"Social Transformation through Dynamic Education"

Bharati Vidyapeeth (Deemed to be University), Pune

YASHWANTRAO MOHITE COLLEGE OF ARTS, SCIENCE & COMMERCE

Erandwane, Pune-411038

M.Sc. Microbiology Syllabus

As per NEP 2020

(To Be Implemented From Academic Year 2023-24)

M. Sc. Microbiology Part I
Semester I

MJMB 101: IMMUNOLOGY
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. Understand classes of immunoglobulin, organization and expression of immunoglobulin genes.
2. Know details of major histocompatibility complex and disease susceptibility.
3. Understand cytokines and their medical significance.
4. Understand hypersensitivity reactions.
5. Know immune deficiencies and auto immunity.
6. Understand details of transplantation immunology and immunity to cancer.

Module	Topics in Details	Lecture Hours
I	**Immunoglobulins**	12
	a. Fine Structure of immunoglobulins, classes & biological activities b. Organization & expression of immunoglobulin genes. c. Variable region gene rearrangements d. Generation of Antibody diversity e. Expression of Ig Genes, Regulation of Ig - Gene transcription. f. Antibody genes and antibody engineering	
II	**Major Histocompatibility Complex**	12
	a. General Organization and Inheritance of the MHC b. MHC molecules and Genes c. Detailed Genomic Map of MHC genes d. Cellular Distribution of MHC molecules e. Regulation of MHC Expression. f. MHC and Immune Responsiveness **g.** MHC and Disease susceptibility	
III	**Immune Effector Mechanisms**	12
	a. Cytokines – properties, receptors, antagonists, cytokine secretion, related diseases, therapeutic uses. b. Complement system - functions, components, activation, regulation, biological consequences, deficiencies. c. Cell adhesion, cell signaling through GPCR and signal transduction pathway, mediators of inflammation, inflammatory process, anti-inflammatory agents. d. Hypersensitive reactions – Type I, Type II, Type III and Type IV	
IV	**Immunodeficiency, Autoimmunity & AIDS**	12
	a. Primary immunodeficiency : Agammaglobunaemia, X- linked, Common Variable immunodeficiency (CVID)	

	b. Acquired or Secondary Immunodeficiency-Down's syndrome,AIDS, Hodgkin's disease c. Organ Specific autoimmune diseases - Insulin Dependent Diabetes d. Systemic Autoimmune diseases - Rheumatoid Arthritis e. Treatment of Autoimmune Diseases.	
V	**Cancer & the Immune System, Transplantation Immunology**	12
	Cancer & the Immune System a. Cancer origin & Terminology b. Malignant transformation of cells c. Oncogenes & cancer induction. d. Tumors of the immune system e. Tumor antigens. f. Immune response to tumors. g. Tumor evasion of the immune system h. Cancer immunotherapy. **Transplantation Immunology** a. Immunologic Basics of Graft Rejection. b. Clinical manifestation of Graft rejection c. General Immunosuppressive Therapy d. Specific Immunosuppressive Therapy e. Clinical Transplantation	

References:

1. Cruse J and R. Lewis (2004) Atlas of Immunology 2nd Edn. CRC Press.
2. David Male, Jonathan Brostoff, David B Roth, Ivan Roitt.(2006).Immunology 7th edition.
3. R.A. Kindt T.S. and B.A. Osborne Kuby(2000) Immunology Fourth Edition W.H. Freeman & Co New York.
4. Reed R; Holmes D; Weyers J and A Jones (1998) Practical skills in Biomolecular Sciences Adison Wesley Longman Ltd.
5. Tizard ; I.R. (1995) Immunology an Introduction 4th Edn. Saunders College Publishing. Harcourt Brace College Publishers.

- Students are supposed to refer to "Current Contents" and periodicals for recent & additional information.

