M.Sc. Microbiology Syllabus

Kerala University

(2022 Admission Onwards)

	FIRST SEMESTER			
MB 511	GENERAL MICROBIOLOGY	6	0	4
MB 512	MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND BIOSTATISTICS	5	0	4
MB 513	BIOPHYSICS, INSTRUMENTATION AND BIOINFORMATICS	5	0	4
MB 514	LAB -1. GENERAL MICROBIOLOGY	0	5	4
MB 515	LAB -2. MICROBIAL BIOCHEMISTRY AND BIOINFORMATICS	0	3	3
MB 516	INDUSTRIAL VISIT	0	1	1
	TOTAL	16	9	20
	SECOND SEMESTER			
MB 521	MOLECULAR BIOLOGY AND rDNA TECHNOLOGY	5	0	4
MB 522	IMMUNOLOGY AND IMMUNOTECHNIQUES	5	0	4
MB 523	FOOD AND INDUSTRIAL MICROBIOLOGY	5	0	4
MB 524	BIOSAFETY, QUALITY ASSURANCE AND IPR (ELECTIVES)	3	0	3
MB 525	LAB-3. rDNA TECHNOLOGY AND IMMUNOLOGY	0	3	4
MB 526	LAB-4. FOOD AND INDUSTRIAL MICROBIOLOGY	0	4	4
	TOTAL	18	7	20
	THIRD SEMESTER			
MB 531	ENVIRONMENTAL, AGRICULTURAL AND EXO MICROBIOLOGY	5	0	4
MB 532	MEDICAL BACTERIOLOGY AND DIAGNOSTIC MICROBIOLOGY	5	0	4
MB 533	MEDICAL VIROLOGY, MYCOLOGY AND PROTOZOOLOGY	5	0	4
MB 534	LAB –5. ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	0	4	4
MB 535	LAB-6. MEDICAL BACTERIOLOGY, VIROLOGY, MYCOLOGY AND PROTOZOOLOGY.	0	5	4
MB 536	HOSPITAL VISIT	0	1	1
	TOTAL	15	10	21
	FOURTH SEMESTER			
MB 541	MARINE MICROBIOLOGY	5	0	4
MB 542	PHARMACEUTICAL MICROBIOLOGY (ELECTIVES)	5	0	3
MB 543	DISSERTATION AND VIVA-VOCE	0	15	2+2
	TOTAL	10	15	11

FIRST SEMESTER

	FIRST SEMESTER			
MB 511	GENERAL MICROBIOLOGY	6	0	4
MB 512	MICROBIAL PHYSIOLOGY, BIOCHEMISTRY AND BIOSTATISTICS	5	0	4
MB 513	BIOPHYSICS, INSTRUMENTATION AND BIOINFORMATICS	5	0	4
MB 514	LAB -1. GENERAL MICROBIOLOGY	0	5	4
MB 515	LAB -2. MICROBIAL BIOCHEMISTRY AND BIOINFORMATICS	0	3	3
MB 516	INDUSTRIAL VISIT	0	1	1
	TOTAL	16	9	20

MB 511

GENERAL MICROBIOLOGY

Number of Hours / Week: 6 **CREDITS:4**

Course Outcome

By attending the course, the students will be able

- To understand the history of microbiology
- To understand the diversity of microbial world
- To categorize microorganisms based on their characteristics
- To emphasize the importance of sterilization and disinfection and the methods used in a microbiology laboratory and premises

UNIT I

Historical developments of Microbiology – Contributors of Microbiology – Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming, Joseph Lister. Overview of Microbial world – Bacteria, Fungi, Algae, Virus, Protozoa (introduction only).

UNIT II

Outline classification of microorganisms- Haeckel three Kingdom classification, Whittaker five Kingdom classification, and Woese's three domain classification, Ainsworth classification of fungi, Fritsch classification of algae, ICTV classification of virus. Bacterial classification as per latest edition of Bergey's Manual of systematic Bacteriology. Classification of Protozoa based on locomotion. Bacterial taxonomy – Binomial Nomenclature, Numerical taxonomy, Identification characters-morphological, staining, physiological, biochemical and molecular (mol % G+C, nucleic acid hybridization, 16SrRNA sequencing) characters.

