

Syllabus and Scheme of Examination for M.Sc. Microbiology

TWO-YEAR FULL TIME PROGRAMME



*Note: Syllabi applicable for students seeking admission in the M.Sc. Microbiology
Course from the academic year 2009-2010*

**DEPARTMENT OF MICROBIOLOGY
FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES
UNIVERSITY OF DELHI SOUTH CAMPUS
NEW DELHI – 110021**

MASTER OF SCIENCE IN MICROBIOLOGY

TWO-YEAR FULL TIME PROGRAMME

The **M.Sc. Microbiology Programme** is of two years duration and is divided into **two parts**, Part I and Part II. Each part has **two Semesters**.

Semester one will have **four theory papers of 100 marks each** and **one practical** paper based on theory papers of **200 marks**. Semester two also has **four theory papers of 100 marks each** including one **Interdisciplinary paper** and **one practical paper of 200 marks**. Semester three has **four theory papers of 100 marks each** and **one practical paper of 200 marks**. Semester **four** has only one **Interdisciplinary theory paper of 100 marks** and **dissertation**. There will be no practical in this Semester. **Dissertation for 500 marks** will start in the beginning of Semester three and will continue till the end of the Semester four. Dissertation will carry marks for continuous assessment, dissertation/thesis its presentation and viva-voce. This will be evaluated at the end of fourth Semester.

All theory, practicals and dissertation will have **30% marks reserved for Internal Assessment (IA)**. Each theory examination will be of **three hours** durations and **practical examination will be for (8+8 hours) spread on two days**.

Teaching time allotted to each paper shall be 4 period for theory and 3-4 period for practicals / per week.

The detailed syllabus for each paper is appended with a list of suggested readings which would be further supplemented with other books/papers and be modified as new material becomes available.

While the students will be asked to refer to older editions of books for some of the topics, the books generally prescribed would consist of the latest editions. To reflect the same, edition numbers have not been mentioned in the Suggested Readings.

MASTER OF SCIENCE IN MICROBIOLOGY

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AFFILIATION

The proposed Programme shall be governed by the Department of Microbiology, Faculty of Interdisciplinary and Applied Sciences, University of Delhi South Campus, New Delhi –110 021.

PROGRAMME STRUCTURE

Part-I	Semester-1		Total(Theory/ Internal Assessment)
	MICROB 0701	Diversity of Prokaryotic and Eukaryotic Microbes	100 (70/30)
	MICROB 0702	Microbial Physiology and Metabolism	100 (70/30)
	MICROB 0703	Virology	100 (70/30)
	MICROB 0704	Immunology	100 (70/30)
	MICROB 0705	Practical (Based on theory papers)	200(140/60)
			Total marks :600 Theory : 400 Practical : 200
	Semester-2		
	BIOCHEM 0801	Enzyme and Techniques in Biochemistry	100 (70/30)
	MICROB 0802	Environmental Microbiology	100 (70/30)
	MICROB 0803	Plant - Pathogen Interaction	100 (70/30)
	MICROB 0804	Microbial Pathogenicity	100 (70/30)
	MICROB 0805	Practical (Based on theory papers)	200 (140/60)
		Total marks for Part-I Examinations: 600+600=1200	Total marks: 600 Theory : 400 Practical : 200
Part-II	Semester-3		
	MICROB 0901	Molecular Biology	100 (70/30)
	MICROB 0902	Recombinant DNA Technology	100 (70/30)
	MICROB 0903	Microbial Genetics	100 (70/30)
	MICROB 0904	Industrial and Food Microbiology	100 (70/30)
	MICROB 0905	Practical (Based on theory papers)	200(140/60)
			Total marks: 600 Theory : 400 Practical : 200
	Semester-4		
	PMBB 0804	Introduction To Bioinformatics	100 (70/30)
	MICROB 1001	**Dissertation (Experimental, Presentation and Viva-Voce)	500
		Total marks for Part-II Examinations: 600+600=1200	Total marks: 600 Theory: 100 Dissertation : 500