MJMB 102: GENETICS OF PROKARYOTES AND EUKARYOTES

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. Understand structure of chromosomes in prokaryotes and eukaryotes
2. Understand concept of gene expression and regulation in prokaryotes and eukaryotes
3. Understand the process of gene transfer in bacteria , genetic recombination and its significance
4. Understand the Mendelian Principles of Inheritance and Population Genetics

Module	Topics in Details	Lecture Hours
I	**Organization of Genetic material**	15
	a. Prokaryotic genome organization and its variability, DNA replication modes & models of DNA replication - theta & rolling circle, Mutagenesis - Mutagens (physical, chemical & biological agents), Mutations – types and phenotypic consequences, Conditionally expressed mutations, Isolation and detection of mutants, Estimation of mutation rate, mutational equilibrium. b. Eukaryotic Chromosome Organization, DNA replication & recombination, Chromatin modelling. Euchromatin and heterochromatin, Histone modifications & its effects, C-value paradox, Rot & Cot concept, Pseudogenes, Repetitive DNA, Satellite DNA, giant DNA Molecules- polytene & lamp brush , Split genes, Overlapping genes. Effect of antibiotics (quinolones and imidazoles) on DNA and its replication.	
II	**Gene Expression and its regulation**	15
	a. Evolution of the one gene one polypeptide concept. b. Transcription and its regulation in prokaryotes and eukaryotes , prokaryotic and eukaryotic RNA polymerases, transcription unit and transcription process, structure of mRNA molecules in Prokaryotes and Eukaryotes, transcription of other genes- ribosomal RNA and ribosomes, transfer RNA. Positive and negative regulation of transcription-, operons, Positive regulation - Maltose operon in *E. coli*, Histidine operon in *Salmonella*, role of attenuators, anti-termination, Post transcriptional RNA processing in eukaryotes. c. Prokaryotic and eukaryotic translation, components in translation process, Shine-Dalgarano sequences, Kozak sequence, initiation factors, elongation factors , translocation of ribosomes , termination of translation and release factors, Concept of protein sorting, chaperons, , post translational modification, fidelity of translation.	
III	**Genetic Recombination in Bacteria**	15
	a. Bacterial Transformation Discovery of Transformation , Process and molecular mechanism of Natural Transformation in Gram positive and Gram negative bacteria. Significance of Transformation, Artificial Transformation, regulation of transformation in *Bacillus subtilis*, gene mapping using transformation. Transfection.	

	b. Bacterial Conjugation F^+ cells, properties of F^+ cells, cross between F^+ and F^- cells Transfer of plasmid DNA, Stages in transfer process, tra genes of F, Host restriction in transfer, Formation of Hfr cells. Hfr Transfer: Cross between Hfr and F-, Chromosome transfer mediated by F' Plasmid (F-duction), gene mapping by conjugation, Conjugation in *Streptococcus faecalis* system, Conjugation in *E. coli* system. **c. Bacterial Transduction** Generalized Transduction , Specialized Transduction , Formation of specialized transducing particles from a λ lysogen , Specialized transduction of a nonlysogen , High frequency transducing phages , Specialized transducing phage as a cloning vehicle , Transduction and phage conversion, gene mapping using transduction	
IV	**Extension of Mendelian Principles of Inheritance and Population Genetics**	15
	A. Principles of Mendelian inheritance and its extensions, Incomplete dominance, co-dominance, epistasis, sex linked inheritance with atleast one example b. Difference in genotype frequencies amongst population. Hardy – Weinberg principle, Random mating, Polymorphic genes, Inbreeding, Introduction of new alleles in population, Natural selection, Random changes in allele frequency.	