UNIT III

General characters of bacteria and archaea. Nutritional types of bacteria (based on sources of carbon, energy and electrons). Factors influencing bacterial growth – pH, temperature, oxygen, pressure, radiation. Bacterial reproduction – asexual (binary fission, budding, baeocyte and spore formation), sexual (conjugation, transduction, transformation). Growth curve. Batch, fedbatch, continuous culture. Measurement of bacterial growth. Microbial locomotion – flagellar motility, spirochete motility, twitching and gliding motility. Ciliary and amoeboid movement. Chemotaxis and Phototaxis.

UNIT IV

Culture media-solid, liquid, semisolid media. Simple media, Differential media, Special media - enriched media, enrichment media, selective media, indicator media, sugar media, transport media. Aerobic and anaerobic media. Culture Methods – pour plate, spread plate, streak plate, lawn, stroke, stab cultures, shake culture, liquid cultures. Anaerobic culture methods – anaerobic jars,

gaspak, anaerobic chamber, Robertson's media, Roll's tube, Wright's tube methods. Culture Preservation – serial sub culturing, mineral oil overlay, cryopreservation, lyophilisation. Culture Collection Centres. Metagenomics.

UNIT V

Sterilization and Disinfection – principle, methods and mechanism of action – Physical Agents – Incineration, dry heat, moist heat, filtration, Radiation – (uv and ionising). Chemical agents – disinfectants – phenol, aldehydes, halogens, hypochlorites. Testing of disinfectants – phenol coefficient test, Rideal Walker test. Plasma sterilization, Principles, functioning and types of Biosafety cabinets.

REFERENCES: -

1. Talaro, K.P. and Talaro, A. (1999) *Foundations of Microbiology* 4th edition. McGraw- Hill Publication.
2. Pelczar,M.J., Chan,E.C.S. and Kreig,N.R.(2006) *Microbiology* 5th edition. McGraw- Hill NY Publication
3. Willet,J., Sherwood,L. and Woolverton. C.(2007) *Prescott, Harley and Klein's Microbiology* 7th edition. McGraw-Hill Higher education
4. Salle, A.J. (2007) *Fundamental Principles of Bacteriology*. Envins Press
5. Madigan, M., Martinko J., Stahl D. and Clark,D.(2011) *Brock Biology of Microorganisms* 13th edition. Pearson Publication
6. Ketchum Paul A. (1988) *Microbiology: Concepts and Application*. John Wiley &Sons Publication
7. Davis,B.D., Dulbecco, R., Eisen, H.N. and Ginsberg, H.S.(1990) *Microbiology* 4th edition. Lippincott Williams &Wilkins Publication
8. Black, J.G. (2012) *Microbiology: Principles and Explorations* 8th edition. Wiley Publishers
9. Prescott L.M. Harley J.P. and Klein D.A. (2005). *Microbiology* (6th edition) McGraw Hill, New York.
10. Schelegel, H.G. (1993) *General Microbiology*, 7th Edn. Cambridge University Press, Cambridge.
11. Dubey R.C and Maheswari D.K (2012). *A text of Microbiology* (Revised edition). S. Chandand Company Ltd., New Delhi.

MB 512
MICROBIAL PHYSIOLOGY, BIOCHEMISTRY & BIOSTATISTICS

Number of Hours / Week: 5 **CREDITS:4**

Course Outcome

By attending the course, the students will be able

- To know about the different cellular transport and signal transduction pathways
- To understand different metabolic pathways in bacteria
- To understand the basic concepts and significance of Biomolecules
- To analyse the structure-function relationships of biomolecules
- To understand enzymology and regulation
- To appraise the role of statistics in research

UNIT I

Cell membrane and transport**:** Membrane proteins, lipids. Fluid mosaic model, membrane fluidity, asymmetry, lipid raft, functions of membrane proteins and lipids. Regulation of transport: porins, facilitated diffusion, porter molecules; Facilitated transport: symport, antiport, uniport, anion porter, glucose porter; Active transport: proton pumps; Na+ K+ pumps, Ca2+ pumps; Ionic channels: general characteristics of ionic channels. Cell signalling: Prokaryotic cell to cell signalling - quorum sensing, mechanism of quorum sensing.