* Grand total of marks after Semester 1, 2, 3 and 4 = 600+600+600+600 = 2400

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

SCHEME OF EXAMINATIONS

1. English shall be the medium of instructions and examination.
2. Examinations shall be conducted at the end of each Semester as per the Academic Calendar notified by the University of Delhi.
3. The system of evaluation shall be as follows:
 - 3.1 Each theory paper will carry 100 marks of which 30% marks shall be reserved for internal assessment based on classroom participation, seminar, term courses, tests, viva-voce and laboratory work and attendance. The weightage given to each of these components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course. Any student who fails to participate in classes, seminars, term courses, test, viva-voce, practical and laboratory work will be debarred from appearing in the end-semester examination in the specific course and no internal Assessment marks will be awarded. His/her Internal Assessment marks will be awarded as and when he/she attends regular classes in the courses in the next applicable semester. No special classes will be conducted for him/her during other semesters.
 - 3.2 Each practical based on theory paper will be of 200 marks of which 30% marks will be reserved for internal assessment. The duration of written examination for each paper shall be three hours and Practical examination shall be for two days (8+8 hours) duration in total.
 - 3.3 As regards Project Work/Dissertation (MICROB 1001), the scheme of evaluation shall be as follows:
 - 3.3.1 Project Work/Dissertation shall begin from the Semester 3 (Part II) and will continue till Semester 4. It will be evaluated at the end of Semester 4.
 - 3.4.1 The candidate has to submit dissertation in a bound form at the end of semester 4. Total marks for dissertation shall be 500 and evaluation will be as follows:

Continuous evaluation (IA)	= 150 marks
Experimental work and Dissertation	= 150 marks
Presentation and viva-voce	= 200 marks
Total	= 500 marks
- 4 Examinations for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examination. Regular as well as Ex-Students shall be permitted to appear/reappear/improve in courses of odd semesters only at the end of odd semesters and for even semester with the even.

PASS PERCENTAGE

Students are required to pass separately both in theory and practical examinations. Minimum marks for passing the examination shall be 45% in aggregate in theory courses, 45% in practical courses and 45% marks in dissertation (if applicable) by scoring at least 40% in each theory paper.

PROMOTION CRITERIA

SEMESTER TO SEMESTER: Within the same Part, the candidate will be promoted from a Semester to the next Semester (Semester 1 to Semester 2 and Semester 3 to Semester 4), provided the candidate has passed at least two of the papers of the current semester by securing at least 40% marks in each paper.

- Note:**
1. A candidate who does not appear in a theory paper will be allowed **ONLY ONE** more attempt to pass the paper. No further attempts for improvement will be allowed.
 2. A candidate will not be allowed to reappear (even if he/she is absent) in the practical examination.

PART I TO PART II: Admission to Part II of the program shall be open to only those students who have fulfilled the following criteria:

1. have scored at least 45% marks in the practical papers of both Semester 1 and 2 taken together,
2. have passed at least 75% of the theory papers (6 papers) offered in courses of Part I comprising of Semester 1 and Semester 2 by securing at least 40% marks in each of these six papers and
3. have secured at least 45% in aggregate of all theory papers of Part I.

Note: 1. The candidate however will have to clear the remaining papers while studying in Part II of the programme.

AWARD OF DEGREE

A candidate will be awarded M.Sc. degree at the end of Semester 4 provided he/she has:

1. passed all the theory papers of Part I (Semester 1&2) and Part II (Semester 3&4) by securing at least 40% marks in each paper and has also obtained at least 45% in aggregate of Part I & Part II,
2. passed the practical examination by securing at least 45% in aggregate of Part I and Part II, separately and
3. passed dissertation (if applicable) by securing at least 45% marks.

Candidates who have fulfilled criteria 2 and 3 (wherever applicable) but not criteria 1:

1. Can reappear for theory papers as per University rules.
A candidate must pass the M.Sc. examination within span period.
2. No candidate shall be allowed to reappear for practical or dissertation.

SCOPE FOR IMPROVEMENT – As per University rules.

DIVISION CRITERIA

Successful candidates will be classified on the basis of the combined results of Part I and Part II examinations as follows:

Candidates securing 60% and above	:	1 st Division
Candidates securing 50% and above but less than 60%	:	2 nd Division
Candidates securing 45% and above but less than 50%	:	Pass

SPAN PERIOD

No student shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of **four years** from the date of admission to the Part I/Semester 1 of the M.Sc. program.

