass spectrometry.
7. Radioisotope and their use in biology, autoradiography, radioactive labeling of biological macromolecules.

## **STUDY MATERIALS:**

1. Enzyme Kinetics and Mechanism by P. F. Cook, W.W. Cleland. Garland Science Publishing, London, England and New York, USA, 2007.
2. Biocatalysts and Enzyme Technology by K. Buchholz, V. Kasche, U.T. Bornscheuer., Wiley-VCH, Weinheim, Germany, 2005.
3. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer Horwood Publishing House, Chichester, England, 2001.
4. Biochemical Calculations by Irwin Segel., John Wiley and Sons, California, USA, 2004.
5. Biocatalysis – Fundamentals and Applications by A.S. Bommarius, B.R. Riebel, Wiley-VCH, Weinheim, Germany, 2004.
6. Enzymology by P.C. Engel. – LABFAX, BIOS Scientific Publishers, Academic Press, San Diego, USA, 1996.
7. Enzyme Inhibitors by U. Brodbeck., Verlag Chemie, Weinheim, Germany, 1980.
8. Guide to Protein Purification by M. P. Deutcher., Academic Press, San Diego, USA, 1993.
9. Physical Biochemistry: Principles and Applications by David Sheehan., John Wiley and Sons Ltd, Chichester, England, 2009.
10. Crystallography Made Crystal Clear by Gale Rhodes., Academic Press, Burlington, USA, 2006.

## MICR5110, MICR5112, MICR5114, MICR5116

### Practicals

(Based on theory papers)

1. To study cultural characteristics of pathogenic bacteria on following selective/differential media: TCBS agar; Hektoen Enteric agar; XLD agar; Endo agar; *Salmonella-Shigella* agar; Deoxycholate citrate agar
2. To study pathogenicity of *Staphylococcus aureus* by coagulase test
3. To perform the rapid (P/A format) coliform test.
4. To study antimicrobial susceptibility testing using an octadisc.
5. To determine minimal inhibitory concentration (MIC) of an antibiotic using an E-test.
6. To perform sterility testing of a sample.
7. To study resident microflora of skin.
8. To study resident microflora of oral cavity.
9. To study cultural and microscopic characteristics of selected pathogenic fungi viz. *Microsporum* sp., *Candida albicans*, and *Aspergillus* sp.
10. To isolate fungi present in soil samples and calculate their relative abundance and frequency of occurrence
11. To determine microbial activities in the soil samples by estimating hydrolysis of FDA
12. To study the effect of moisture content and organic matter on microbial activity, by estimating hydrolysis of FDA
13. To determine microbial activity in the soil by measuring CO<sub>2</sub> evolution, and to study the effect of moisture content and organic matter on microbial activity
14. To determine the following enzyme activities in the soil sample: Amylase, Cellulase, Xylanase, Protease, and Phosphatase
15. Laboratory methods for studying soilborne diseases
  - a. Isolation of soilborne pathogens from plant tissue and soil.
  - b. Physical extraction of pathogens from soil.
  - c. Molecular methods for detection and identification of pathogens in plants and soil. By monoclonal antibody based tests and PCR.
  - d. Quantification of population of pathogens in soil and estimation of inoculum potential by MPN and DILUTION END POINT methods.
  - e. Chemical control of soilborne pathogens using Acylanilide and Alkyl phosphonates.
16. Bacterial diseases of food plants.
  - a. Isolation of bacteria from vegetables and fruits.
  - b. Biochemical and physiological tests for detection of pathogens in fruits and vegetables, eg; Arginine hydrolysis for *Pseudomonas*.
  - c. Effects of processing methods in vegetables;
    - i. Bacterial counts in blanched vegetables.

- ii. Bacterial counts in unblanched vegetables.
  - iii. Bacterial counts in frozen vegetables.
17. To study the production of lignocellulolytic enzymes (cellulases, hemicellulases and lignin degrading enzymes such as Lip, Mnp and Laccase).
  18. To study the fungal degradation of lignocellulosic biomass (Crop byproducts).
  19. To study the application of lignocellulolytic enzymes in bleaching of paper pulp.
  20. To study the use of cellulases in saacharification of cellulosic material.
  21. To study the microbiological quality of water samples from different sources.
  22. To study the decolorization of distillery or textile industrial waste.
  23. To study microbial degradation of hydrocarbon(s) or pesticides(s).

## MICR6101

### MOLECULAR BIOLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

**The nature of Genetic material:** The structure of DNA and RNA; Melting of DNA, Superhelicity, Organization of Microbial Genomes, Organization of Eukaryotic Genomes, Chromatin arrangement, nucleosome formation.

