

**Social Transformation Through Dynamic Education”**



**Bharati Vidyapeeth (Deemed to be University), Pune**  
**YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE & COMMERCE**  
**Erandwane, Pune-411038**

**M.Sc. Part I Microbiology**  
**Semester II Syllabus**

**(To Be Implemented From Academic Year 2023-24)**

# M.Sc. Part I Microbiology - Semester II

## MJMB 201: VIROLOGY

Total: 4 Credits; Workload: 15 hrs /Credit

(Total Workload: 4 Credits x 15 hrs = 60 hrs in Semester)

### Course Outcomes:

At the end of this course the students will be able to:

1. Know viruses as infectious agents and their classification
2. Comprehend the techniques to cultivate viruses
3. Understand mechanism for infectivity and replication
4. Describe the applications of viruses in different fields

Module	Topics in Detail	Lecture Hours
I	<p><b>A. Classification of viruses</b></p> <ol style="list-style-type: none"><li>a. General classification of viruses based on structure</li><li>b. Baltimore scheme of viruses Classification</li><li>c. Disease based classification of viruses – respiratory, gastrointestinal, and hepatic</li><li>d. Virosphere</li></ol> <p><b>B. Replication of Animal Viruses</b></p> <ol style="list-style-type: none"><li>a. Outline of virus replication</li><li>b. Attachment</li><li>c. Entry of enveloped and non-enveloped viruses, role of cellular receptors</li><li>d. Uncoating of enveloped and non-enveloped viruses</li><li>e. Replication mechanisms</li><li>f. Replication of DNA Virus – Adenovirus.</li><li>g. Replication of positive sense RNA virus -Polio virus</li><li>h. Replication of negative sense RNA virus - Influenza virus</li><li>i. Replication of Retrovirus</li><li>j. Replication of Dengue Virus</li><li>k. Packaging of helical capsid and icosahedral capsid, generation of envelope</li><li>l. Lysis</li></ol>	15
II	<p><b>A. Techniques in cultivating Viruses</b></p> <ol style="list-style-type: none"><li>a. Cultivation in Chick Egg, in animal cell culture</li><li>b. Large scale production, types of cell culture reactors,</li><li>c. Immobilization and hollow fibre reactors</li><li>d. Harvesting viral components</li><li>e. Growth of viruses in plant cell culture and use of animals</li></ol> <p><b>B. Identification of Viruses</b></p> <ol style="list-style-type: none"><li>a. Serological methods</li><li>b. Electrophoretic separation of antigenic polypeptides and identification</li><li>c. Southern and Northern blotting</li><li>d. Infectivity assay for animal, plant and bacterial viruses-plaque method, pock counting, end point methods, LD50 .ID50, EID50, TCID50, etc.</li></ol> <p><b>C. Counting of Viruses:</b></p> <p>Direct electron microscopy, plaque assay, hemagglutination assay, acid end point method, precipitation reaction.</p>	15

<b>III</b>	<p><b>Bacteriophages</b></p> <p>a. Morphology, genome organization and life cycle and replication of T-even, T-odd, <math>\lambda</math> phage, Mu phage and M13</p> <p>b. Phage Bacterium interaction / Phage Biology</p> <p>c. Lytic &amp; Lysogenic conversion</p> <p>d. Genome mapping- T<sub>4</sub>R II locus, Benzer's Spot Test, Complementation test</p>	<b>15</b>
<b>IV</b>	<p><b>Applications of Phages &amp; other important aspects of viruses</b></p> <p>a. Application of phages in medical science</p> <p>b. Phage therapy for control of bacterial poultry diseases</p> <p>c. Application of Phages in Food industry</p> <p>d. Viral vaccines: live attenuated and killed vaccines.</p> <p>e. Recombinant DNA vaccines</p> <p>f. Role of viruses in recombinant DNA technology</p> <p>g. Viruses and agriculture /crop protection</p> <p>h. Viruses and teratogenesis.</p> <p>i. Viruses and cancer, Human cancer viruses and oncogenes , Mechanisms of viral transformation</p>	<b>15</b>

