MASTER OF SCIENCE

(MICROBIOLOGY)

2025

CENTRE FOR EXCELLENCE IN PHARMACEUTICAL SCIENCES

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

SECTOR-16C, DWARKA, NEW DELHI-110078

Semester-I	Semester-II	Semester-III	Semester-IV
MB-601: Introduction to Microbiology and Microbial Diversity ④	MB-602: Bacteriology and Virology ④	MB-701: Industrial Microbiology ④	MB-702*: Devel Entrepreneurial Mindset ②
MB-603: Microbial Physiology and Metabolism ④	MB-604: Mycology and Phycology ④	MB-703: Medical Microbiology④	MB-800: Project/Dissertatior
MB-605: Principles of Biochemistry ④	MB-606: Microbial Genomics, Proteomics + Metabolomics ④	MB-705: Food Microbiology④	
MB-607: Fundamentals of Immunology②	MB-608: Advanced Analytical Techniques ②	MB-707: Environmental Microbiology②	
MB-609: Fundamentals of Bioinformatics ②	MB-610: Genetic Engineering ②	MB-709: Fundamentals of Computer Aided Drug Design ②	
MB-651: Biochemistry and Immunology (LAB-I) ⑧	MB-652: Bacteriology and Virology LAB-I ⑧	MB-751: CADD (LAB-I) ④	
MB-653: Microbial Methods (LAB-II) ⑧	MB-654: Omics (LAB-II) ⑧	MB-753: Applied Microbiology (LAB-II)⑫	
		MB-799: Project/Dissertation ②	

**NUES: Non University Examinational Subject (Entitled for credit and not to be considered for the purpose of declaration of Result)*

o : Depicts Hours

Deepa Deswal Bagchal. Pawar

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Program Structure:

The Master of Science in Microbiology Course is a Two Year Full-Time Course consisting of four Semester, viz. Semester-I, Semester-II, Semester-III and Semester-IV.

First Year	Part-I	First Semester	Second Semester
Second Year	Part-II	Third Semester	Fourth Semester

Course Credit Scheme at a Glance:

First Semester

Course Code	Nomenclature of the Paper	M.M.	C.E.	E.E.	No. of Hours		Credits
					Th.	Pr.	
MB-601	Introduction to Microbiology	100	40	60	4	-	4
MB-603	Microbial Physiology and Metabolism	100	40	60	4	-	4
MB-605	Principles of Biochemistry	100	40	60	4	-	4
MB-607	Fundamentals of Immunology	100	40	60	2	-	2
MB-609	Fundamentals of Bioinformatics	100	40	60	2	-	2
MB-651	Biochemistry and Immunology (LAB-I)	100	40	60	-	8	4
MB-653	Microbial Methods (LAB-II)	100	40	60	-	8	4
		700			**16**	**16**	**24**

Second Semester

Course Code	Nomenclature of the Paper	M.M.	C.E.	E.E.	No. of Hours		Credits
					Th.	Pr.	
MB-602	Bacteriology and Virology	100	40	60	4	-	4
MB-604	Mycology and Phycology	100	40	60	4	-	4
MB-606	Microbial Genomics, Proteomics + Metabolomics	100	40	60	4	-	4
MB-608	Advanced Analytical Techniques	100	40	60	2	-	2
MB-610	Genetic Engineering	100	40	60	2	-	2
MB-652	Bacteriology and Virology (LAB-I)	100	40	60	-	8	4
MB-654	Omics (LAB-II)	100	40	60	-	8	4
		700			**16**	**16**	**24**

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Third Semester

Course Code	Nomenclature of the Paper	M.M.	C.E.	E.E.	No. of Hours		Credits
					Th.	Pr.	
MB-701	Industrial Microbiology	100	60	40	4	-	4
MB-703	Medical Microbiology	100	60	40	4	-	4
MB-705	Food Microbiology	100	60	40	4	-	4
MB-707	Environmental Microbiology	100	60	40	2	-	2
MB-709	Fundamentals of Computer Aided Drug Design	100	60	40	2	-	2
MB-751	CADD (LAB-I)	100	60	40	-	4	2
MB-753	Applied Microbiology (LAB-II)	100	60	40	-	12	6
MB-753#					-	2	1
		800			**16**	**18**	**25**

#To be evaluated at the end of the fourth semester

Fourth Semester

Course Code	Nomenclature of the Paper	M.M.	C.E.	E.E.	No. of Hours		Credits
					Th.	Pr.	
MB-702*	Developing Entrepreneurial Mindset	100			2	-	2
MB-800	Project/Dissertation	100		100		16	8
		500			**2**	**16**	**10**

*** NUES: (Entitled for credit and not to be considered for the purpose of declaration of Result)**

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Annexure-A

Scheme for awarding internal assessment: continuous mode

	Theory (4 Credits/2 Credits)
Criteria	**Maximum Marks**
Continuous Evaluation	15
Mid-Term	25
Total	**40**
Practical	**Practical (4 Credits/2 Credits)**
Based on Practical Records, Regular viva voce, etc.	40
Total	**40**

(Objective Learning involves Multiple Choice Test, Matching Test, True / False Test Correct / Incorrect Test, Recall Test, Best Answer Test, Completion Test etc.)

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Grading System

After adding the teaching continuous evaluation marks to the term end examinations marks, the marks secured by a student from maximum 100 shall be converted into a letter grade. The grade points are the numerical equivalent of letter grade assigned to a student in the points scale as given below:

Percentage of marks obtained	Grade	Grade Point
90-100	O	10
75-89	A+	9
65-74	A	8
55-64	B+	7
50-54	B	6
Less than 50 or absent	F	0

Grade B (grade point 6) shall be the course passing grade unless specified otherwise by the Syllabi and Scheme of Teaching and Examination for the programme. For grade(s) below the passing grade as defined in the Syllabi and Scheme of Teaching and Examination, the associated grade points shall be zero. Both acquired marks and grades shall be reflected on the term and marksheets.

Calculation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

1. Performance in a semester will be expressed as Semester will be expressed as Semester Grade Point Average (SGPA) and shall be rounded to two decimal digits.
2. Cumulative performance of all the semesters together will reflect performance in the whole programme and it will be known as Cumulative Grade Point Average (CGPA), and shall be rounded to two decimal digits.
3. The formula for calculation for SGPA and CGPA is given below:

$$\boldsymbol{SGPA} = \frac{\sum_i CiGi}{\sum_I Ci}$$

$$\boldsymbol{CGPA} = \frac{\sum_n \sum_i CniGni}{\sum_n \sum_i Cni}$$

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Deepa Bansal

$$\boldsymbol{CGPA} = \frac{\sum_n \sum_i CniGni}{\sum_n \sum_i Cni}$$

Where;

Ci– number of credits for the i^{th} course.

Gi – grade point obtained in the i^{th} course.

Cni – number of credits of the i^{th} course of the nth semester.

Mni – marks of the i^{th} course of the nth semester.

Gni – grade points of the i^{th} course of the nth semester.