UNIT II

Metabolic pathways in bacteria - Energy production in bacteria – energy and ATP, aerobic and anaerobic respiration, glycolysis, tricarboxylic acid cycle, electron transport and oxidative phosphorylation, phosphoketolase pathway, pentose phosphate pathway, gluconeogenesis and glyoxylate cycle. Photosynthetic bacteria and cyanobacteria- pigments of photosynthetic apparatus, mechanism of photosynthesis in bacteria – oxygenic and anoxygenic.

UNIT III

Carbohydrates: Classification, function and properties of monosaccharides, disaccharides, oligo saccharides, homo polysaccharides and hetero polysaccharides. Properties and functions of glycolipid, glycoprotein, chemical structure and properties of starch, cellulose, hemicellulose and glycogen. Lipids: Classification and properties of saturated and unsaturated fatty acids, complex lipids and sterols in microbial system. Amino acids and proteins**:** Classification of amino acids, Peptide bonds, classification and functions of proteins. Protein sequencing. Protein structure-primary, secondary, tertiary and quaternary structures, forces stabilizing denaturation kinetics, torsion angle, protein – ligand interactions, Ramachandran plot.

UNIT IV

Enzyme-Classification and nomenclature, Active site, apoenzyme, holoenzyme, prosthetic group, co enzymes and its functions. Mechanism of enzyme action, activation energy. Factors affecting the velocity of enzyme action, Michaelis Menton kinetics- derivation of MM equation, Km value determination and its significance, Vmax and its significance, LB plot and its application, turn over number. Expression of enzyme activity, enzyme specificity. Enzyme inhibition, enzyme regulation, allosteric regulation. Isoenzymes. Microbial cellulase

UNIT V

Introduction, scope and concept of sampling – representative sampling and sampling size. Data presentation – graphics, tables, histograms and pi – diagrams. Frequency, distribution, measures of central tendency (mean, median, mode, quartile, decile and percentile). Measures of dispersion, mean deviation and standard deviation. Correlation and regression, scatter diagram, coefficient of correlation, rank correlation, lines of regression. Probability. Basic concepts related to probability theory, classical probability and probability distributions. Introduction and simple properties of binomial, normal and skewed distribution and their applications in biology. Tests of hypotheses- Some basic concepts, errors in hypotheses testing, critical region, students t – test for the significance of population mean, chi square test for population variance, F- test for the equality of two population variance. Analysis of variance – one way and two-way analysis.

REFERENCES: -

1. David White, James Drummond, Clay Fuqua (2011) *The Physiology and Biochemistry of Prokaryotes.* 4thEdition.
2. Rose A H (1977) *Chemical Microbiology. An Introduction to Microbial Physiology* (3rd Edition). Butterworth, London.
3. Berg,J.M., Stryer,L(2002) *Biochemistry* W.H Freeman & Company.
4. Nelson, D.L., Cox,M(2008) *Lehninger's Principles of Biochemistry* Mac Millan.
5. Voet,D and Voet, J.G (2010) *Biochemistry* 4th edition Wiley.
6. Jain,J.L(2005)*Fundamentals of Biochemistry* 6 th edition S.Chand & Co.
7. Deb,A.C(2001*) Fundamentals of Biochemistry* New Central Book Agency(P) Ltd.
8. Pelczar,M.J., Chan,E.C.S and Kraig(1977) *Microbiology* Mc Graw-Hill
9. Talaro, K.P., and Talaro A(2004) *Foundations of Microbiology* 5 th edition Mc Graw- Hill
10. Aneja, K.R., Jain, P. and Aneja, R(2008)*Text book of Basic and Applied Microbiology* New Age International
11. Kenney, J.F. and Keeping,E.S. (1951) Mathematics of Statistics 2nd edition. D Van Nostrand Company
12. Athel Cornish-Bowden (2000) Basic Mathematics for Biochemists 2nd edition. Oxford Press

13. Norman T.J.Bailey (1995) Statistical Methods in Biology 3rd edition. Cambridge University Press
14. Rao,P.S.S.Sundar and Richard,J.(2006) Introduction to Biostatistics and Research Methods 5th edition PHI Learning Pvt. Ltd.