**References:**

1. Black J.G. (2002) Microbiology Principles and Explorations – ‘Viruses’ 255 – 283. 5<sup>th</sup>Edn. John Wiley & Sons Inc.
2. Darnell J.E. and Baltimore, Allan Campbell, General Virology
3. Dimmock N.J., A.J. Easton and K.N. Leppesrd, “ Introduction to Modern Virology” Fifth edition, Blackwell Science (Topic B)
4. Flint S.J., L.W. Enquist, R.M. Krug, V.R. Racaniello, A.M. Skalka (2000) Principles of Virology, Molecular Biology Pathogenesis and Control ASM Press.
5. Lewin B. (2000) Genes VII. Oncogenes & Cancer 875-913. Oxford University Press.
6. Matthew K. Waldor, David I. Friedman and Sankar L. Adhya (2005) Phages : Their role in Bacterial Pathogenesis and Biotechnology, ASM Press, Washington DC
7. McKane. L. and K.J. Kandel. (1996) Microbiology Essentials and Applications. Viruses – pg. 305-332 McGraw Hill Inc.
8. Packer. M. (1983) Veterinary Bacteriology and Virology. 7<sup>th</sup> Edition CBS Publisher.
9. Rangaswami G & D.J. Baygyaraj. (1993) Agriculture Microbiology, 2<sup>nd</sup>Edn. Viral diseases of plants – 313-323.
10. Talaro. K.P and A. Talaro. (2002) Foundation in Microbiology. 4<sup>th</sup> Edition. An introduction to viruses. 159 – 185. McGraw Hill.

\* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.

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## MJMB202: MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY

**Total: 4 Credits; Workload: 15h /Credit**

(Total Workload: 4 Credits x 15 h = 60 h in Semester)

### Course Outcomes:

**At the end of this course the students will be able to:**

1. To acquaint about technical know-how of molecular tools and techniques.
2. To illustrate applications of RDT in biotechnology industry
3. To understand the diagnostics and therapeutic applications of RDT.
4. Understand social and ethical concern on GM organism release

Module	Topics in Detail	Lecture Hours
I	<b>Molecular Biology Techniques</b> a. Agarose gel electrophoresis: DNA and Protein electrophoresis – Principle, technique and applications b. Blotting / Hybridization Techniques : Northern, Southern, South-Western and Far-Western Blotting, Colony hybridization, DOT blot, SLOT blot, Fluorescence in situ hybridization (FISH) and Microarray technology c. PCR, LCR, Nick translation –types and applications d. Chromosome walking, DNA foot printing and 16s rRNA analysis. e. Transformation and Transfection : Transformation of <i>E. coli</i> using Physical methods, chemical methods , transfection, gene gun protoplast fusion, electroporation f. Gel Assay : Yeast two and three hybrid assay, Activity gel assay, DNA helicase assay, Chromatin Immuno-precipitation (ChIP), Designing probe, Epitope tagging.	15
II	<b>Tools in Recombinant DNA Technology</b> a. 1.Enzymes used in Recombinant DNA technology : Restriction endonuclease, DNA ligases, T4 DNA polymerase, Terminal transcriptase, Alkaline phosphatase, Polynucleotide kinase b. Vectors for cloning and gene expression : Plasmids- pBR322, pUC18, pUC19, Bacteriophages -M13, Lambda phage vectors, Blue script vectors, plant-based vectors (Ti and Ri as vectors) , Baculovirus and Pichia vectors, YAC and BAC. Vectors for gene expression : types (pMal, GST, pET-based vectors) c. Cohesive and blunt end ligation: Linkers, adaptors, homo polymeric tailing. d. Cloning strategies: Labelling and detection of nucleic acid sequences, End-labeling (3'- and 5'-), Random priming and nick translation , radioactive non - radioactive labeling techniques. e. Screening strategies: Blue White screening, Insertional inactivation of antibiotic resistance gene, Insertional inactivation of cI gene, antibiotic resistance, auxotrophic yeast strain, negative selection, reporter gene assay. f. Construction of genomic DNA and cDNA libraries	15
III	<b>Molecular diagnostics and Therapeutics:</b> a. Introduction to Microarray and array techniques, the lab-on-a-chip concept b. Use of array techniques in detection of polygenic diseases and diseases-associated changes in gene expression c. DNA fingerprinting and DNA foot printing. d. Gene therapy , Detection of RNA signatures of 'Antibiotic Resistance' in bacteria e. Detection of microRNA (mi RNA): A signature of cancer diagnostics f. CRISPR-Cas, Human and <i>E. coli</i> genome project: Introduction and applications. g. Concept of comparative genomics h. Production and applications of hybrid human-mouse monoclonal antibodies,	15