References:

1. Alberts. B.; Johnson. A, Lewis J. Raff, M. Roberts. K. and P. Walter (2002) Molecular Biology of the cell 4th Edition. Garland Science, Taylor & Francis Group.
2. Elliott. W.H. and D.C. Elliot (2001) Biochemistry and molecular Biology. 2ndEdn. OxfordUniversity Press.
3. Gardner E.J., Simmons, M.J and D.P. Snustad. (1991) Principles of Genetics. 8th Edition. John Willey & Sons. Inc.
4. Hartl. D.L. and E.W. Jones. (1999) Essential Genetics. Second Edition. Jones and Bartlett Publisher.
5. Kleinsmith L.J. and V.M. Kish. (1995). Principles of Cell and molecular Biology 2ndEdn. Haper Collins. College Publishers.
6. Lewin B. (2004) Genes VIII – International Edition. Pearson. Prentice Hall. Pearson Education International.
7. Lewin. B. (2000) Genes VII. Oxford University Press.
8. Pierce. B. A, (2005) Genetics A Conceptual Approach.2ndEdition.W.H.Freeman and Company,New York
9. Primrose. S.B. and R.M. Twyman and R.W. Old (2003). Principles of Gene Manipulation. 6thEdn. Blackwell Science.
10. Russel P. (1998) Genetics Fifth edition. Addison. Wesley Longman Inc.

MJMB103: PRACTICAL COURSE I (Based on MJMB101 & CCCMB-101)

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. Perform various diagnostic tests using immunological principles
2. Identify blood group and select donor
3. Select and apply statistical methods for data analysis
4. Use excel tool for statistical analysis and generation of graphs and charts

Module	Practicals	No. of Practical Hrs
I	**Immunology** a. Blood grouping and Cross matching b. Study of Single Radial Immunodiffusion (SRID) c. Study of Ouchterlony Double Diffusion d. Purification of antibody fraction by ammonium suphate method e. Immunoelectrophoresis f. RA test g. ASO test h. CRP test i. Weil Felix Test j. ELISA– DOT	**30**
II	**Biostatistics** a. Measures of central tendency - mean, median & mode b. Measures of dispersion – Variance & standard deviation c. Estimation of confidence interval for a normal distribution d. Correlation analysis e. Plotting of histograms and frequency polygons f. ANOVA – CRD,RBD g. F-test h. T-test i. r^2 test j. Use of excel tool for generating graphs and charts	**30**

References :

1. Handbook of Practical Immunology – (Vol.1, 2 & 3) by D.M.Weir
2. Practical Microbiology by R.C.Dubey and D.K.Maheshwari . S.Chand & Co.
3. Advanced techniques in Diagnostic Microbiology by Tang and Charls W
4. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
5. Wardlaw A.C. (1985) Practical statistics for experimental Biologists John Wiley & Sons. Ltd.

MJMB104: PRACTICAL COURSE II (Based on MJMB102)

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. Perform isolation of genomic DNA, plasmid DNA, RNA from the bacteria and yeast cells
2. Characterization and estimation of DNA and RNA
3. Study the process of transformation and conjugation in bacteria
4. Study some basic techniques in genetics and molecular biology

Module	Practicals	No. of Practical Hrs
I	a. Staining of nuclear material of bacteria and yeast by feulgen / Giemsa method b. Isolation of genomic DNA from bacteria and yeast c. Isolation of plasmid DNA from bacteria. d. Characterization of DNA by gel Electrophoresis e. Quantitative estimation of DNA by using diphenylamine method f. Recombination in bacteria – Preparation of competent cells and transformation of plasmid DNA in *E. coli*. g. Curing of bacterial Plasmid using different agents	30
II	a. Conjugation in bacteria. b. Isolation of bacterial / yeast RNA c. Estimation of RNA by Orcinol method d. Thermal denaturation of DNA e. Determination of mutation rate - Natural and Induced f. Southern blotting (demonstration) g. PCR (demonstration) h. Protoplast fusion in bacteria (demonstration)	30

References:

1. Practical Microbiology by R C Dubey and D K Maheshwari. S.Chand and Co.
2. Laboratory Manual in Biochemistry by J.jayraman , New Age International Publication
3. Experimental Microbiology by R.J.Patel , Aditya Publishers , Ahmadabad
4. Environmental Science and Biotechnology : Theory and Techniques by A.G.Murugesan And C Rajkumari, MJP Publishers.