MB 513

BIOPHYSICS, INSTRUMENTATION & BIOINFORMATICS

Number of Hours / Week: 5 **CREDITS:4**

Course outcome

By attending the course, the students will be able

- To understand the significance of energetics in biological system
- To handle various instruments used in laboratories
- To understand the biochemical techniques used in research and industry
- To demonstrate the *in silico* analytical tools for biological data analysis

UNIT I

Laws of conservation of energy-first and second laws and their relevance in the biological system, entropy, enthalpy, thermodynamic equilibrium, redox potential, Gibb's free energy, bioenergetics –endothermic and exothermic reactions of biological systems, energy change in the biological reactions. Electrical properties of biological compartments. Electricity as a potential signal, electrochemical gradients, membrane potential, ATP synthesis, chemiosmotic hypothesis.

UNIT II

Microscopy, Principles of microscopy, various types of microscopy – simple microscope, phase contrast microscope, fluorescent microscope. Principles of staining of bacteria- Gram's staining, Acid fast staining (Ziehl Neelsen staining), Capsule staining, flagellar staining. Electron microscope (SEM & TEM). TEM – specimen preparation – negative staining, shadowing, freeze – etching. Polarization, confocal and interference microscopy, CCD camera, Introduction to Atomic force microscopy.

UNIT III

Basic principles and working of instruments, pH meter, spectrophotometer (UV and visible), Beer-Lambert's law, flame photometry, colorimeter. Brief account of densitometry, fluorimetry, manometry, atomic absorption spectroscopy, IR, NMR, X – ray crystallography, flow cytometry and GM counter.

UNIT IV

Centrifugation-Principles of sedimentation technique. Principle, procedure and application of ultra-centrifugation, differential centrifugation and density gradient centrifugation. Principle, Instrument Design, types of Chromatography. Principles and procedure of paper chromatography, thin layer chromatography, column chromatography, ion- exchange chromatography, affinity chromatography and gel filtration, GLC, HPLC, FPLC, LC-MS. Electrophoresis-Principles of electrophoresis and applications – paper electrophoresis, gel electrophoresis (native, SDS).

UNIT V

Introduction to bioinformatics and Data Mining, Biological databases and search tools, DNA and RNA sequence databases, genomic databases, protein sequence databases, structural databases, derived and specialized databases, Sequence analysis, pairwise and multiple alignments, sequence analysis software, Phylogenetic analysis- methods, Protein structure prediction, structural alignment methods, homology modeling and molecular docking.

REFERENCES: -

1. Martin, R.B. (1964) Introduction to Biophysical Chemistry. Mc Graw Hill
2. Banerjee,P.K. (2008) Introduction to Biophysics .S.Chand & Co
3. R.N Roy. A Text of Biophysics,
4. Nelson, D.L., Cox,M (2008) Lehninger's Principles of Biochemistry Mac Millan.
5. Voet,D and Voet, J.G (2010) Biochemistry 4th edition Wiley
6. Potter, G.W.H. and Potter, G.W. (1994) Analysis of biological molecules: An introduction to principles, instrumentation and techniques. Springer publication
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8. Watson,J.D. et al.(2014) Molecular Biology of the Gene 7th edition. Pearson publication
9. Nair, A.J. (2007) Principles of Biotechnology. Laxmi Publication (P) Ltd
10. Kumar,H.D., Gupta B.R., Engeldrum, D.(2000)Textbook of Biotechnology. East-West Press
11. Prescott L.M. Harley J.P. and Klein D.A. (2005). *Microbiology* (6th edition) McGraw Hill, New York.
12. Harris DA and CL Bashford (Ed.) (1987) *Spectrophotometry and Spectrofluorimetry:A Practical Approach*. IRL Press, Oxford.

13. DonaldL.Pavia Gary M.Lipman, George S Kriz. Introduction to Spectroscopy. Harcourt brace College Publishers, Orlands, Florida
14. Braithwate A and Smith F J (1986) Chromatographic methods. Chapman and hall, NewYork.
15. White R, Downs,T(2007) *How computers work* 9th edition Pearson publishers
16. Kothekar,V(2004)*Introduction to Bioinformatics* 1st edition Dhruv publication
17. Baxevaris,A.D. *Bioinformatics* B.F Publication
18. Higgins, D.,Taylor,W(2000) *Bioinformatics* Oxford University Press
19. Persuki,Jr and Persuki (1997*) The internet and new biology :tools for genomics and molecular research* ASM Press.