**DNA replication:** Arrangement of replicons in a genome, Various modes of replication, continuous, discontinuous synthesis, various replication Enzymes, Replication Fork and priming, leading and lagging strand, elongation, termination, specific features of replication in Prokaryotes and Eukaryotes, action of topoisomerases, Telomere maintenance and Chromatin Assembly, Single stranded DNA replication, Relationship between DNA replication and cell cycle, DNA copy number maintenance.

**Recombination and Repair of DNA:** DNA repair and recombination, DNA Mismatch Repair, Double Strand Break Repair, Recombination as a molecular biology tool.

**Transcription:** Transcription machinery of prokaryotes, various transcription enzymes and cofactors, initiation, elongation and termination, sigma factors, Transcription machinery of eukaryotes, various forms of RNA polymerase and cofactors, initiation, elongation and termination, promoters, enhancers, silencers, activators, effect of chromatin structure, regulation of transcription.

**Post-transcriptional processes:** RNA processing, splicing, capping and polyadenylation, rRNA and tRNA processing, RNA Editing; RNAi and miRNAs, Antisense RNA, Post-transcriptional gene regulation.

**Translation:** The genetic code and protein structure, Mechanisms of translation in prokaryotes, Mechanisms of translation in eukaryotes, initiation complex, ribosomes & tRNA, factors, elongation and termination, *in vitro* translation systems, polycistronic/ monocistronic synthesis, Regulation of translation, RNA instability, inhibitors of translation, stringent response in bacteria.

**Post-translational processes:** Protein modification, folding, chaperones, transportation; The Signal Hypothesis, protein degradation.

**Molecular basis of cell physiology:** Signals and cascades in organism development, Molecular mechanisms of dormancy, persistence and drug tolerance and drug resistance Molecular mechanisms of Oncogenesis and cancer, genetic disorders, aging, mitochondrial inheritance. Approaches for treatment of same Genetically modified organisms. Use in basic and applied research. Implications of genome organization, Genes and behavior, Genome analysis, DNA typing, Genomics and beyond.

### STUDY MATERIALS:

1. Gene IX by Benjamin Lewin, Jones and Bartlett Publishers, Sudbury, Massachusetts, 2007.
2. Molecular Biology by R.F. Weaver , 4<sup>th</sup> edition, McGraw Hill. New York. USA, 2007.
3. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levin, R. Losick, 6<sup>th</sup> edition, Benjamin Cummings, San Francisco, USA, 2007.

4. Molecular Biology of the Cell by B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter, 5<sup>th</sup> edition, Garland Science, New York and London, 2007.
5. Biochemistry (5<sup>th</sup> edition) by J.M. Berg, J.L. Tymoczko, L. Stryer, W.H. Freeman and Company, New York, USA, 2008.
6. Current Protocols in Molecular Biology Edited by: Fred M. Ausubel; Roger Brent; Robert E. Kingston; David D. Moore; John A. Smith; Kevin Struhl, John Wiley and Sons, Inc. 2007

## MICR6103

### RECOMBINANT DNA TECHNOLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

**Basics of DNA cloning:** Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, P1 phage, PACs, BACs and YACs. Selection and screening of clones.

**Methods of DNA and protein analysis:** Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. Isolation and purification of DNA. RFLP analysis. DNA fingerprinting and its application in forensics, in disease diagnosis and in identification of strains. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Western Blotting analysis.

**Polymerase Chain Reaction:** Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PRC, Vectors PCR, RT-PCR, 5' and 3' RACE, qPCR, Real Time PCR using SYBR Green, Scorpion primers and TaqMan probes, MOPAC, Multiplex PCR, Differential Display PCR, RAPD fingerprinting of micro-organisms, Ligation Chain Reaction, Overlap PCR, Rolling Circle Amplification Technology.

**Construction of cDNA and genomic DNA libraries:** Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries. Screening libraries by colony hybridization and colony PCR. Screening expression libraries. Enriching for clones in cDNA libraries by positive selection and subtractive hybridization. Identifying genes in complex genomes by direct selection of cDNA and exon trapping.

**Genome sequencing:** DNA sequencing by Sanger's method – traditional and cycle sequencing. Physical mapping by restriction fragment fingerprinting of BAC clones and STS mapping. E-PCR. Whole genome shotgun sequencing. Clone-by-clone shotgun sequencing of genome – preparation of BAC/YAC library, map construction, clone selection, subclone library construction, random shotgun phase, finishing phase and sequence authentication. Genome annotation at the nucleotide level, protein level and process level. Comparative genome sequencing of micro-organisms to identify and categorize SNPs. Array CGH.