4. The successful candidates as per clause 11.6 and having an overall CGPA higher than or equal to the minimum CGPA specified in the Syllabi and Scheme of Teaching and Examination for the award of the degree, shall be awarded the degree and shall be placed in Divisions as below:

- **CGPA of 4.00 – 4.99** shall be placed in the Third Division.
- **CGPA of 5.00 – 6.49** shall be placed in the Second Division.
- **CGPA of 6.50 or above** shall be placed in the First Division.
- **CGPA of 10** shall be placed in the Exemplary Performance. Exemplary Performance shall be awarded, if and only if, every course of the programme offered to the student is passed in the first chance of appearing in the paper that is offered to the student. A student with an academic break shall not be awarded the exemplary performance.
- The CGPA x 10 shall be deemed equivalent to percentage of marks obtained by the student for the purpose of equivalence to percentage of marks.

Deepa Desmal

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Maximum Marks: 60 + 40

Course Code: MB-601

Credit: 4

Unit-I

History of Development of Microbiology

Development of microbiology as a discipline, spontaneous generation vs. biogenesis. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, germ theory of disease, development of various microbiological techniques and golden era of microbiology, development of the field of soil microbiology: contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit-II

Systems of classification Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's threekingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms.

General characteristics of different groups: Acellular microorganisms (Viruses,Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit-III

Preparation and sterilization of culture media using various techniques. Microbial growth: different phases of growth. Measurement of microbial growth. Effects of various environmental factors on microbial growth; Uptake of nutrients by microbial cells and their nutritional requirements. Control of microbial growth: physical control, chemical control and antibiotics. Isolation, culture, identification and preservation of bacteria. Gram positive and gramnegative organisms. Structure and functions of peptidoglycan in gram positive and gramnegative organisms. Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms. Special features of bacterial metabolism.

Unit-IV

Ecosystems, habitats, symbiosis, mutualism, parasitism, commensalism and antagonism. Microbial diversity in anoxic ecosystem – methanogens – reduction of carbon monoxide – reduction of iron, sulphur, manganese, nitrate and oxygen – microbes and mechanisms of metal reduction – bioleaching of ore metal corrosion. Microbial transformation of carbon, phosphorus, sulphur, nitrogen and mercury.

Extremophiles – acidophilic, alkalophilic thermophilic, barophilic and osmophilic microbes – mechanisms and adoption. Halophiles – membrane – variation – electron transport – application of thermophiles and extremophiles.

Suggested Readings:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
3. Cappucino J. and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Recommended Books:

1. Johri, B.N 2000. Extermophlies. Springer Veriag. New York
2. Colwd, D.1999. Microbial Diversity. Aademic Press
3. Introduction to Microbiology and Microbial Diversity Paperback – 2018 by by Dr. Prasanna V Dharani Aiyer (Author)

Deepa Deswal

MICROBIAL PHYSIOLOGY AND METABOLISM

Maximum Marks: 60 + 40

Course Code: MB-603 **Credit: 4**

Unit-I

Solute Transport: Introduction, primary and secondary transport, kinetics. membrane transport proteins: porins and aqua porins, mechanosensitive channels, ABC transporter, group translocation PEP-PTS system. Catabolite repression, inducer exclusion and expulsion.

Central Metabolic Pathways and Regulation: Glycolysis and its regulation, Gluconeogenesis, Pentose-Phosphate Pathway, Entner-Doudoroff Pathway, Citric Acid Cycle, alternate TCA, Glyoxylate Pathway and its regulation. Co-metabolism of pentoses and hexoses, Succinic and citric acid production.

Unit-II

Nitrogen metabolism: Inorganic nitrogen assimilation- nitrate and ammonia assimilation, regulation of glutamate synthetase, general reaction of amino acid and stickland reaction. Glutathione: distribution in bacteria, biosynthesis and role in redox regulation. Outline of amino acid biosynthesis, protein utilization, detailed account of biochemistry of glutamate producing strains.

Unit-III

Metabolism of lipids and nucleotides: Biosynthesis and degradation of lipids and its regulation in E. coli, lipid accumulation in yeast. Purine and pyrimidine biosynthesis, deoxyribonucleotide synthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide biosynthesis.

Unit-IV

Physiological Adaptation and Intracellular signaling: Introduction to two component system. Response to physiological stress: aerobic-anaerobic shifts- Arc and Fnr system, osmotic homeostasis. Response to nutritional stress: phosphate supply- Pho regulon, and stringent response.

Suggested Readings:

1. Biochemistry by Geoffrey L. Zubay. 4th Edition. Brown Co, USA. 1999.
2. Microbial Physiology by A.G. Moat, J. W. Foster, M. P. Spector. 3rd Edition. John Wiley & Sons. 2002
3. Lehninger Principles of Biochemistry by D. L. Nelson, M. M. Cox. 6th Edition. W. H. Freeman. 2012

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4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua. 4th Edition. Oxford University Press. 2011.
5. Microbial Biochemistry by G. N. Cohen. 2nd Edition. Springer. 2014.
6. Lippincott's Illustrated Reviews: Biochemistry edited by D. R. Ferrier. 6th Edition. Lippincott Williams & Wilkins. 2013
7. Biochemical Calculations: by Irwin H. Segel. 2nd Edition. Wiley. 2004.
8. Understanding Enzymes by T. Palmer, E.Horwood. 3rd Edition. Wiley. 1991.

Deepa Agrawal

PRINCIPLES OF BIOCHEMISTRY

Maximum Marks: 60 + 40

Course Code: MB-605 **Credit: 4**

Unit-I

Monosaccharides-structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers. Disaccharides: maltose, lactose and sucrose. Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides.

Unit-II

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes-phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols.

Unit-III

Amino acids and peptides- classification (essential and non-essential amino acids), chemical reactions and physical properties. Introduction to protein structure and function. Enzymes: classification, kinetics (significance of km, kcat and Vmax), inhibition.

Unit-IV

Nucleotides - structure and properties. Nucleic acid structure-Watson - Crick Model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. DNA replication, Transcription and Translation

Suggested Readings:

1. Nelson, DL and Cox, MM (2017) Lehninger: Principles of Biochemistry 7th ed., WH Freeman and Company (New York), ISBN: 978-1319108243.
2. Garrett RH and Grisham CM (2017) Biochemistry 6th ed., Brooks/Cole, ISBN: 9781305577206.
3. Rodwell VW, Bender DA, Botham KM, Kennelly, PJ and Weil PA (2018) Harper's Illustrated Biochemistry 7th ed., McGraw-Hill, ISBN: 9781259837937.
4. Ferrier, DR (2017) Lippincott's Illustrated Reviews Biochemistry 7th ed., Wolters Kluwer India Pvt. Ltd., ISBN: 978-9351297949.
5. Stryer L, Berg JM, Tymoczko JL, Gatto Jr. GJ (2019) Biochemistry 9th ed., W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9.