ELMB-101A: MICROBIAL ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY

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. Understand microbial ecology with respect to microbial evolution , biodiversity and its significance
2. Study the microbial forms in an extreme environment and their applications
3. Understand the concept of Bioleaching and Bioremediation with respect to heavy and toxic metals
4. Study the concept, mechanisms and applications of quorum sensing and biofilm formation
5. Understand the characteristics and management of industrial waste management
6.

Module	Topic in Detail	Lecture Hours
I	**Microbial Ecology** a. Microbial evolution and biodiversity: Biodiversity concept, Alpha and Beta biodiversity, Steps to preserve biodiversity, diversity indices (Shannon and Simpson's index). b. Genetic basis for evolution and Ribosomal RNA analysis for tracing microbial evolution c. Biodiversity conservation and Species conservation d. Microbial communities and ecosystem Development of microbial communities, Succession within microbial communities, Diversity and stability within microbial communities, Risk of introducing genetically modified microorganisms, e. Quantitative ecology: Sample collection, Sample processing, Detection of microbial populations, Determination of microbial numbers, Measurement of microbial metabolisms f. Bioresource and uses of biodiversity	**15**
II	**Microbial life in extreme environment:** Abiotic limitations to microbial growth. Diversity, adaptations, molecular mechanisms and potential applications of extremophilic bacteria – methanotrophs, oligotrophs, thermophiles, psychrophiles, metallophiles, acidophiles, alkaliphiles, halophiles and organic solvent and radiation tolerant	**15**
III	**Bioleaching and Bioremediation** **1. Bioleaching** a. Microbial assimilation of metals b. Bioleaching of metals - Gold, Uranium, Copper. c. Metal and metallic transformation- Mercury, Arsenic, Lead. d. Recovery of petroleum **2. Bioremediation of Metals** a. Metal toxicity effect on microbes b. Mechanisms of microbial resistance to metals, metal -microbe interactions c. Microbial remediation of metal contaminated soils d. Microbial remediation of metal contaminated aquatic systems	**15**

	e. Bioremediation of oil and petroleum products f. Bioremediation of waste gases	
V	**1. Quorum Sensing -** Stages , mechanism, AHI, AIP, AI. Quorum Sensing in gram positive and gram negative bacteria, QS inhibitors, QS applications. **2. Biofilms** a. Population, physiology, morphology and biochemistry of microbial biofilms b. Mechanism of cell adhesion and roles of different adhesion molecules c. Beneficial and harmful aspects of biofilms. d. Fouling Biofilms e. Control of Biofilms **3. Industrial Waste Management** a. General characteristics of liquid wastes of industries - pH, electrical conductivity, COD, BOD, total solids, total dissolved solids, total suspended solids, total volatile solids, chlorides, sulphates , oil & grease. b. Characteristics of waste and effluents, environmental impact and, treatment of distillery industry, food industry, dairy industry, beverage industry, dye industry, textile industry, pharmaceutical industry.	**15**

References:

1. Asthana D.K. and M. Asthana (2003) Environment Problems & Solutions. S. Chand and Co. Ltd. New Delhi.
2. Bathra Atlas (2007) Microbial Ecology Fundamentals and Application, 4th edition,Pearson Education Publication
3. De. A.K. (1994) Environmental Chemistry, New Age International (P) Limited, Publishers.
4. Gray. N.F. (2000) Water Technology. An Introduction for Environmental Scientists and Engineers. Viva Books Pvt. Ltd. New Delhi.
5. Jadhav H.V. (1992) Elements of Environmental Chemistry. Himalaya Publishing House.
6. Kormondy E J. (2007) Concepts in Ecology,4th edition, Pearson Education Publication
7. MooreJ.W. and E.A. Moore (1976) Environmental Chemistry Academic Press, New York.
8. Rao. C.S. (1991) Environmental pollution control Engineering Wiley Eastern Limited New Delhi. Bangalore, Bombay, Calculta, Guwahati, Hyderabad, Lukknow Madra & Pune.
9. Rittman B.E. and P.L. Mc Garty. (2001) Environmental Biotechnology. Principles & Applications. McGraw Hill International Editions. Biological Sciences Series.
10. Santra. S.C. (2001_ Environmental Science, New Central Book Agency (P) Ltd.
11. Sharma B.K. and H. Kaur (1994). Water pollution Goel Publishing House Meerut.
12. Subbarao N.S., Soil Microbiology Fourth Edition of Soil Micro-organisms and plant growth. Published by Raju Primlani for oxford and JBH Publishing. Co. Pvt. New Delhi.