**Transcriptional analysis of gene expression and transcriptomics:** Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Promoter analysis – deletion analysis and linker scanning analysis coupled to reporter assays, mapping transcriptional start sites by S1 nuclease mapping, primer extension studies or 5' RACE. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE).

**Overexpression of recombinant proteins:** Overexpression and tagging of recombinant proteins in *E.coli*, driven by lac, T7 and Tet-regulatable promoters, Expression in *B. subtilis*. Overexpression systems in *S.cerevisiae*, *P.pastoris*, *S.pombe* and *K.lactis*. Baculovirus overexpression system. Mammalian cell overexpression system.

**Analysis of protein-DNA and protein-protein interactions:** Gel retardation assay, DNA footprinting by DNase I and chemical methods, yeast one-hybrid assay, ChIP- chips. Yeast two



hybrids, three-hybrids, split hybrids and reverse hybrids. Co-immunoprecipitations, pull-downs and Far-Westerns. GFP and FRET. Phage display.

**Protein engineering and proteome analysis:** Insertional and deletion mutagenesis. Site directed mutagenesis by conventional and PCR-based methods. Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. Protein arrays and their applications.

**Pharmaceutical products of DNA technology:** Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines.

**Transgenics and animal cloning:** Creating transgenic animals and plants. Animal cloning.

### **STUDY MATERIALS:**

1. Molecular Biology by David P. Clarke, 1<sup>st</sup> edition; Elsevier Academic Press; 2005.
2. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3<sup>rd</sup> edition; CSHL press; 2001.
3. DNA Technology : The Awesome Skill by I. Edward Alcamo, 2<sup>nd</sup> edition; Hardcourt Academic Press; 2001.
4. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6<sup>th</sup> Edition; CSHL Press; 2007.

## MICR6105

### MICROBIAL GENETICS

(4 credits Theory + 2 credits Practical = 6 credits)

**Genetic analysis of bacteria:** Importance and uses of mutation analysis. Inheritance in bacteria, types of mutations, spontaneous and induced mutagenesis, isolating mutants, selecting mutants, mutant enrichment. Reversions versus suppression. Complementation tests, recombination tests and gene replacements. Cloning genes by complementation. Cloning genes by marker rescue.

**Gene transfer and mapping by conjugation:** Basis of fertility in bacteria. Self-transmissible and mobilizable plasmids. Molecular mechanism of gene transfer by conjugation – genes and proteins involved. Regulation of gene transfer by conjugation. Hfr strains. Mapping bacterial genomes using Hfr strains. Chromosomal DNA transfer by plasmids – by integrated plasmids, by chromosome mobilization and by creation of prime factors. Transfer systems in gram positive bacteria. Ti plasmid transfer system and its application in creating transgenics.

**Lytic bacteriophages:** Lytic development cycle using phages T4 and T7 as models. Regulation of expression of genes in phage T4 – transcriptional activators, antitermination, a new sigma factor and replication-coupled transcription. Regulation of gene expression in phage T7 – a phage-encoded RNA polymerase. Replication of T4 versus T7 phages – recent advances. Replication and packaging of filamentous phages M13 and f1 – recent advances. Genetic analysis of phages – complementation and recombination tests with phages. Genetic experiments with the rII genes of phage T4. Deciphering the genetic code using rII mutants. Constructing phage genetic linkage maps using two-factor and three factor crosses.

**Gene transfer by transformation and transduction:** Natural transformation and competence. Molecular basis of natural transformation – DNA uptake competence systems in gram positive and gram negative bacteria. Regulation of competence in *B.subtilis*. Importance of natural transformation. Artificially induced competence. Generalized versus specialized transduction - T4 and lambda phage. Mapping bacterial genes by transduction.

**Lysogenic phages:** Lambda phage – gene and promoter organization. Lambda lytic cycle – regulation of gene expression – very early, early and late genes. Establishment and maintenance of lysogeny. Regulation of gene expression in lysogenic phase - role of cI, cII and cIII proteins. Lambda immunity region and immunity to superinfection. Events leading to induction – role of cI and cro repressors in regulating the events. Other lysogenic phages – P2 and P4. Lysogenic phages and bacterial pathogenesis.

**Transposons:** Discovery of transposition. Classes of bacterial transposons. Regulation of transposition activity. Effects of transposition in bacteria. Genetic requirements for transposition. Assays to analyze transposition events – suicide vectors and mating out assays. Molecular mechanisms of transposition – genetic evidence supporting the mechanisms. Conjugative transposons. Transposon mutagenesis. Cloning out genes by transposon mutagenesis. Mu transposon, Mud transposons and gene fusions, mini-Mu elements and their use in *in vivo* cloning. Yeast Ty-1 transposon. Site-specific recombination – *loxP*-Cre system, phase variation system in *Salmonella*.