Deepa Bhargad

FUNDAMENTALS OF IMMUNOLOGY

Maximum Marks: 60 + 40

Course Code: MB-607 **Credit: 2**

Unit-I

Introduction and overview of the Immune System. Origin of Immunology and its evolution. Infection and immunity. Types of immunity- Innate and acquired, active and passive, humoral and cell mediated. Clonal selection theory. Organs and cells of the immune system: structure and function. Hematopoesis. Lymphocyte traffic. Antigens and immunogens. Adjuvants, Requirements for immunogenicity.

Unit-II

Structure and function of immunoglobulins. Antibody variants- isotypes, allotypes and idiotypes. Monoclonal antibodies. Hybridoma technology. Organization of immunoglobulin genes. Theories and genetic basis of antibody diversity. Antibody – antigen binding: affinity, avidity, cross reactivity. Antigen-antibody interactions; agglutination, hemagglutination. Precipitation reactions in solution and in gels. Immunoassays: Radioimmunoassay, ELISA, ELISPOT, immunoflourescent assays. Fluorescence activated cell sorting. Western blotting.

Unit-III

Major histocompatibility complex. MHC genes and Histocompatibility antigens. Role of MHC in T cell selection. Cytokines and their role in immune regulation. Complement system. Mechanism of its fixation; complement activation and its biological activities. Classical, alternative and lectin pathways; Regulation of complement.

Unit-IV

Immunological tolerance to self and to antigens; its induction and features. Immunosuppression-specific and non-specific. Allergy and hypersensitivity. Effector mechanisms and examples of each type of hypersensitivity. Transplantation immunology. Tumor immunology. Immuno deficiencies; primary and secondary. Autoimmunity: factors contributing to autoimmunity; examples and diagnosis. Immunization and Vaccines.

Suggested Readings:

1. Kuby Immunology by J.A. Owen, J. Punt, S.A. Stranford. 7th edition. WH Freeman. 2013.
2. Cellular and Molecular Immunology by A.K. Abbas, A.H. Lichtman, S. Pillai. 9th edition. Saunders Elsevier. 2018.
3. Janeway's Immunobiology by K. Murphy, W. Casey. 9th edition. Garland Science Publishing. 2017.

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4. Review of Medical Microbiology and Immunology by W. Levinson. 15th edition. Lange Publication. 2018.
5. Fundamental Immunology by W.E. Paul. 7th edition. Lippincott Williams and Wilkins. 2013.
6. Roitt's Essential Immunology by P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt. 13th edition. Blackwell Publishing. 2017.

FUNDAMENTALS OF BIOINFORMATICS

Course Code: MB-609

Maximum Marks: 60 + 40
Credit: 2

Unit-I

Introductory Concepts: Bioinformatics and Applications of Bioinformatics in Various Areas, **Biological Databases**: Protein Sequence and Structural Databases, Nucleotide Sequence Databases;

Methods of Sequence Analysis: Pairwise sequence alignment methods; Heuristic Methods; BLAST and its variants, Statistics of Sequence Alignment Score; E-Value, P-Value, Scoring matrix, PAM, BLOSUM and Gap Penalty; Multiple Sequence Alignments; ClustalW, Hidden Markov Models, HMM Based Multiple-Sequence Alignment. Introduction to Phylogenetic Analysis

Unit-II

Computational Molecular Modeling: Molecular Mechanics (MM), Force Field, Energy minimization, Geometry optimization methods.

Structure Based Drug Design: Introduction, Molecular interactions; Molecular Docking.

Protein Structure Prediction and Biologics: Introduction: Homology modeling, Threading method; Introduction to Quantitative Structure Activity Relationship (QSAR). Introduction to Molecular Dynamics; Ensembles: Canonical and micro-canonical ensemble.

Suggested Readings:

1. Bioinformatics Sequence and Genome Analysis, David. W. Mount, Cold spring Harbor Lab. NY.USA, 2001.
2. Molecular Modelling: Principles and applications (2nd Edition), Leech Andrew, Prentice Hall, 2001.
3. Computational Medicinal Chemistry for Drug Discovery, Patrick Bultinck, Marcel Dekker Inc., 2000.
4. Essential Bioinformatics, Jin Xiong, 2006, Cambridge Univ Press.
5. Understanding Bioinformatics, Jeremy O. Baum, Marketa J. Zvelebil. 2007, Garland Science, USA.
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley Publishers, 1998.

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BIOCHEMISTRY AND IMMUNOLOGY (LAB-II)

Maximum Marks: 60 + 40

Course Code: MB-651 **Credit: 8**

Practical:

1. To train students in handling, upkeep and calibration of micropipette for measuring small volumes
2. To prepare standard curve of BSA and determine the concentration of unknown protein sample using Bradford method using regression equation.
3. To separate amino acids, sugars and lipids using Thin Layer Chromatography (TLC)
4. To determine activity and specific activity of the enzyme sample provided.
5. To study the pH optima, pH stability, temperature optima and temperature stability of the given enzyme sample
6. To determine Km,Vmax and Kcatof a purified enzyme.
7. Enzyme-linked Immunosorbent assay (ELISA)
8. To study quantitative precipitation assay
9. To perform dot-ELISA.

Suggested Readings:

1. Biochemistry Lab Manual by D.A. Thompson. 3rd edition. Create Space Independent Publishing Platform. 2013.
2. Biochemical calculations: how to solve mathematical problems in general biochemistry by Irwin H. Segel, Wiley, 2nd Edition 2004

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

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MICROBIAL METHODS (LAB-I)

Maximum Marks: 60 + 40

Course Code: MB-653 **Credit: 8**

Practical:

1. Sterilization techniques and their application in microbiology lab.
2. Study of Design, working and principal of important instrumentation used in microbiology lab.
3. Preparation and sterilization of liquid and solid media for growth of microorganisms.
4. Isolation of organisms by plating, streaking and serial dilution methods.
5. Isolation of microorganisms pure; cultures from soil
6. Isolation of microorganisms pure; cultures from water.
7. Isolation of microorganisms pure; cultures from air.
8. Different staining methods, colony morphology and microscopic examination of bacteria and fungi.
9. Identify the given bacterial sample by determining their biochemical characteristics.
10. Effect of temperature on Microbial growth.
11. Effect of pH on Microbial growth.
12. Effect of Oxygen on Microbial growth.
13. Study of bacterial growth curve.
14. Study of physical and chemical agents for the control of Microbial Growth.
15. Permanent Slides of microorganisms.

Suggested Readings:

1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh, 11th edition, Pearson.
2. Microbiological Methods: Collins and Lyne's, Hodder Arnold; 8th edition.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Deepa Dewal

Paul

BACTERIOLOGY AND VIROLOGY

Maximum Marks: 60 + 40

Course Code: MB-602 **Credit: 4**

Unit-I

Morphology and Structure of Bacteria- Morphological types, size, shape, and arrangement of bacteria, Cell wall structure and chemical composition: Gram-positive and Gram-negative bacteria, Archaea, cell wall synthesis, Inhibitors of cell wall synthesis, Cell membrane: structure, composition, and properties, Surface structures: Capsule, slime layer,S-layer, Flagella, Pili and fimbriae, Cytoplasmic structures: Nucleoid, ribosomes, Plasmids, Cytoskeletal, Reserve food materials, Endospore.