	i. human monoclonal antibodies and anticancer antibodies.	
<b>IV</b>	<p><b>Applications of Recombinant DNA Technology and Ethical Issues</b></p> <p>a. Recombinant microbial production processes in pharmaceutical industries – streptokinase, recombinant vaccines (Hepatitis B vaccine), SARS-CoV vaccine.</p> <p>b. Synthesis of commercial products: Amino acids ( L-valine &amp; L-cysteine), ascorbic acid, novel antibiotics, peptide antibodies</p> <p>c. Synthesis of biopolymers: gum, rubber, polyhydroxyalkanoates.</p> <p>d. Unconventional microbial systems for production of high quality protein drugs.</p> <p>e. Transgenic plants - Biotic and abiotic stress-tolerant, fertility, yield and quality improvement in plants, cultivar identification and analysis of seed purity, GM crops- Golden Rice, Flavr Savr tomato, Bt plants, herbicide resistance</p> <p>f. Transgenic animals - Transgenic fish, fluorescent drosophila.</p> <p>g. Social and ethical concerns of RDT and release of GM organisms</p>	<b>15</b>

### References:

1. Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4<sup>th</sup> Edition. Garland Science, Taylor & Francis Group.
  2. Clayton. J and C. Dennis. (2003) 50 years of DNA. Nature Publishing group.
  3. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2<sup>nd</sup>Edn. Oxford University Press.
  4. Gardner E.J., Simmons, M.J and D.P. Snustad (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
  5. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
  6. Kleinsmith L.J. and V.M. Kish. (1995). Principles of Cell and molecular Biology 2<sup>nd</sup>Edn. Haper Collins. College Publishers.
  7. Lewin B. (2004) Genes VIII – International Edition. Pearson. Prentice Hall. Pearson Education International.
  8. Lewin. B. (2000) Genes VII. OxfordUniversity Press.
  9. Pierce. B. A, (2005) Genetics A Conceptual Approach.2<sup>nd</sup>Edition.W.H.Freeman and Company,New York
  10. Primrose. S.B. and R.M. Twyman and R.W. Old (2003). Principles of Gene Manipulation. 6<sup>th</sup>Edn. Blackwell Science.
  11. Russel. P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.
  12. Sambrook. J and D.W. Russel. (2001) Molecular cloning. A Laboratory Manual. 3<sup>rd</sup>Edn. Vol. 1,2,3. ColdSpringHarbor laboratory Press.
  13. Sheeler P. and Bianchi D.E. (1987) Cell and Molecular Biology 3<sup>rd</sup>Edn. John Wiley and Sons. Inc.
  14. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press. Washington. D.C.
  15. Watson J.D. Baker T.A., Bell S.P. Gann A, Levine M. and R. Losick. (2004) Molecular Biology of the Gene. 5<sup>th</sup>Edn. Low Price edition. Pearson Education.
  16. Winter P.C., G.I. Hickey and H.L. Fletcher (2000) Instant notes in Genetics. Viva Books Pvt. Ltd.
- \* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.

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**MJMB203: PRACTICAL COURSE IV (Based on MJMB201 & ELMB201C)****Total: 2 Credits; Workload: 30 hours / Credits**

(Total Workload: 2 Credits x 30 hours = 60 hours in Semester)

**Course Outcomes:**

At the end of this course the students will be able to:

1. Demonstrate phage typing of coliform bacteria
2. Perform data analysis using standard methods and computing
3. Know animal inoculation technique