ELMB 101B: BIOSTASTISTICS AND BIOINFORMATICS

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. Know concepts in Bioinformatics
2. Understand computing tools in bioinformatics
3. Explore websites and biological databases
4. Select and apply statistical methods for data analysis.

	A. Bioinformatics.	
Module	**A. Biostatistics**	**Lecture Hours**
I	a. Collection, Classification and presentation of Data: Primary and secondary data, methods of collecting primary data, Sources of secondary data, Precautions in the use of secondary data. Organization of data, Classification, Frequency distribution, Basic principles for forming a grouped frequency distribution, Cumulative frequency distribution, Bivariate frequency distribution, table, graphs and charts. b. Correlation Analysis: Introduction, Methods of studying correlation, Scatter diagram method, Karl Pearson's method of correlation (covariance method), Probable error, Correlation in bivariate frequency table, Rank correlation method, Method of concurrent deviations, Coefficient of determination, Lag and lead correlation. c. Regression analysis: Linear and nonlinear regression, Lines of Regression, Coefficient of regression, mean value of the two lines of regression, Standard error, Regression equations for a bivariate frequency table, Correlation analysis vs Regression analysis	**15**
II	a. Measures of Central Tendency and Dispersion, Probability distribution (Poison**,** Binomial and Normal), Hypothesis testing. b. Statistical Tests: Z-test, T-test, ANOVA, chi squared test, F test.	**15**
	B. Bioinformatics	
III	a. Overview, History and Scope of Bioinformatics, Bioinformatics websites, data types and source. Types of databases in bioinformatics - primary, secondary and composite, Submission and Retrieval of entry from database. b. Retrieval of biological data Entrez and DBGET/Link DB, SRS c. Nucleotide sequence databases, analysis and identification. GeneBank, NCBI, EMBL Nucleotide sequence databank, DNA Data Bank of Japan (DDBJ), PubMed, PDB Examples of related tools (FASTA, BLAST, BLAT, RASMOL) d. Relation of bioinformatics with molecular biology , cloning vectors, concept of maps, physical maps, shotgun libraries, DNA polymorphism e.g. the Human Genome Project e. Protein sequence databases: NCBI Protein, EMBL Protein, PIRPSD, SwissProt	**15**

IV	**Bioinformatics Tools** a. Sequence similarity searches -FASTA and BLAST, Sequence Filters. b. Amino acid substitution matrices. Protein structure visualization and prediction, Structural Databases- PDB, SCOP, Molecular visualization tools- RasMol, Cn3D, SPDBV, Interactive database searches and PSI – BLAST c. Multiple sequence alignment- gene and protein families and pattern databases. Multiple sequence alignment (MSA) and family d. Application of MSA in phylogenetics - taxonomic analysis of microorganisms, graphical forms - Rooted, Unrooted, Cladogram, Dendrogram, Phylogram, Phenogram. Application of Bioinformatics in various fields: agriculture, molecular medicine.	**15**

References :