Unit-II

Bacterial Genetics- Overview of bacterial genome: DNA structure and organization, Plasmids: types and roles, Genetic exchange mechanisms: Conjugation: F-plasmid, sex pili, Hfr strains, and its role in antibiotic resistance, Transduction: lytic and lysogenic cycles, generalized and specialized transduction, Transformation: mechanism and significance.

Unit-III

History and discovery of viruses, Properties of viruses, Morphology and structure: Capsids and their arrangements, Viral envelopes and enzymes, Viral genome types and organization-dsDNA, ssDNA, dsRNA, ssRNA, Reproduction and cultivation of viruses: embryonated egg, cell culture, Virus purification and assay-differential centrifugation, hemagglutination, plaque method. Virulent double stranded DNA phaegs : One step growth curve experiment, Adsorption and penetration, synthesis of phage nucleic acids and proteins , assembly of phage particles, Release of phage particles, Single stranded DNA phages, RNA phages, Temperate bacteriophages and lysogeny.

Unit – IV

Plant Viruses - Structure, classification, and replication, transmission of plant viruses: TMV, Cauliflower Mosaic Virus, Gemini viruses, Potato Virus X, Symptoms and pathophysiology of viral plant diseases. Animal and Human Viruses - structure and replication of animal/human viruses: DNA viruses: Pox, Herpes, Adeno, Hepatitis, Retroviruses (HIV), Reoviruses, pathogenesis, and clinical diagnosis, Prevention and treatment, Antiviral drugs and interferons, Vaccines: conventional, recombinant, DNA-based.

Suggested Readings:

1. Prescott's Microbiology by J. Willey, L. Sherwood, C. J. Woolverton. 10th edition. McGraw Hill Education. 2017.

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2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Alcamo's Fundamentals of Microbiology by J. C. Pommerville. 10th Edition. Jones and Bartlett Learning. 2013.
4. The Physiology and Biochemistry of Prokaryotes by D. White, J. Drummond, C. Fuqua.4th Edition. Oxford University Press. 2011.
5. Dimmock NJ, Primrose SB (1994). Introduction to modern Virology, IV Edition, Blackwell Scientific Publication, Oxford.
6. Conrat HF, Kimball PC and Levy JA (1994) Virology-III Edition Prentice Hall, Engelwood cliff, New Jersey.
7. Methew, RE,(1992) Functional of Plant virology, Academic Press, San Diego.
8. Cann, A (2011) Principle of molecular Virology. Academic press London.

MYCOLOGY AND PHYCOLOGY

Maximum Marks: 60 + 40

Course Code: MB-604 **Credit: 4**

Unit- I

Algae – General characteristics, classification, occurrence, and distribution of algae, Thallus structure and modes of nutrition, Asexual and sexual reproduction, Detailed study of representative genera:**Chlorophyceae**: *Chlamydomonas*, *Spirogyra,* **Phaeophyceae**: *Ectocarpus*, *Sargassum,* **Bacillariophyceae**: Diatoms, **Rhodophyceae**: *Polysiphonia,* **Cyanophyceae**: *Spirulina*, *Anabaena and* **Dinoflagellates.**

Unit-II

Algae in Environment and Industry- Algae as indicators of pollution and agents of eutrophication, Role in bioremediation, carbon capture, and environmental sustainability,Use of cyanobacteria and microalgae in agriculture (biofertilizers, algalization),Industrial applications: production of algal pigments, biofuels, hydrogen, and bioactive compounds.

Unit- III

Fungi – General features and classification of fungi,Structure of fungal cells: hyphae, unicells, motile cells, spores, dormancy,Growth dynamics: population, colonies, and environmental influences on growth,Life cycles of selected fungi: *Aspergillus*, *Penicillium*, Yeast,Nutrition and reproduction: asexual, sexual, parasexual. Representative groups and genera: **Mastigomycotina:** *Albugo*, *Phytophthora,* **Zygomycotina:** *Rhizopus,* **Ascomycotina:** *Saccharomyces*, *Neurospora*, *Penicillium,* **Basidiomycotina:** *Puccinia*, *Agaricus,* **Deuteromycotina:** *Cercospora*, *Colletotrichum,* Slime molds (*Dictyostelium*).

Unit-IV

Structure, reproduction, and types of lichens: ascolichens, basidiolichens, deuterolichens, Types of mycorrhizae: ecto-, endo-, ecto-endo, vesicular-arbuscular mycorrhizae (VAM), Fungi as insect symbionts and biocontrol agents, Fungal antagonism towards other microorganisms, Applications in environment, agriculture, biotechnology, and industry, Role of fungi in biodeterioration of wood, paper, textiles, Overview of mycotoxins and fungal quorum sensing, Mycoses: superficial and cutaneous fungal infections — causative fungi (*Candida*, *Microsporum*, *Trichophyton*, *Sporothrix*, etc.), pathogenesis, and treatment

Suggested Readings:

1. Alexopoulos, C.J., & Mims, C.W. (1979). *Introduction to Mycology* (3rd ed.). Wiley Eastern Ltd., New Delhi.
2. Burnett, J.H. *Fundamentals of Mycology*. Edward Arnold Crane Russak.

3. Charlile, M., & Watkinson, S.C. *The Fungi*. Academic Press.
4. Moore-Landecker, E. *Fundamentals of the Fungi*. Prentice Hall.
5. Barsanti, L., & Gualtieri, P. (2006). *Algae: Anatomy, Biochemistry, and Biotechnology*. Taylor and Francis Group, LLC.
6. Graham, L.E., Graham, J., & Graham, J.M. (2009). *Algae*.
7. Lee, R.E. (1999). *Phycology* (3rd ed.). Cambridge University Press, Cambridge.
8. Demirbas, A., & Demirbas, M.F. (2010). *Algae Energy: Algae as a New Source of Biodiesel*.

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MICROBIAL GENOMICS, PROTEOMICS + METABOLOMICS

Maximum Marks: 60 + 40

Course Code: MB-606 **Credit: 4**

Unit-I

Introduction to Omics Biology and Genomics-Overview of Omics Biology: history, concepts, and the central dogma, Scope of Bioinformatics: tools and databases (BLAST, NCBI, PDB),Genetic architecture of genomes: Prokaryotic vs. Eukaryotic genome organization, Organelle genomes: structure, origin, and genetic content, Genome sequencing technologies and annotation, Human Genome Project and genome browsers, Genome evolution: gene duplication, horizontal gene transfer, non-coding DNA, transposable elements, Introduction to molecular phylogenetics: principles and applications in evolutionary biology.