<b>Module</b>	<b>Practicals</b>	<b>No. of Practical Hrs</b>
1.	Phage typing of <i>E.coli</i> Titration of <i>E. coli</i> phages	06
2.	Preparation of high titer stock of <i>E. coli</i> phages Study of one step growth of T-4phage	04
3.	Isolation of plaque morphology mutants of phages by using UV radiations	04
4.	Isolation of plaque morphology mutants of phages by using chemical mutagen	02
5.	Demonstration of egg inoculation techniques	02
6.	Extraction of Exo-polysaccharide from Microbial culture using organic solvent. (may use ethanol method) and estimation of extracted sugar and validation of Beer and Lamberts law.	06
7.	Isolation of biopolymer producing bacteria and extraction - gum / PHB	04
8.	Extraction of microbial pigments -bacterial/fungal	04
9.	Extraction of bacterial protein using chemical method (TCA)	04
10.	Preservation of microbial culture: Oil overlay method , Glycerol stock method , culture preservation using sterile soil	04
11.	Displaying data a. Frequency plots, bar charts, histograms, scatter plots, box plots functions and graph b. Linear function c. Logarithmic function, Slope of curves, Quadratic function	10
12.	Use of Excel in data analysis	06
13.	Demonstration of animal inoculation techniques : Oral route, Cutaneous, subcutaneous, and intravenous administration	02
14.	Visit to animal cell culture laboratory	02

## References:

1. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
4. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
5. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
6. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
7. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
8. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
9. Bergey's Manual of Systematic Bacteriology
10. Microbiological Methods by Michael Collins
11. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
12. Laboratory Exercises in Microbiology by Robert A. Pollock and others
13. Laboratory Techniques in Microbiology and Biotechnology by R. P. Tiwari, G. S. Hoondal and R. Tewari, Abhishek Publications, Chandigarh
14. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh. Scientific Publishers, Jodhpur
15. Laboratory Exercises in Microbiology by J. P. Harley and L. M. Prescott 5th Ed.
16. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
17. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
18. Identification Methods for Microbiologists by B. M. Gibbs & F. A. Skinner. Academic Press
19. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
20. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
21. Microbiological Methods by Michael Collins
22. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
23. Laboratory Exercises in Microbiology by Robert A. Pollock and others
24. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
25. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
26. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by Alfred E. Brown
27. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
28. Applied Microbiology Laboratory Manual by F. Duncan.
29. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2<sup>nd</sup> Ed
30. Laboratory Exercises in Microbiology 5th ed. Harley Prescott.

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## MJMB204: PRACTICAL COURSE V (Based on MJMB202)

**Total: 2 Credits; Workload: 30 hours / Credits**

(Total Workload: 2 Credits x 30 hours = 60 hours in Semester)

### Course Outcomes:

At the end of this course the students will be able to:

1. Analyse electrophoretic gels of proteins and DNA
2. Understand Mendelian and non-Mendelian inheritance and its phenotypic effect
3. Know the concept of phylogenetic tree

Module	Practicals	No. of Practical Hrs
1.	Restriction digestion of sample DNA, Gel electrophoresis and characterization of gel, documentation of gel	08
2.	Native gel electrophoresis of proteins-PAGE	08
3.	Study of blotting :Southern blotting, Western blotting	08
4.	Blue White colony screening	04
5.	Non Mendelian gene ratios	08
6.	Bio informatics tools, NCBI, PDB search, BLAST	08
7.	Construction of phylogenetic tree	08
8.	Understanding pedigree design for various traits	08

### References:

31. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
32. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
33. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
34. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
35. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
36. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
37. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
38. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
39. Bergey's Manual of Systematic Bacteriology
40. Microbiological Methods by Michael Collins
41. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
42. Laboratory Exercises in Microbiology by Robert A. Pollock and others
43. Laboratory Techniques in Microbiology and Biotechnology by R. P. Tiwari, G. S. Hoondal and R. Tewari, Abhishek Publications, Chandigarh
44. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh. Scientific Publishers, Jodhpur
45. Laboratory Exercises in Microbiology by J. P. Harley and L. M. Prescott 5th Ed.
46. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers



47. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
48. Identification Methods for Microbiologists by B. M. Gibbs & F. A. Skinner. Academic Press
49. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
50. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
51. Microbiological Methods by Michael Collins
52. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
53. Laboratory Exercises in Microbiology by Robert A. Pollock and others
54. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
55. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
56. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by Alfred E. Brown
57. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
58. Applied Microbiology Laboratory Manual by F. Duncan.
59. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2<sup>nd</sup> Ed
60. Laboratory Exercises in Microbiology 5th ed. Harley Prescott.