ATTENDANCE REQUIREMENT

No student shall be considered to have pursued a regular course of study and be eligible to take examination unless he/she has attended 75% of the total number of lectures, tutorials, seminars and practicals conducted in each semester, during his/her course of study. Under special circumstances, the Head of the Department may allow students with at least 65% attendance to take the examination.

SEMESTER SYSTEM COURSE DETAILS

M.Sc. MICROBIOLOGY



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FACULTY OF INTERDISCIPLINARY AND APPLIED SCIENCES
UNIVERSITY OF DELHI SOUTH CAMPUS
NEW DELHI-110021

UNIVERSITY OF DELHI SOUTH CAMPUS

M.Sc. Microbiology

Note: Each theory examination will be 3 hours duration and practical examination will be 8+8 hours duration for two days.

Part-I	Semester-1		Total(Theory/ Internal Assessment)
	MICROB 0701 MICROB 0702 MICROB 0703 MICROB 0704 MICROB 0705	Diversity of Prokaryotic and Eukaryotic Microbes Microbial Physiology and Metabolism Virology Immunology Practical (Based on theory papers)	100 (70/30) 100 (70/30) 100 (70/30) 100 (70/30) 200(140/60) Total marks :600 Theory : 400 Practical : 200
	Semester-2 BIOCHEM 0801 MICROB 0802 MICROB 0803 MICROB 0804 MICROB 0805	Enzyme and Techniques in Biochemistry Environmental Microbiology Plant - Pathogen Interaction Microbial Pathogenicity Practical (Based on theory papers) Total marks for Part-I Examinations: 600+600=1200	100 (70/30) 100 (70/30) 100 (70/30) 100 (70/30) 200(140/60) Total marks: 600 Theory : 400 Practical : 200
Part-II	Semester-3 MICROB 0901 MICROB 0902 MICROB 0903 MICROB 0904 MICROB 0905	Molecular Biology Recombinant DNA Technology Microbial Genetics Industrial and Food Microbiology Practical (Based on theory papers)	100 (70/30) 100 (70/30) 100 (70/30) 100 (70/30) 200(140/60) Total marks: 600 Theory : 400 Practical : 200
	Semester-4 PMBB 0804 MICROB 1001	Introduction To Bioinformatics **Dissertation (Experimental, Presentation and Viva-Voce) Total marks for Part-II Examinations: 600+600=1200	100 (70/30) 500 Total marks: 600 Theory: 100 Dissertation : 500

* Grand total of marks after Semester 1, 2, 3 and 4 = 600+600+600+600 = 2400

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

MICROB 0701

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 (12th 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.

MICROB 0702

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 signaling 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.

MICROB 0703

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 2nd edition, ASM Press, Washington, DC, 2004.
2. Introduction to Modern Virology EPZ by Nigel Dimmock, Andrew Easton and Keith Leppard, 5th edition, Blackwell Publishing, 2005
3. Basic Virology by Edward K. Wanger, Martinez Hewiett, David Bloom and David Camerini, 3rd edition, Blackwell Publishing, 2007.
4. Principles of Molecular Virology by Alan J. Cann, 3rd edition, Elsevier Academic Press, 2001.
5. Plant Virology by Roger Hull, 4th edition, Academic press, 2002.

MICROB 0704

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⁺ CD25⁺ Foxp3⁺ T_{reg}, 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: 6th 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: 6th 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: 4th edition. New York. Raven Press; 2000.
6. Roitt's Essential Immunology by Delves PJ, Martin SJ, Burton DR, Roitt IM; 11th edition. Blackwell Publishing/Oxford Univ. Press; 2006.

MICROB 0705
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 β -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.

BIOCHEM 0801

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.

MICROB 0802

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

Section A

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

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)

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

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

Global warming: The source and variety of gases which contribute to global warming, effects of global warming and remedial measures

Section B

Lignin degradation: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production.