Unit-II

Proteomics and Protein Function Analysis-Introduction to proteomics: proteome definition and major branches (structural, functional, expression proteomics),Protein separation and identification techniques: 2D gel electrophoresis, mass spectrometry (ESI, MALDI), Edman sequencing,Protein quantification and post-translational modifications, Protein structure determination: X-ray crystallography, NMR spectroscopy, Protein-protein interactions: yeast two-hybrid, pull-down assay, tandem affinity purification (TAP),Protein expression profiling: differential in-gel electrophoresis, isotope-coded affinity tagging (ICAT),Protein microarrays: analytical and functional types, Functional proteomics: approaches to protein function determination

Unit-III

Metabolomics and Metabolic Engineering-Introduction to metabolism and metabolomics, Metabolic pathways and metabolite profiling techniques, Integration of genome, transcriptome, proteome, and metabolome data, Metabolic regulation and control mechanisms (e.g., glycolysis regulation),Metabolic flux analysis and homeostasis,Principles and applications of metabolic engineering: gene/pathway transfer, metabolite flow manipulation, challenges and limitations

Unit-IV

Functional Genomics, Systems Biology, and Applications-Functional annotation of genes and proteins,Systems biology integration of omics data, Comparative and evolutionary genomics,Applications in drug discovery: protein-drug interaction studies, computer-aided drug design (CADD),Role of genomics and proteomics in diagnostics and therapeutics, Biomarker identification and personalized medicine, Emerging role of Artificial Intelligence (AI) in genomics and proteomics.

Deepa Bansal

Suggested Readings:

1. David M. (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press; ISBN 978-087969712-9.
2. Pevsner, J. (2003). Bioinformatics and Functional Genomics (1st ed.), John Wiley & Sons, Inc. (New Jersey); ISBN: 0-47121004-8.
3. Baxevanis A.D. and Ouellette Francis B.F. (2005), Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.), John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Ghosh, Z. and Mallick, B., (2008) Bioinformatics – Principles and Applications, (1st ed.) Oxford University Press (India), ISBN: 9780195692303.
5. Introduction to Proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., Humana Press Inc., New Jersey, USA. 2002.
6. Vince Buffalo – Bioinformatics Data Skills– O'Reilly Media 2015.
7. Abraham Silberschatz, Henry F. Korth, and S. Sudarshan– Database System Concepts – 7th Ed McGraw-Hill Education, 2020
8. Jake Chen and Amandeep S. Sidhu– Biological Database Modeling– Artech House, 2007

ADVANCED ANALYTICAL TECHNIQUES

Maximum Marks: 60 + 40

Course Code: MB-608 **Credit: 2**

Unit-I

Spectroscopy: Various theories exploring the concept of light: Corpuscular theory, Wave theory, Electromagnetic theory, Planck's concept and modern theory. Basic concepts, principles and biological applications of different types of spectroscopy: absorption spectroscopy, fluorescence spectroscopy, phosphorescence, Infrared and Raman spectroscopy, Optical Rotatory Dispersion (ORD), Circular Dichroism (CD).

Unit-II

Principle of microscopy: resolving powers of different microscopes, magnification; different types of microscopes, principle and applications of compound microscopy, dark microscopy, fluorescence microscopy, phase contrast microscopy, confocal microscopy, atomic force microscopy and electron microscopy (SEM, TEM, STEM); fixation and staining, freeze fracture/etch techniques.

Unit-III

Macromolecular structure determination: Basics of X-ray Crystallography: symmetry, space groups, unit cells, structure factors, reciprocal lattice, Fourier transform, electron density, phase problems and it's solutions, Biological applications and interpretations. Basics of Magnetic resonance spectroscopy: chemical shifts, resonance condition, relaxation studies, coupling and decoupling, biological application and interpretations of Nuclear Magnetic Resonance (NMR) & Electron Spin Resonance (ESR).

Unit-IV

Separation Techniques-I (Chromatography): Basics principles and applications of various chromatography methods: Partition and Absorption chromatography, gel filtration, ion exchange and affinity chromatography. Biological applications of HPLC and FPLC.

Separation techniques-II (Hydrodynamic methods): Basics of centrifugation based methods: viscosity, diffusion, sedimentation equilibrium, dialysis, solvent fractionation, centrifugation, Biological applications and interpretations of Density Gradient methods, Ultracentrifugation methods. Basics of electrophoresis: electrophoretic mobility and affecting factors, Biological applications and interpretation of different types of electrophoresis: PAGE, gradient gel, Agarose Gel Electrophoresis, 2D Electrophoresis, Dialectrophoresis, iso-electric focusing.

Deepa Bansal

Suggested Readings:

1. Fundamentals of Molecular Spectroscopy by Colin Banwell. 4th edition. McGraw Hill.1994.
2. Principles of Fluorescence Spectroscopy by J. Lakowicz, R. Joseph. 2nd edition. Springer.1999.
3. Molecular Fluorescence: principles and Applications by B. Valeur. 2nd edition. Wiley. 2013.
4. NMR – Conformation of Biological Molecules by G. Govil, R.V. Hosur. 1st edition. Springer- Verlag, 2011.
5. Biomolecular crystallography: Principles, practice and application to structural biology by B. Rupp. 1st edition. Garland Science. 2009.
6. Optical methods in Biology by E.M. Slayter. 1st edition. John Wiley. 1970.
7. NMR of proteins and nucleic Acids by K. Wuthrich. 1st edition. Wiley Interscience Publications. 1988.
8. Biophysical chemistry, Part 2: Techniques by C.R. Cantor, P. R. Schimmel. 1st edition. W.H Freeman and Co. 2008.

GENERIC ENGINEERING

Course Code: MB-610

Maximum Marks: 60 + 40
Credit: 2

Unit-I

Recombination and Repair of DNA: DNA repair and recombination, DNA mismatch repair, Double Strand Break repair, recombination as a molecular biology tool, CRISPR-Cas systems for editing, regulating and targeting genomes.

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, Posttranscriptional gene regulation.

Unit-II

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.

Unit-III

Basics of DNA cloning, and methods of DNA and protein analysis: 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. 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.

Unit-IV

Polymerase chain reaction and construction of cDNA and genomic DNA libraries: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Long PCR, Inverse PCR, Vectorette PCR, RT-PCR, 5' and 3' RACE, 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. Vectors used in the construction of cDNA versus genomic DNA libraries. Steps 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.

Suggested Readings:

1. Gene IX by Benjamin Lewin. Jones and Bartlett Publishers. 2007.
2. Molecular Biology by R.F. Weaver, 4th edition. McGraw Hill, 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. 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 by J.M. Berg, J.L. Tymoczko, L. Stryer. 5th edition. W.H. Freeman and Company, USA. 2008.
6. Current Protocols in Molecular Biology edited by: F. M. Ausubel, R. Brent, R.E. Kingston, D. D. Moore, J. A. Smith, K. Struhl. John Wiley and Sons, Inc. 2007.
7. Molecular Biology by D.P. Clarke, N. Pazdernik. 2nd edition. Academic Press. 2012.
8. Department of Microbiology, University of Delhi-57
9. Molecular Cloning: A laboratory manual by J. Sambrook, D. Russell. 4th edition. Cold Spring Harbor laboratory Press. 2012.
10. DNA Technology: The Awesome Skill by I. Edward Alcamo. Harcourt Academic Press. 2001.
11. Molecular Biology of the Gene by J. Watson, T. Baker, S. Bell, A. Gann, M. Levine, R. Losick. 7th edition. Pearson. 2014.
12. Gene Cloning and DNA Analysis: An Introduction by T.A. Brown. 7th edition. Wiley Blackwell Publishers. 2016.