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## ELMB201A: MICROBIAL SYSTEMATICS & DIVERSITY

**Total: 4 Credits; Workload: 15hrs /Credit**

(Total Workload: 4 Credits x 15 h = 60 h in Semester)

### Course Outcomes:

**At the end of this course the students will be able to:**

1. Understand the diversity of microorganisms.
2. Know the concept of classification of microorganisms.
3. Understand various characteristics of different types of microorganisms.
4. Understand how to classify newly discovered organisms.

Module	Topics in Detail	Lecture Hours
I	a. Comparison of prokaryotes and eukaryotes, Archaeobacteria and Eubacteria b. Classification of Prokaryotic organisms- Concept of bacterial Speciation, Bacterial nomenclature, Modern trends in Prokaryote taxonomy c. Bergey's Manual System of bacterial classification, Brief history of the Bergey's Manual of Determinative Bacteriology, Bergey's Manual of Systematics, Prokaryotic Domains, phenetic and phylogenic approach, d. Introduction to Polyphasic taxonomy- Types of information used, polyphasic strategy, polyphasic taxonomy in practice, Phylogenetic basis- Reconstruction and interpretation of Phylogenetic trees.	15
II	a. Gene sequencing : Maxam Gillbert Method, Sanger's Method, Automated sequencer, BLAST Analysis, RFLP, RAPD, DGGE, TGGE , Tm value and G+C content, DNA hybridization b. Whole genome sequencing-shotgun sequencing. rRNA in molecular taxonomy, 16S rRNA, 18s rRNA / rDNA fingerprinting, c. Unculturable microorganisms, culture independent methods for identifying unculturable microbes d. Metagenomics- Concepts, work flow, Collection and processing of samples, metagenomic DNA isolation.	15
III	a. General characteristics and outline classification of Actinomycetes yeasts and fungi, Fungal taxonomy: Different groups phenotypic characterization, description of new species, genotypic methods, databases b. General characteristics of Lichens and Mycorrhiza c. Space biodiversity: Introduction, aims and common goals, Life detection methods	15
IV	a. General characteristics and outline classification of Archaea. b. General characteristics of methanogenic, extremely halophilic and extremely thermophilic archaeobacteria c. General characteristics of – i. Anoxygenic photosynthetic bacteria : purple bacteria and green bacteria, ii. Oxygenic photosynthetic bacteria : Cyanobacteria - external and internal features, physiology and ecology d. General characteristics Magnetotactic bacteria, Magnetosomes Enrichment and isolation of Magnetotactic bacteria.	15

**References:**

1. Introductory Mycology by C. J. Alexopoulos (7<sup>th</sup> Ed.) Wiley Eastern Pvt. Ltd., New Delhi.
2. Bergey's Manual of Systemic Bacteriology (2<sup>nd</sup> Ed.) Springer, USA.
3. Bergey's Manual of Determinative Bacteriology (2<sup>nd</sup> Ed.) Springer, USA.
4. Basic Bacteriology (3<sup>rd</sup> Ed.) by C. Lamanna and F. Mallette. The William and Wilkins Company. Calcutta.
5. Fundamental Principles of Bacteriology (3<sup>rd</sup> Ed.) by A. J. Salle TMH Publishing Company, New Delhi.
6. Metabolism and Physiology of Yeast by A.H.Rose. Academic Press 1989.
7. General Microbiology (5<sup>th</sup> Ed.) by R. Y. Stanier and others
8. The Prokaryotes: A handbook on the Biology of Bacteria by Martin Dworkin (Editor-in- Chief) and others Springer
9. Developmental Microbiology by J. F. Peberdy Blackie & Sons, Glasgow

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## ELMB201B: PROTEINS AND PROTEOMICS

**Total: 4 Credits; Workload: 15h /Credit**

(Total Workload: 4 Credits x 15 h = 60 h in Semester)