**Gene regulation:** Control of gene expression. Positive gene regulation, negative gene regulation and attenuation, using the *lac*, *gal*, *trp*, *ara* and *tol* operons, with emphasis on recent advances.

**STUDY MATERIALS:**

1. Molecular Genetics of Bacteria by Larry Snyder and Wendy Champness, 3<sup>rd</sup> edition; ASM press; 2007.
2. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempy, 1<sup>st</sup> edition; Blackwell Science Publishers; 2004.
3. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2<sup>nd</sup> edition; Wiley Publishers; 2002.
4. Microbial Genetics by Stanly R. Maloy, John E. Cronan, Jr. & David Freifelder, 2<sup>nd</sup> edition; Narosa Publishing House; 1987.

## MICR6107

### INDUSTRIAL AND FOOD MICROBIOLOGY

(4 credits Theory + 2 credits Practical = 6 credits)

#### Section A

**Introduction to industrial microbiology:** Sources of industrially important microbes, strain development, types of fermentation and fermenters, process optimization, and recent developments in fermentation technology.

**Downstream processing of microbial products:** Filtration, centrifugation, cell disruption, liquid-liquid extraction, chromatography, membrane processes, drying (lyophilization and spray drying), and crystallization

**Fermentation economics:** Basic objective for successful economically viable fermentation process, cost break down for well established fermentation processes, market potential of the products, cost aspects of various stages in the processes development including effluent treatment

**Production aspects:** Microbial strains, substrates, strain improvement, flow diagrams, product optimization, and applications of industrial alcohol (ethanol and butanol), amino acids (lysine, phenylalanine, tryptophan), antibiotics (cephalosporins, tetracyclines, polyenes), enzymes and immobilized enzymes, SCP, microbial polyesters, biosurfactants, and recombinant products (insulin, somatostatin, thaumatin).

#### Section B

**Microbiology of foods:** Vegetables, fruits, milk, fermented and non-fermented milk products, fresh meats, poultry and non-dairy fermented foods.

**Microbial spoilage of foods**

**Food preservation:** Chemical, physical and biological methods.

**Fermentation processes:** Production of milk and milk products, plant based products, fish products, meat products and food beverages.

**Food-borne diseases**

#### **STUDY MATERIALS:**

1. Biotechnology: A Text Book of Industrial Microbiology by W. Crueger & A. Crueger, Panima Publishing Corporation, New Delhi/Bangalore, 2000.
2. Principles of Fermentation Technology by P.F. Stanbury, W. Whitaker & S.J. Hall, Aditya Books (P) Ltd., New Delhi, 1997.
3. Modern Industrial Microbiology & Biotechnology by N. Okafer, Scientific Publishers, Enfield, USA., 2007.
4. Fermentation Microbiology and Biotechnology by El Mansi & Bryce, Taylor & Francis, London, Philadelphia, 1999.
5. Fermentation Biotechnology by O.P. Ward, Open University Press, Milton Keynes, U.K., 1989

6. Industrial Microbiology: An Introduction by Waites, Morgan, Rockey & Highton, Blackwell Science, 2001.
7. Biochemical Engineering and Biotechnology by B. Atkinson & F. Mavituna , The Nature Press, 1982.
8. Microbial Biotechnology: Fundamentals of Applied Microbiology by Glazer & Nikaido , W.H. Freeman and Co., New York, 1995.
9. Modern Food Microbiology, 4th edition by J.M. Jay, Springer, 2006.
10. Fundamental Food Microbiology , 3<sup>rd</sup> edition by B. Ray., CRC press, 2006.
11. Food Microbiology: Fundamentals and Frontiers, 2<sup>nd</sup> edition by Michael P. Doyle, Larry R. Beuchat, Thomas J. Montville, ASM press, 2001.
12. Food Microbiology by M.R. Adams & M.O. Moss., Royal Society of Chemistry, 2000.
13. Food Microbiology by M.R. Adams, Royal Society of Chemistry, 2008.