1. Bergeron. B. (2003). Bioinformatics Computing. Prentice Hall Inc. Eastern Economy Edition.
2. Bailey N.T.J (1995) Statistical Methods in biology 3rd Edition. Cambridge lowprice Edition Cambridge university press.
3. Dixit J.V. (1996) Principles & Practice of Biostactistics 1st Edn. M/s. Banarasidas Bhanot (Publisher).
4. Dwyer. R.A. (2003) Genomic Perl. From Bioinformatics Basics to working code. Cambridge University Press.
5. Simpson R.J. (2004) Purifying Proteins for Proteomics. A laboratory Manual. Cold spring Harbor laboratory press.
6. Westhead. D.R.,.Parish J.H and R.M. Twyman (2003) Instant notes in 'Bioinformatics' Viva Books Private Ltd.
7. T. Bhaskararao (2002) Methods of Biostatistics. Paras Publishing.
8. Wardlaw A.C. (1985) Practical statistics for experimental Biologists John Wiley & Sons. Ltd.
9. Reed R, Holmes; D; Weyers. J & A. Jones (1998) Practical skills in Biomolecular sciences. Adison Wesley Longman Ltd. Pg. - 251 - 268, 303 - 323.

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

ELMB 101C: BIOCHEMISTRY

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. Understand basic concepts in biochemistry.
2. Understand structural features and chemistry of macromolecules.
3. Know membrane transport mechanism in bacteria.

Module	Topics in Detail	Lecture Hours
I	**Basic concepts in Biochemistry** • Common organic compounds found in living system • Common functional groups in biochemistry. OH, CHO, C = 0, NH2, C – NH2, SH, ester, ethers, methyl, ethyl, phospho, guanidio, imidazole etc). • Common ring structures in biochemistry, Isomerism, Isotopes, Energetics, Redox systems, High energy compounds. **Structural Features and Chemistry of Macromolecules** **Nucleic acids:** • Tautomeric forms of bases and their implication in pairing of bases. • Structure of polynucleotides, DNA structure, DNA and RNA (t -RNA, r-RNA, m- RNA etc). • Structure of DNA double helix. • R and L handed forms. • A, B, C and Z forms of DNA. • Denaturation and Renaturation of DNA and Tm value.	**15**
II	**Proteins** • Amino acids. • Peptides – Prepeptide linkage, partial double bond nature of peptide linkage. • Proteins – structural classification of Proteins, primary structure, secondary structure, tertiary structure, Quarternary structure. • Determination of primary structure of polypeptide (N terminal determination, C terminal determination, Partial hydrolysis, Overlapping sequence etc), helix of polypeptide. • Structure and functions of globular proteins. • Immunological techniques to investigate proteins. • Artificial synthesis of polypeptides.	**15**
III	**Carbohydrates** • L forms and D forms of sugar. • Reducing and non reducing sugars. • Aldoses / ketoses. • Alpha and Beta, ring forms of sugars. • Glycosidic linkages. • Sugar derivatives – sugar alcohol, amino sugars, dextro sugars, sugar acids • Polysaccharides (starch, glycogen, cellulose)	**15**

	Lipids • Fatty acids – Types and nomenclature. • Saturated and unsaturated fatty acids, • Structure and function of Triglycerides, Phospholipids, Sphingolipids. • Structure and function of steroids, terpenes, prostaglandins.	
IV	**Membrane Transport** • Overview of membrane transport. • ATP powered pumps and intracellular ionic environment. • Non gated Ion channels and the resting membrane potential. • Co-transport – symport, antiport. • Neurotransmitters. • ATP driven active transport system for Sodium and Potassium ions. • Proton gradient in Halobacteria. • Transport of antibiotics that increase the ionic permeability of membranes	**15**

References:

a. Doelle, H.W. (1975) Bacterial Metabolism 2nd Edition Academic Press, Inc. N.Y.

b. Jayraman – Laboratory manual in Biochemistry, New Age International publishers, New Delhi.

c. Lehninger A.L. (1984): Principles of Biochemistry, 1st Indian Edition, LBS publishers and distributors Pvt. Ltd. New Delhi.

d. Lehninger A.L.(2000) Principles of Biochemistry II Edition by D.KL. Nelson and

e. M.M. Cox Mcmillan Worth Pub. Inc. N.Y.

f. Mehler H.R. (1968) Basic biological chemistry, Harper and Row publisher, Inc. New York.

g. Murray R.K., Harper's Biochemistry, Appleton and Lange Stanford, 25th Edition.