### Course Outcomes:

At the end of this course the students will be able to:

1. Classify proteins and know the functions
2. Develop perception on analysis of protein structure
3. Compare purpose and use of advanced analytical tools in proteomics

Module	Topics in Detail	Lecture Hours
I	<b>Structure and classification of proteins</b> a. Amino acids, peptide linkage, polypeptides b. Structural classification of proteins Primary, secondary, tertiary and quaternary structure of proteins, c. Globular proteins with example d. Fibrous proteins with example	12
II	<b>Characterization of protein structure</b> a. Determination of C and N terminal of polypeptide b. Ramchandran plot c. Artificial synthesis of polypeptides d. Functions of proteins: structural proteins, signaling proteins e. Protein folding & misfolding f. Protein-DNA interaction	12
III	<b>Introduction to Proteomics</b> a. Top-Down proteomics and Bottom-up proteomics b. Purification of proteins: -Dialysis, ultracentrifugation, Partition chromatography c. Proteomic techniques: overview	12
IV	<b>Techniques based Gel methods</b> a. Techniques based on antibody proteins –ELISA, immunodiffusion, western blotting, b. 2 D-GE, 2D-PAGE c. Chromatography technologies: Liquid chromatography-Affinity chromatography, IEC	12
V	<b>Advanced tools in Proteomics</b> a. MALDI analysis b. Fundamentals of mass spectrometry, Mass spectrometry: Ionization sources, Mass spectrometry: Mass analyzers c. Mass spectrometry based techniques iTRAQ d. Introduction to microarrays	12

## References :

1. Lehninger A.L. (1984): Principles of Biochemistry, 1<sup>st</sup> Indian Edition, LBS publishers and distributors Pvt. Ltd. New Delhi.
  2. Lehninger - Principles of Biochemistry (2000) 2<sup>nd</sup> Edition by D.KL. Nelson and M.M. Cox Mcmillan Worth Pub. Inc.N.Y.
  3. Mehler H.R. and E.H. (1968) Basic biological chemistry, Harper and Row publisher, Inc. New York.
  4. Murray R.K & others, Harper's Biochemistry, Appleton and Lange Stanford, 25<sup>th</sup> Edition.
  5. Stryer, W.H. Freeman (1992) Biochemistry IV Edition and Co. N.Y..
  6. Sanjeeva Shrivastava : Proteins to proteomics :Basic concepts, techniques and applications.
  7. Wilson K. and J. Walker,(1999)CambridgeUniversity Press. Principles and techniques at Practical biochemistry
- \* Students are supposed to refer to “Current Contents” and periodicals for recent & additional information.

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## ELMB201C: QUANTITATIVE BIOLOGY

**Total: 4 Credits; Workload: 15h /Credit**

(Total Workload: 4 Credits x 15 h = 60 h in Semester)

### Course Outcomes:

**At the end of this course the students will be able to:**

1. Learn different methods and aspects of biostatistics.
2. Understand statistical analysis of genetic data and different aspects of Mendelian genetics.
3. Understand population genetics and its use during pursue of research.

Module	Topics in Detail	Lecture Hours
I	<b>Mendelian Genetics</b> a. Monohybrid crosses and Mendel's principle of segregation. b. Dihybrid crosses and Mendelian principle of independent assortment. c. Statistical analysis of Genetic data. The chi-square test. d. Multiple alleles – ABO blood groups. e. Modification of Dominance relationships. f. Gene interactions and modified Mendelian ratios. g. Essential genes and lethal genes. h. The environment and gene expression.	15
II	<b>Population Genetics</b> a. Difference in genotype frequencies amongst population. Hardy – Weinberg principle. b. Random mating. c. Polymorphic genes and DNA typing. d. Inbreeding. e. Genetic change in species leads to evolution. f. Introduction of new alleles in population. g. Natural selection, Random changes in allele frequency.	15
III	<b>Data Display Methods</b> a. Frequency plots, Bar chart, Histograms, Scatter plots, Box plots b. Mathematical functions and graph of a function: c. Linear function, Quadratic function, Exponential function, Periodic function, Logarithmic function d. Slope of curves, Limits and idea of derivative, Derivative of simple and exponential function Calculus, Diffusion equation and mean square displacement	15
IV	<b>Genetic Inheritance Patterns</b> a. Understanding a Pedigree (Family Tree) Design b. Pedigrees for specific conditions c. Autosomal Recessive d. Autosomal Dominant e. Sex(X)-linked Recessive f. Sex(X)-linked Dominant g. Sex Influenced Female Dominant h. Sex Influenced Male Dominant i. Y-linked j. Sex Limited traits k. Mitochondrial	15