Liquid waste management: Treatment of sewage (Primary, Secondary and Tertiary treatments) and Treatment of Industrial effluents (distillery, textile, pulp and paper).

Solid waste management: Waste types & their possible usages, landfill development and composting.

Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides.

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 (2nd 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.

MICROB 0803

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: 4th 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. Sigeo, 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.

MICROB 0804

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), LD₅₀, ID₅₀, TCID₅₀. 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 β -lactamases (ESBL), X-MDR *M. tuberculosis*, Methacillin-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 . 23rd edition. Lange Publication. 2004.
2. Cellular Microbiology by Cossart P, Boquet P, Normark S, Rappuoli R eds. 2nd 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.

MICROB 0805

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 CO₂ 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).

MICROB 0901

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 and 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 , 4th 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, 6th 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, 5th edition, Garland Science, New York and London, 2007.
5. Biochemistry (5th 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

MICROB 0902

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

MICROB 0903

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, 3rd edition; ASM press; 2007.
2. Fundamental Bacterial Genetics by Nancy Trun and Janine Trempey, 1st edition; Blackwell Science Publishers; 2004.
3. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002.
4. Microbial Genetics by Stanly R. Maloy, John E. Cronan, Jr. & David Freifelder, 2nd edition; Narosa Publishing House; 1987.

MICROB 0904

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, 3rd edition by B. Ray., CRC press, 2006.
11. Food Microbiology: Fundamentals and Frontiers, 2nd 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.

MICROB 0905

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

PMBB 0804

INTRODUCTION TO BIOINFORMATICS

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

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.

MICROB 0904

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 4th semester for 500 marks as follows:

Continuous evaluation (IA)	= 150 marks
Experimental work and Dissertation	= 150 marks
Presentation and viva-voce	= 200 marks
Total	= 500 marks

MASTER OF SCIENCE IN MICROBIOLOGY

TWO YEAR FULL TIME PROGRAMME

AFFILIATION

The proposed Programme shall be governed by the Department of Microbiology, Faculty of Interdisciplinary and Applied Sciences, University of Delhi South Campus, New Delhi –110 021.

PROGRAMME STRUCTURE

Part-I	Semester-1		Names of the Faculty
	MICROB 0701	Diversity of Prokaryotic and Eukaryotic Microbes	Prof. Rani Gupta, Prof. T. Satyanarayana
	MICROB 0702	Microbial Physiology and Metabolism	Prof. Rani Gupta, Prof. R.K. Saxena
	MICROB 0703	Virology	Prof. T. Satyanarayana Dr. Amita Gupta
	MICROB 0704	Immunology	Prof. J.S. Viridi
	MICROB 0705	Practical (Based on theory papers)	All the teachers of the department associated with the Semester teaching.
	Semester-2		
	BIOCHEM 0801	Enzyme and Techniques in Biochemistry	* Dr. Suman Kundu
	MICROB 0802	Environmental Microbiology	Prof. T. Satyanarayana Prof. R.C. Kuhad
	MICROB 0803	Plant - Pathogen Interaction	Prof. R.K. Saxena
	MICROB 0804	Microbial Pathogenicity	Prof. J.S. Viridi
	MICROB 0805	Practical (Based on theory papers)	All the teachers of the department associated with the Semester and Prof. Rani Gupta

Part-II	Semester-3		
	MICROB 0901	Molecular Biology	Dr. Amita Gupta
	MICROB 0902	Recombinant DNA Technology	Dr. Swati Saha
	MICROB 0903	Microbial Genetics	Dr. Swati Saha
	MICROB 0904	Industrial and Food Microbiology	Prof. T. Satyanarayana Prof. R.C. Kuhad
	MICROB 0905	Practical (Based on theory papers)	All the teachers of the department associated with the Semester
	Semester-4		
	PMBB 0804	Introduction To Bioinformatics	** Dr. Saurabh Saran
	MICROB 1001	Dissertation (Experimental, Presentation and Viva-Voce)	All the teachers of the department

Teachers from outside the department: * Department of Biochemistry
 ** Department of Plant Molecular Biology and Biotechnology

Departmental UTA and CSIR/UGC, NET candidates will also be involved in practicals.

Head of the Department