h. D. Plummer, J. Wiley & Sons Introduction to practrical Biochemistry by – W.H. Freeman & Company publishers, SanFrancisco

i. Stryer, W.H. Freeman (1992) Biochemistry IV Edition and Co. N.Y.

j. Tood, H.S. Mason, J.T.V. Burger (1966). Text book of biochemistry, 4th Edition – west

k. E.S.W. R MacMillan Company, New York

l. West E.S., W.R. Todd, H.S. Mason. J.T.V. Burgger (1966) Text book of biochemistry, 4th Edition, MacMillan, New York.

m. White A., P. Handler. E.L. Smith (1973) Principles of Biochemistry, 5th Edition.

n. Wilson K. and J. Walker, (1999) Cambridge University Press. Principles and techniques at Practical biochemistry

ELMB-101A: PRACTICAL COURSE III (Based on ELMB101A)

Total: 2 Credits; Workload: 30 hours / Credits

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

Course Outcomes:

1. Able to isolate the extremophiles from natural habitats
2. Able to carry out analysis of waste water of different industries
3. Understand the isolation of pesticide degrading and biosurfectant producing organisms from natural habitats.
4. Study the biofilm formation by organisms
5. Perform bioleaching of heavy metals
6. Study quantitative ecology

Module	Practical	No. of Practicals Hrs
I	**Isolation and study of Indigenous Extremophiles :** Sample Collection, Processing and Isolation, Morphological Characterization and Identification by Biochemical tests (Using Bergey's Manual) a. Thermophiles b. Acidophiles c. Alkalophiles d. Halophiles e. Psychrophiles	30
II	1. Waste Water Analysis : a. Determination of TS, TSS & TDS b. Determination of BOD and COD of a given sample 2. Isolation of pesticide degrading bacteria, demonstrating determining efficiency using colorimetric assay 3. Isolating biosurfactant producing bacteria and demonstration of bio surfactant activity 4. Bacterial Biofilm formation detection by Crystal violet staining assay 5. Bioassay for determination of quorum sensing signals produced by bacteria. 6. Bioleaching of metals from waste 7. Determination of heavy metals (Fe/Cu) by spectrophotometric methods. 8. Quantitative Ecology: Biodiversity estimation, calculating diversity Indices	30

CCCMB-101: RESEARCH METHODOLOGY

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. Understand concept of research
2. Design a research proposal
3. Know presentation skills and scientific writing.
4. Select tool and analyze research data

Module	Topics in Detail	Lectures Hours
I	**a. Foundation of Research :** Definition, meaning, characteristics of scientific research, types of research, nature of qualitative and quantitative research, Process of Research, Formulation of Research Design, types of research designs, meaning and sources of research problem, characteristics of good research problem, Formulation of Research Problem – Introduction, Review of Literature, Objectives, hypothesis, scope, limitations etc. **b. Biostatistics** Introduction to statistics - Basic terms, population, sample , variable, parameter, Measures of central tendency- mean, median & mode, Frequency distribution, Measures of dispersion – range, variation , coefficient of variation, Probability & Distribution – Bernoulli, Binomial, Poisson and normal distributions. **c. Collection of Data:** Primary and secondary data, methods of collecting primary data, drafting or framing the questionnaire, sources of secondary data, **d. Classification and Tabulation:** Organization of data, Classification, Frequency distribution, Basic principles for forming a grouped frequency distribution, Cumulative frequency distribution, Bivariate frequency distribution, Tabulation - meaning and importance **e. Graphical Representation of Data:** Difference between diagrams and graphs, Diagrammatic representation, Graphic representation of data, Limitations of diagrams and graphs, Construction and interpretation of a histogram.	**12**
II	**a. Correlation Analysis:** Methods of studying correlation, scatter diagram method. **b. Linear Regression Analysis:** Linear and nonlinear regression, Lines of Regression, Coefficient of regression, mean value from two lines of regression, regression coefficients and the correlation coefficient from the two lines of regression ,Standard error of an estimate, Regression equations for a bivariate frequency table, Correlation analysis vs Regression analysis **c. Handling Proportion data:** Examples of proportion data (MPN, Sterility testing of medicines, animal toxicity, therapeutic trials of drug and vaccines, infection and immunization studies e. g LD50, ED50, PD50 Statistical treatment of proportion data, Chi-Square test, goodness of fit to	**12**