## References:

1. Aitken, M., Broadhursts, B., & Haldky, S. (2009) Mathematics for Biological Scientists. Garland Science.
2. Billingsley, P. (1986). Probability and Measure. New York: Wiley.
3. Biostatistics for the Biological and Health Sciences [2 ed.] by Triola
4. Daniel, W. W. (1987). Biostatistics, a Foundation for Analysis in the Health Sciences. New York: Wiley
5. Introductory biostatistics, Authors: Chap T. Le, Lynn E. Eberly, Second edition ,Publisher:Wiley, Hoboken, New Jersey, 2016
6. Rosner, B. (2000). Fundamentals of Biostatistics. Boston, MA: Duxbury Press.
7. Stroud, K. A., & Booth, D. J. (2009). Foundation Mathematics. New York, NY: Palgrave Macmillan.
8. Bailey N.T.J (1995) Statistical Methods in biology 3<sup>rd</sup> Edition. Cambridge lowprice Edition Cambridge university press.
9. Dixit J.V. (1996) Principles & Practice of Biostactistics 1<sup>st</sup> Edn. M/s. Banarasidas Bhanot (Publisher).
10. Frank H. Stephenson (2003) Calculations for Molecular Biology and Biotechnology. A guide to Mathematics in the laboratory Academic Press an imprint of Elsevier.
11. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8<sup>th</sup> Edition. John Willey & Sons. Inc.
12. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and BartlettPublisher.
13. Irwin H. Segel (1976) Biochemical Calculations 2<sup>nd</sup> Edition John Viley & Sons.
14. Pranab Kr. Banerjee (2006) Problems on Genetics, Molecular Genetics and EvolutionaryGenetics. New Central Book Agency (P) Ltd. Kolkata.
15. Pierce.B.A, (2005) Genetics A Conceptual Approach.2<sup>nd</sup> Edition.W.H.Freeman and Company,New York
16. Russel. P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.
17. Snyder. L. and W. Champress. (1997) Molecular Genetics of Bacteria. ASM Press.Washington. D.C.
18. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
19. Wardlaw A.C. (1985) Practical statistics for experimental Biologists John Wiley & Sons.Ltd.

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## ELMB202: PRACTICAL COURSE VI (Based on ELMB201A/B/C)

**Total: 2 Credits; Workload: 30 hours / Credits**

(Total Workload: 2 Credits x 30 hours = 60 hours in Semester)

### Course Outcomes:

At the end of this course the students will be able to:

1. Demonstrate use of Bergey's manual of Bacterial identification
2. Understand microbial interactions
3. Identify fungi and yeasts based on morphological criteria

Module	Practicals	No. of Practical Hrs
1	Study of Bergey's manual of systematics for identification of LAB /Gram positive bacteria	06
2	Isolation and morphological study of mycelium and spore for fungi identification	05
3	Isolation and morphological studies of yeast from sugar and starchy materials	04
4	Induction and observation of Ascospores of <i>Saccharomyces cerevisiae</i>	04
5	Isolation and morphological studies of Actinomycetes by coverslip technique, Determination of diversity index	05
6	Enrichment, isolation of ruminant gut bacteria/ methanotrophs	06
7	Detection of chlorophyll a from cyanobacteria	04
8	Isolation of lipase/cellulase/producers or lignin/xyalan degraders	04
9	Enrichment and isolation of chitin degrading bacteria	05
10	Enrichment of Clostridium species	04
11	Detection of siderophore production by microorganisms	06
12	Developing Winogradsky's column	02
13	Enrichment, isolation of sulphur reducing bacteria	04
14	Enrichment and isolation of Anoxygenic phototrophic bacteria	05
15	Detection of synergism and antagonism in microorganisms	04