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BACTERIOLOGY AND VIROLOGY (LAB-I)

Maximum Marks: 60 + 40

Course Code: MB-652 **Credit: 8**

Practical:

1. Determine the ability of microorganism to excrete hydrolytic extracellular enzymes capable of degrading the polysaccharide starch, the lipid tributyrin, and the protein casein and gelatin.
2. Determine the ability of microorganisms to degrade and ferment carbohydrates.
3. Distinguish between the Enterobacteiaceae and other group of intestinal bacilli.
4. Determination of minimum inhibitory concentrations (MICs) of antimicrobial agents.
5. Antibiotic susceptibility testing
6. Biochemical tests - IMVic test
7. Isolation and identification of fungi from different environmental samples.
8. Production of enzymes, organic acids and metabolites by fungi.
9. Culturing of algae under lab conditions.
10. Study of hydrogen and bioethanol production by algae.
11. Algae as a source of SCP and pollution control by algae.
12. Study the symptoms of viral infection in Plants.
13. Chemical structures, morphologies and replicative activities of bacterial viruses (bacteriophages).
14. Cultivation and enumeration of Bacteriophages.
15. Transduction by Bacteriophages & Determination of Phage Titration.
16. Diagnosis of Viral agents by Radio-immunoassays/ELISA.

Suggested Readings:

1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11th edition. Pearson.
2. Microbiological Methods: Collins and Lyne & 39s, Hodder Arnold; 8th edition.
3. A Practical Guide to Clinical Virology, 2nd Edition. L. R. Haaheim (Editor), John R. Pattison (Editor), Richard J. Whitley (Editor).
4. Practical Plant Virology. Jeanne Dijkstra, Cees P. Jager.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

OMICS (LAB-II)

Maximum Marks: 60 + 40

Course Code: MB-654 **Credit: 8**

Practical:

1. Isolation & Quantification of Genomic DNA from Bacterial culture
2. Quantitative estimation of microbial DNA.
3. Microbial DNA denaturation and determination of total G+C content
4. DNA amplification (PCR), quantification, and detection
5. BLAST analysis of DNA/protein sequence
6. Multiple Sequence alignment
7. Primer design and In-silico PCR
8. Searching docking resources for structure-based drug design using SPLINTER.
9. Working with NGS databases (NCBI-SRA, etc.), NGS file formats, File format conversion.
10. Quality checking and trimming using freely available software (e.g. FastQC).
11. Read mapping using BWA or Bowtie or any other freely available software,
12. Interpretation and Visualization of Sequence Alignment Map (SAM) file.
13. Identification of SNPs using GATK Pipeline.
14. RNA-Seq and Chip-seq analysis using cloud-based server (e.g. Galaxy).

Suggest Readings:

1. Textbook of Drug Design and Discovery, Kristian Stromgaard, Povl Krogsgaard Larsen, Ulf Madsen, CRC Press, 2009.
2. Drug Design and Discovery: Methods and Protocols, Volume 716, Seetharama D. Satyanarayanajois, Humana Press, 2011.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Baxevanis A.D. and
4. Ouellette, Third Edition. John Wiley and Son Inc., 2005.
5. Bioinformatics Sequence and Genome Analysis by Mount D.W., CSHL Press, 2004.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

INDUSTRIAL MICROBIOLOGY

Maximum Marks: 60 + 40

Course Code: MB-701 **Credit: 4**

Unit-I

Introduction to industrial microbiology: Introduction to microbial products and fermentation processes, sources of industrially important microorganisms, stoichiometric analysis of biochemical reactions, carbon and nitrogen balance, oxidation-reduction principle in fermentation, recent developments in fermentation technology. Batch cultivation, continuous cultivation, multistage chemostat, feedback systems, types of fed-batch cultures, open and closed systems, Monod kinetics of microbial growth, growth and non-growth associated product formation, product formation kinetics and mathematical modeling, bioprocess optimization strategies (exponential fed-batch, DOstat, pHstat)

Unit-II

Sterilization methods and principles: Media sterilization, mathematical modeling of sterilization processes, Arrhenius equation, Del factor, effect of sterilization on media quality and yield coefficients, batch and continuous sterilization, filter and steam sterilization at industrial scale.

Unit-III

Designing of industrial Strains and media optimization: Industrially important microorganisms, preservation techniques for microbial cultures, inoculum development, microbial strain improvement, high throughput screening methods, recombinant DNA technology in strain improvement, metabolic engineering and flux analysis, media optimization strategies like Plackett–Burman design, Box-Wilson central composite design, response surface methodology.

Unit-IV

Design and types of fermenters: Basic components of a fermenter, fermenter construction materials, designing of laboratory and industrial scale fermenters, types of impellers, mechanical seal, types of baffle and spargers, sampler design, foam controller, types of fermenter like stirred tank, bubble column, airlift, hollow fibers chambers, packed beds, fluidized beds, perfusion cultures, photo-bioreactors and animal cell culture bioreactor.

Unit-V

Bioprocess instrumentation and control parameters: Measurement of various control parameters in bioreactor like pH, dissolved oxygen, temperature, antifoam, principles of feed-back control, PID control, respiratory quotient, effect of dissolved oxygen on microbial production processes, effect of foam and anti-foam on oxygen transfer, oxygen mass transfer coefficient, measurement of KLa values using sulfite oxidation techniques, gassing-out techniques, fluid rheology,

newtonian and non-newtonian fluids, bingham plastic, pseudo plastic, power number, Reynolds number

Unit-VI

Downstream processing of microbial products: Batch filtration, centrifugation, cell disruption, liquid-liquid extraction, solvent recovery, supercritical fluid extraction, various chromatography techniques in product recovery, diafiltration, ultra-filtration and reverse osmosis, drying (lyophilization and spray drying), whole broth processing and crystallization.

Suggested Readings:

1. Principles of Fermentation Technology by P. Stanbury, A. Whitaker, S. Hall. 3rd edition. Butterworth-Heinemann. 2016.
2. Bioprocess Engineering: Basic Concepts by M. L. Shuler, F. Kargi, 2nd edition. Pearson Education India. 2015.
3. Modern Industrial Microbiology & Biotechnology by N. Okafor. 1st edition. CRC Press, USA. 2007.
4. Fermentation Microbiology and Biotechnology edited by E.M.T. El-Mansi, C.F. Bryce, A.L. Demain, A.R. Allman. 3rd edition. CRC Press. 2012.
5. Microbial Biotechnology: Fundamentals of Applied Microbiology by A.N. Glazer, H. Nikaido. 2nd edition. Cambridge University Press. 2007.

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MEDICAL MICROBIOLOGY

Course Code: MB-703

Maximum Marks: 60 + 40
Credit: 4

Unit-I

Classical view of microbial pathogenicity: Define pathogenicity and virulence; Quantitative measures of pathogenicity: minimal lethal dose (MLD), LD50, ID50, TCID50. Virulence determinants: colonization, toxins, enzymes and invasiveness. Facultative/ obligate intracellular pathogens.