## MICR6102, MICR6104, MICR6106, MICR6108

### PRACTICALS (Based on theory papers)

1. To determine the specific growth rate and generation time of a bacterium during submerged fermentations.
2. To compare glucoamy;ase production by parent and mutant of thermophilic fungus *Thermomucor indicae* under submerged and SSF conditions.
3. To grow yeast (*S. cerevisiae*) and fungus (*Rhizopus* sp.) in artificial medium and to calculate the yield and productivity of the biomass produced.
4. To make wine from different juices by fermentation.
5. To compare glucoamylase production of free and immobilized sporangiospores of *Thermomucor indicae*.
6. To study microbiology of vegetables, fruits, milk and milk products.
7. To test the quality of milk.
8. To demonstrate production of curd and cheese.
9. To study production of wine from grape juice.
10. Restriction digestion analysis by agarose gel electrophoresis.
11. Restriction digestion analysis by polyacrylamide gel electrophoresis.
12. Isolation of plasmid DNA from minicultures.
13. Isolation of plasmid from maxicultures.
14. Isolation of genomic DNA.
15. Cloning
16. Amplification of DNA by PCR
17. RAPD analysis
18. Overexpression of proteins and analysis by SDS-PAGE
19. Purification of recombinant protein
20. Western Blotting analysis
21. Preparation of competent cells and determination of transformation efficiency
22. Alpha-complementation
23. Phage titration
24. Bacterial transduction
25. Bacterial conjugation
26. Bacterial transposition

## MICR6109

### INTRODUCTION TO BIOINFORMATICS

(4 credits Theory)

**Introduction to computers and bioinformatics-** Types of operating systems, concepts of networking and remote login, basic fundamentals of working with unix.

**Biological databases-** Overview, modes of database search , mode of data storage (Flat file format, db-tables), flat-file formats of GenBank, EMBL, DDBJ, PDB.

**Sequence alignment** –Concept of local and global sequence alignment, Pairwise sequence alignment, scoring an alignment, substitution matrices, multiple sequence alignment.

**Phylogenetic analysis-** Basic concepts of phylogenetic analysis, rooted/uprooted trees, approaches for phylogenetic tree construction (UPGMA, Neighbour joining, Maximum parsimony, Maximum likelihood).

**Generation and analysis of high throughput sequence data-** Assembly pipeline for clustering of HTGS data, format of “.ace” file, quality assessment of genomic assemblies, International norms for sequence data quality, Clustering of EST sequences, concept of Unigene.

**Annotation procedures for high through-put sequence data-** Identification of various genomic elements (protein coding genes, repeat elements, strategies for annotation of whole genome, functional annotation of EST clusters, gene ontology (GO) consortium.

**Structure predictions for nucleic acids and proteins-** Approaches for the prediction of RNA secondary and tertiary predictions, energy minimization and base covariance models, Basic approaches for protein structure predictions, comparative modeling, fold recognition/“threading”and *ab-initio* prediction.

#### STUDY MATERIALS:

1. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and Ouellette, Third Edition. John Wiley and Son Inc., 2005.
2. Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004.
3. Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
4. Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

## MICR6110

### MEDICAL MICROBIOLOGY

(4 credits Theory)

**Unit-I Basics in Medical microbiology-** Infectious diseases overview. Medically important microbes. Microbial diseases - sources, route of transmission. Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. Immunity of microbial diseases.

**Unit-II Diagnosis of microbial diseases -** Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.

**Unit-III Bacteriology-** Characteristics, classification, pathogenesis, pathology, diagnosis, treatment, prevention and control of diseases caused by Staphylococci, Streptococci, Bacillus, Clostridium, Corynebacterium, Escherichia, Salmonella, Shigella, Klebsiella, Proteus, Vibrio, Pseudomonas, Mycobacteria, Spirochaetes, Rickettsia.

**Unit-IV Virology -** Structure, multiplication, classification and medical importance of DNA viruses - Pox, Herpes, Hepatitis, Adeno; RNA viruses - Picorna, Orthomyxo, Paramyxo, Rabdo and HIV virus. Viral vaccines and antiviral agents.

**Mycology -** Human mycotic infections caused by Dermatophytes, Histoplasma, Cryptococcus, Candida, opportunistic mycoses. Mycotoxins.

**Parasitology -** Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory techniques in parasitology.

### STUDY MATERIAL

1. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd 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. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.
4. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition. Blackwell Scientific Publication, Oxford.
5. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7th edition. Edward Arnold. A division of Hodder and Stoughton.
6. Ronald M. Atlas. (1989) Microbiology. Fundamentals and Applications. II edition, Maxwell Macmillan international editions.
7. Topley & Wilson's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.



## **MICR6111**

### **DISSERTATION**

Dissertation will start in semester 3 (Part II) and will continue in semester 4 (Part II). It will be evaluated at the end of 4<sup>th</sup> semester for 400 marks as follows

Continuous evaluation (IA)	= 200 marks
Experimental work and Dissertation	= 200 marks
Presentation and viva-voce	= 400 marks
Total marks	= 800 marks