### References:

1. Practical Microbiology by R. C. Dubey and D. K. Maheshwari. S. Chand & Co.
2. Environmental Science and Biotechnology: Theory and Techniques by A. G. Murugesan and C. Rajakumari. MJP Publishers
3. Experimental Microbiology by R. J. Patel. Aditya Publishers, Ahmedabad
4. Analysis of Plants, Irrigation water and Soils by R. B. Somawanshi and others. Mahatma Phule Agricultural University, Rahuri
5. Identification Methods for Microbiologists by B. M. Gibbs and F. A. Skinner. Academic Press
6. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
7. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
8. Methods in Microbiology (Vol. 5B and Vol. 3A) by Norris and Ribbons. Academic Press
9. Bergey's Manual of Systematic Bacteriology – Springer 2<sup>nd</sup> edition



10. Microbiological Methods by Michael Collins
11. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
12. Laboratory Exercises in Microbiology by Robert A. Pollock and others
13. Laboratory Techniques in Microbiology and Biotechnology by R. P. Tiwari, G. S. Hoondal and R. Tewari, Abhishek Publications, Chandigarh
14. Handbook of Techniques in Microbiology by A. S. Karwa, M. K. Rai and H. B. Singh. Scientific Publishers, Jodhpur
15. Laboratory Exercises in Microbiology by J. P. Harley and L. M. Prescott 5th Ed.
16. Laboratory Manual in Biochemistry by J. Jayaraman. New Age International Publishers
17. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
18. Identification Methods for Microbiologists by B. M. Gibbs & F. A. Skinner. Academic Press
19. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
20. Benson's Microbiological Applications Laboratory Manual in General Microbiology by Alfred E. Brown
21. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
22. Laboratory Exercises in Microbiology by Robert A. Pollock and others
23. Laboratory Methods in Food Microbiology by Harrigan, Academic Press
24. Laboratory Microbiology by L. Jack Bradshaw. W. B. Saunders & Co.
25. Benson's Microbiological Applications: Laboratory Manual in General Microbiology by Alfred E. Brown
26. Handbook of Microbiological Media by R. M. Atlas. CRC Publications
27. Applied Microbiology Laboratory Manual by F. Duncan.
28. Practical Handbook of Microbiology by Emanuel Golman and Lawrence H. Green, 2<sup>nd</sup> Ed
29. Laboratory Exercises in Microbiology 5th ed. Harley Prescott.

## **CCCMB201: OJT/INTERNSHIP/FP/CEP**

**Total: 4 Credits; Workload: 30 hours / Credits**

(Total Workload: 4 Credits x 30 hours = 120 hours in Semester)

- Students will have to complete an on job training or internship program or field project / community engagement program of 4 credits (120 clock hours duration) during semester II in the subject related industry / laboratory / research institute or any other academic institute.
- The 120 hours clock hours should be completed as 15 days x 8 hrs daily or 30 days x 4 hrs daily.
- He / She may start his on job training or internship program or field project / community engagement program immediately after completion of the theory examination of first semester.
- He / She has to submit the a brief report and certificate of on job training or internship program or field project / community engagement program to the department before commencement of practical examination.
- Further, he has to give the presentation of his work at the time of practical examination before external and internal examiners.
- Each student will have a mentor from the Department who will monitor the activity of a student during OJT.
- The student is expected to learn the day-to-day activities, processes etc. in the industry during OJT.
- The OJT report is to be prepared in the consultation with the mentors from the department and industry both, for evaluation at the end of the second semester.
- They are required to submit a neatly typed and bound report and a soft copy to the department.
- The department shall arrange for a presentation session of 15 min at the time examination, each for all the students to share their experience during OJT.
- The spiral bound report should include information about the industry, work process, products etc. and also specific information of the work done or experience gained by the student in the industry.
- For the purpose of term end examination, a hard bound report must be duly signed by both the mentors.
- The students are required to attach an original certificate, mentioning the successful completion of training, issued by the competent authority from the industry where he/she has undergone training.
- Assessment shall be done jointly by the internal and external examiner based on the knowledge/skills gained by the student.

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