Protozoan diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control:Malaria, Kala-azar.

Unit-II

Bacterial diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Respiratory Diseases: Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis. Gastrointestinal Diseases: Escherichia coli, Salmonella typhi, Vibrio cholerae, Helicobacter pylori. Others: Staphylococcus aureus, Bacillus anthracis, Clostridium tetani, Treponema pallidum, Clostridium difficile.

Viral diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control: Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.

Unit-III

Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention: Cutaneous mycoses: *Tinea pedis* (Athlete's foot). Systemic mycoses: Histoplasmosis. Opportunistic mycoses: Candidiasis.

Unit-IV

Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

Suggested Readings:

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.

FOOD MICROBIOLOGY

Maximum Marks: 60 + 40

Course Code: MB-705

Credit: 4

Unit-I

Foods as a substrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Microbial spoilage of foods: Types and causes of spoilage of cereals and cereals products, spoilage of vegetables and fruits, spoilage of meat and meat products, spoilage of fish and other sea foods, spoilage of eggs and other poultry products, spoilage of milk and milk Department of Microbiology, University of Delhi 69 products. Study of microorganisms responsible for spoilage and microbial succession during spoilage. Brief insights into chemical and physical spoilage of foods.

Unit-II

Principles and methods of food preservation: Principles of food preservation; various methods of food preservation - physical, chemical and biological methods; hurdle technology; recent developments in food preservation methods including predictive microbiology, and modified atmospheric packaging; food sanitation - HACCP, indices and regulations of food quality and safety.

Unit-III

Fermentation processes: Production of fermented milk and milk products, plant-based products, fish products, meat products and nutraceuticals. Manufacture of starter cultures from lab to pilot scale. Batch submerged and solid-state fermentation of foods.

Food beverages and enzymes: Concept of human microbiome, probiotics and prebiotics. Insight into health benefits of fermented milk products. Understanding benefits of tradition and non-traditional fermented foods. Introduction to the concept of bioactive compounds and brief study of such compounds from fermented foods including malt beverages, wines, distilled liquors and vinegar.

Unit-IV

Food-borne diseases: Food borne infections including bacterial, viral and fungal infections. Study of infections due to food borne parasites. In depth study of various types and causes of food intoxication. Summary of prevention of microbial food infections. Identification and first aid for specific types of food infections.

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Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

Suggested Readings:

1. Food Microbiology by W.C. Frazier, D.C. Westhoff, K.N. Vanitha. 5th edition. McGraw Hill Education. 2013.
2. Modern Food Microbiology by J.M. Jay, M.J. Loessner, D.A. Golden. 7th edition. Springer. 2006.
3. Fundamental Food Microbiology by B. Rayand A. Bhunia. 5th edition. CRC press. 2013.
4. Food Microbiology by M. R. Adams, M. O. Moss, P. McClure. 4th edition. Royal Society of Chemistry. 2015.
5. Food Microbiology: Fundamentals and Frontiers by M. P. Doyle, L. R. Beuchat. 3rd edition. ASM press. 2007.
6. Food Microbiology: An Introduction by T. Montville, K. Matthews, K. Kniel. 4th edition. ASM press. 2017.

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ENVIRONMENTAL MICROBIOLOGY

Maximum Marks: 60 + 40

Course Code: MB-707 **Credit: 2**

Unit-I

Historical developments and contributions of scientists in environmental microbiology; introduction and scope of environmental microbiology; environmental factors affecting microbial growth; Culture-dependent and culture-independent approaches for understanding microbial diversity in the environment: Understanding microbial diversity in the environment by culture-dependent and culture-independent approaches, Analysis by FAME, measuring metabolic capabilities using BIOLOG, G+C analysis, slot-blot hybridization of community DNA, and fluorescent in situ hybridization of intact cells, metagenomic analysis of solid and aquatic sediments.

Unit-II

Soil and water microbiology: Importance of soil microorganisms, nutrient transformation processes, plant-microbe symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.

Bioremediation of environmental pollutants: Petroleum hydrocarbons and pesticides, use of biosensors for their detection. Microbial enhanced oil recovery, bioleaching of copper, gold and uranium, electronic waste management

Unit-III

Biomass waste management of plant's residues: Lignocellulolytic microorganisms, enzymes and their biotechnological applications in: (i) biopulping, (ii) biobleaching, (iii) textiles (iv) biofuels, (v) animal feed production.

Unit-IV

Liquid and solid waste management: Treatment of sewage (primary, secondary and tertiary treatments), treatment of industrial effluents (distillery, textile, pulp and paper), methods to detect various pollutants (metals, sediments, toxin and organic matters). Solid waste types, composting, landfill development, incineration methods, composting and sustainable agriculture, biogas production, plastic degrading microorganisms as a tool for bioremediation, challenges in waste management.

Suggested Readings:

1. Microbial Ecology by R.M. Atlas, R. Bartha. 3rd edition. Benjamin Cummings Publishing Co, USA. 1993.

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2. Environmental Microbiology by A.H. Varnam, M.G. Evans. Manson Publishing Ltd. 2000.
3. Manual of Environmental Microbiology edited by C.J. Hurst, R.L. Crawford, J.L. Garland, D.A. Lipson, A. L. Mills, L.D. Stetzenbach. 3rd edition. Blackwell Publishing. 2007.
4. Environmental Microbiology edited by R. Mitchell, J-D Gu. 2nd edition. Wiley-Blackwell. 2009.
5. Environmental Microbiology by R. Maier, I. Pepper, C. Gerba. 2nd edition. Academic Press. 2009.
6. Environmental Microbiology: Principles and Applications by P.K. Jjemba, Science Publishing Inc. 2004.
7. Lignocellulose Biotechnology: Future Prospects by R.C. Kuhad, -A. Singh. I.K. International. 2007.
8. Environmental Microbiology of Aquatic & Waste systems by N. Okafor. 1stedition, Springer, New York. 2011.

FUNDAMENTALS OF COMPUTER AIDES DRUG DESIGN

Maximum Marks: 60 + 40

Course Code: MB-709

Credit: 2

Unit-I

Concepts in Molecular modeling: Molecular mechanics and energy minimization: Empirical force field models – Bond stretching – angle bending – torsional term –nonbonding Interactions, derived and non-derived energy minimization method, conformational search methods

Unit-II

Structure based drug design: Protein target selection, binding site prediction and analysis, Molecular docking, rigid Vs flexible docking, induced fit docking, Covalent docking, Binding affinity calculation, de novo drug design method, ligand based drug design, 3D QSAR and 3D pharmacophore.

Unit-III

Protein structure prediction: Homology modeling, threading methods, Template identification and selection, sequence and fold based alignment methods, model building, protein loop building and refinement methods, validation methods for homology model

Unit-IV

Molecular Dynamics and Monte Carlo simulation: Introduction – Using single Model – time steps – Multiple steps – Setting up MD –energy conservation in MD Simulation Examples – Monte Carlo – Random number generation –Difference in MD & MC.