	normal distribution **d. Handling Count data:** Examples of count data Bacterial Cell count, radioactivity count, colony and plaque count etc. Statistical treatment to count data: Poison distribution, standard error, confidence limits of count. **e. Analysis of variance:** Introduction, procedure, F & T test.	
III	**Scientific Writing** **a. General aspects:** Organizing time, Organizing information and ideas e.g. writing – adopting a scientific style, Developing technique, Getting started, Revising your text with the help of words and phrases, sentences, paragraphs, using dictionaries, using a thesaurus, using guides for written English. **b. Review and literature survey writing:** Selecting a topic, making a plan to construct possible content, construction of an outline, scanning the literature and organizing references. Introduction, main body of the text, conclusion, References, Style of literature Surveys, reviewing your write-up **d. Writing research paper:** Title, Authors and address, Abstract, Key words, Introduction, Materials and Methods, Results & Discussion (IMRAD), Conclusions, Acknowledgements, Literature cited (Bibliography)	**12**
IV	**a. Reporting practical and project work:** Practical & project reports, Thesis Structure of reports of experiment works - Title, Authors & their institution, Abstract Summary, List of Contents. Abbreviations, Introduction, Materials and Methods Results Discussion / conclusions, Acknowledgements, Literature cited (Bibliography) Production of a practical report, steps - choose the experiment, make up plans, write, Revise, prepare final version. Submit Producing a Scientific paper Assessing potential content, choosing a journal, writing, submitting. Responding to referees comments, checking proofs & waiting for publication. **b. Organizing a poster display:** Preliminaries, Design, Layout, Title Text, Sub titles and headings, Colour Content. Introduction, Materials and Methods, Results and conclusion, the poster session. **c. Giving an oral presentation:** Preparation - Preliminary information, Audio - Visual aids, Audience. Content - Introductory remarks, the main message. Concluding remarks on presentation **d. Ethics in Research:** Plagiarism- Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good researcher.	**12**
V	**Introduction to Bioinformatics ,ICT tools in Research and IPR** a. Internet and its use for research and communication, Internet and Related Programmes, HTML, HTTP, telnet, FTP, internet browsers, TCP/IP. NCBI,	

	ENTREZ, Databases, Database search - Data mining, Data management and interpretation, literature database. BLAST, sequence alignment, protein modeling, protein structure analysis, docking, genomics and proteomics. **b. Excel Spreadsheet Tool :** Application, using formulas and functions, features for statistical data analysis, generating charts / graph and other features. **c.** Software tools like EViews , MATLAB, and Minitab. **d.** Understanding major indexing databases like Scopus, Web of Science, INFLIBNET. Concept of impact factor of Journals, citation, citation index and h-index etc. **e**. IPR – Introduction , Nature, Patents, Designs, Trademarks, Copyright, Process of Patent and Development, Technological Research and Innovation.	**12**

References:

1. Day Robert A.: How to write and publish a scientific paper.
2. Gibaldi Joseph: MLA handbook for Writers of Research Papers.
3. Kothari R. C.: Research Methodology, Methods and Techniques, 2nd revised edition, New Age International.
4. Ranjit Kumar: Research Methodology.
5. Reed, R. Homes, D; Weyers, J. and A. Jones. Practical skills in Bimolecular Sciences. Addison Wesley Longman Limited
6. Bailey N.T.J (1995) Statistical Methods in biology 3rd Edition. Cambridge low price Edition Cambridge university press.
7. Baxevanis A. D. and B.F. F. Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins.
8. Campbell R.C. : Statistics for Biologists, Cambridge University Press.
9. Day Robert A. : How to write and publish a scientific paper.

****