Suggested Readings:

1. Young David C., *Computational Drug Design: A Guide for Computational and Medicinal Chemist,* Wiley (2009).
2. Silverman R.B., *Organic Chemistry of Drug Design and Drug Action,* 3rd Edition, Academic Press, (2014).
3. Charifson P.S., *Practical Applications of Computer Aided Drug Design,* Marcel Deckker, (1997).
4. Cohen N.C., *Molecular Modeling in Drug Design,* Online.
5. Goodman J., *Chemical Applications of Molecular Modeling,* RSC, (2004).
6. GunerO.F.,*PharmacophorePerceptio, Development and use in Drug Design,* International University, (2000).
7. Lemke Thomas L. and William David A., *Berger'sMedicinal Chemistry and Drug Design,* 6th Edition, Lippincott, (2008).
8. Purcell William P., *Strategies of Drug Design,* RSC, (2011).

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Sudhir Bhargava

9. Abraham Donald J. and Rotella D.P., *Foye's Medicinal Chemistry,* Vol. 1-8, 7th Edition, Wiley, (2010).
10. Korolkovas A. and Burckhalter J.H., *Essentials of Medicinal Chemistry,* John Wiley, (1976).
11. VeerapandionPandi, *Structure Based Drug Design,* Monograph, Vol. II and III, Academic Press.

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CADD (LAB-I)

Course Code: MB-751

Maximum Marks: 60 + 40
Credit: 4

Practical:

1. Visualizing Protein and Ligand Structures: Load protein from the PDB (Protein Data Bank), View binding pockets and ligand molecules, Tools: PyMOL, Chimera, Discovery Studio Visualizer.
2. Molecular Docking Practical: Choose a target protein (e.g. HIV protease),Prepare ligand and protein structure, Perform docking using Auto Dock Vina, Analyze docking scores and binding poses.
3. Virtual Screening: Use a small ligand library, Run high-throughput docking or similarity search, Rank molecules based on binding affinity or similarity.
4. QSAR Modeling: Collect data on similar molecules and their activity, Use a tool like KNIME to build a simple regression/classification model, Predict the activity of new compounds.
5. Pharmacophore Modeling: Identify key pharmacophoric features from active molecules, Use them to search chemical databases.

Suggest Readings:

1. Textbook of Drug Design and Discovery, Kristian Stromgaard, Povl Krogsgaard Larsen, Ulf Madsen, CRC Press, 2009.
2. Drug Design and Discovery: Methods and Protocols, Volume 716, Seetharama D. Satyanarayanajois, Humana Press, 2011.
3. Introduction to Bioinformatics by Tramontano A., Chapman & Hall/CRC, 2007.
4. Understanding Bioinformatics by Zvelebil, M. and Baum, Chapman & Hall/CRC, 2008.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

APPLIED MICROBIOLOGY (LAB-II)

Maximum Marks: 60 + 40

Course Code: MB-753

Credit: 12

Practical:

1. Enumeration of microorganism from soil.
2. Eneumaration of microorganism from Air.
3. Biodeterioaration of paper/textile.
4. Biofuel production from lignocelluloses.
5. Bacteriological examination of water (potable/ waste): presumptive test, Confirmed test, Coliform test.
6. Determination of Biological oxygen demand (BOD) of water.
7. Determination of Chemical oxygen demand (COD) of water.
8. Microbial analysis of food products: Bacterial count.
9. Microbial Fermentation: Alchol fermentation.
10. Microbial Fermentation: Lactic acid fermentation.
11. Study of quality of milk by methylene blue reductase test.
12. Study of Microbial flora of the Mouth.
13. Study of effectiveness of Hand washing.

Suggested Readings:

1. Microbiology: A laboratory manual by JG Cappucino, C.T. Welsh. 11th edition. Pearson.
2. Atlas R.M. and Bartha R. 1993, Microbiology Ecology, Benjamin Cummings Publishings Co, Redwood City, CA.
3. Froster C.F. and John D.A., Environmental Microbiology, Ellis Horwood ltd. Hurst C.J., Ceawford R.L., Garland J.L., Lipson D.A. and Mills A.L., 2007.
4. Manual of Environmental Microbiology.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

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PROJECT / DISSERATION

Course Code: MB-799

Maximum Marks: 60 + 40
Credit: 2

Every student, who has been enrolled in M.Sc. (Microbiology) course, shall have to deliver a Seminar on a Recent Topic related to Recent and Applied Developments in Microbiology. Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members well in advance so that the same may be displayed on the notice board.

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 # To be evaluated after IV semester

DEVELOPING ENTREPRENEURIAL MINDSET

Maximum Marks: 60 + 40

Course Code: MB-702*

Credit: 2

Unit-I

Introduction to entrepreneurship: Who is an Entrepreneur? Advantage of becoming entrepreneur, Characteristics of entrepreneur, Competencies and skills possessed by entrepreneur, Myths about entrepreneur etc. Difference between entrepreneur and manager, between entrepreneur and entrepreneurship. Case studies on Indian entrepreneur.

Unit-II

Steps involving in starting enterprise: Deciding the type of organization to start business, deciding the name of the enterprise, registration formalities, identification of opportunities, sources of finance, arranging finance and managing the enterprise.

Unit-III

Definition of MSME& Institutional support: Definition as per MSMED Act 2016, revised guideline 2020, incentives available to MSME by Govt. of India, Institutional setups available at the center and state level supporting MSME. Case study on MSME enterprises in India.

Unit-IV

Developing entrepreneurship attitude: Practical training on developing creativity and Innovation in the students, entrepreneur attitude using behavioral scales, entrepreneurship scorecard for the students. Improving public speaking and negotiation skills, doing a live project.

Suggested Reading:

1. NathSuryakant, *Entrepreneurship Development and Small Scale Industries*, Neha Publishers & Distributors, Delhi(2012),
2. Holt D.H., *Entrepreneurship New Venture Creation*, Pearson Education (2016).
3. Charantimath, *Entrepreneurship Development and Small Business Enterprise Pearson Education* (2013).
4. Scarborough N.M. and Cornwall H.R., *Essentials of Entrepreneurship and small Business Management, 8/e, Pearson Education* (2016).
5. TaingKalpana, *Entrepreneurship Theory and Practice, Anmol Publication Pvt. Ltd.*, Delhi (2014).

*NUES: Non University Examination System

PROJECT / DISSERATION

Maximum Marks: 60 + 40

Course Code: MB-800 **Credit: 16**

Dissertation work would comprise of research work carried out by each student during semester IV under the supervision of a particular faculty member. The student would carry out the review of literature on the topic of research and formulate the plan of work in consultation and in the supervision of the mentor. The student would then conduct the research experiments for the proposed work. Towards the end of semester IV, the student will compile the research work including review of literature, aims and objectives, methodology and results and discussion in the form of a dissertation in the supervision of the mentor. At the end of semester 4, students would make presentations in the presence of all faculty members and would be collectively judged by the faculty members. Marks will be assigned to each student collectively by the faculty based on his/her performance, work and continuous assessment throughout the year by the mentor.

Deepa Bansal