MB 514
LAB 1: GENERAL MICROBIOLOGY

Number of Hours / Week: 5 **CREDITS:4**

Course Outcome

By attending the course, the students will be able

- To learn good microbiological practices in the laboratory
- Know various Culture media and their applications and to understand various physical and chemical means of sterilization
- To familiarize with Master aseptic techniques and to attain skill to perform routine culture handling tasks safely and effectively
- To perform staining, biochemical and cultural tests to characterize and identify microorganisms
- To understand procedures for sterilization, cultivation procedures and enumeration methods of microorganism.

1. Cleaning and sterilization of glass wares.
2. Preparation of solid and liquid media and their sterilization.
3. Uses and study of microscopes.
4. Measurement of microorganisms – micrometry.
5. Bacterial cell counting by haemocytometer.

6. Staining of bacteria
    i) Gram staining.
    ii) Negative staining.
    iii) Capsule staining
    iv) Endospore staining.
    v) Acid – fast staining.
    vi) Volutin granule staining
7. Microscopic test for bacterial motility by hanging drop method.
8. Efficiency testing of autoclave
9. Evaluation of potency of disinfectant by phenol coefficient method.
10. Cultivation of bacteria
    i) Pour plate method.
    ii) Spread plate method.
    iii) Streak plate method.
    iv) Anaerobic culture method by liquid paraffin overlay
11. Study of cultural characteristics of bacteria and biochemical reaction of bacteria
12. Microbial culture preservation by glycerol stock
13. Bacterial growth curve
14. Measurement of bacterial growth by turbidity method.
15. Effect of pH, incubation temperature and salinity on bacterial growth.
16. Isolation of fungi using suitable media.
17. Identification of fungi by lactophenol cotton blue mounting and study of the cultural characteristics of various fungi.

REFERENCES: -

1. Dubey RC & Maheshwari DK (2002) *Practical Microbiology* (S. Chand & Company Limited
2. Aneja KR (2003) *Experiments In Microbiology, Plant Pathology And Biotechnology*. New Age International.
3. Kannan N (2002) *Manual in General Microbiology*. 2nd Edition, Panima Publishing Co., New Delhi
4. Cappucino, J.G & Sherman, S (2010*) Microbiology. A Laboratory Manual* 9th edition Benjamin-Cummings Publishing Company

MB 515
LAB – 2: Microbial Biochemistry and Bioinformatics

Number of Hours/Week: 3 **CREDITS:3**

Course Outcome

By attending the course, the students will be able

- To prepare molar, normal and percentage solutions
- To quantify samples, present in solutions by selecting appropriate methods
- To isolate and identify samples present in a mixture, by various separation techniques
- To retrieve data and/or information present in databanks

PART I – MICROBIAL BIOCHEMISTRY

1. Separation of serum proteins by electrophoresis.
2. Separation and identification of amino acids by paper chromatography and Thin Layer Chromatography.
3. Separations of proteins by SDS - PAGE.
4. Separation of any biomolecule by column chromatography.
5. Separation of any biological macro molecule by gel filtration chromatography.
6. Measurement of cellulase by reducing sugar assay test.
7. Estimation of glycogen in a bacterial cell.
8. Estimation of glucose in a bacterial cell by DNS method.
9. Estimation of protein in a bacterial cell by Lowry' method.
10. Estimation of amino acid content in a bacterial cell using ninhydrin method.
11. Measurement of alkaline phosphatase activity.
12. Nitrate reductase assay in vivo.
13. Measurement of enzyme activity of alpha amylase.
14. Effect of temperature on enzyme activity.

PART II – BIOINFORMATICS

1. Analysis of Nucleic Acid Sequences
2. Sequence Similarity Searching
3. ORF Prediction
4. Multiple sequence Alignment
5. Pairwise sequence alignment using BLAST and FASTA
6. Gene Structure and Function prediction
7. Protein structure analysis
8. Phylogenetic tree construction
9. Phylogenetic analysis using PHYLIP.

REFERENCES: -

1. Beedu Sasidhar Rao and Vijay Deshpande (2006) *Experimental Biochemistry: A student companion* IK International Pvt.Ltd
2. Sawhney, S.K and Randhir Singh (2001) *Introductory Practical Biochemistry* Narosa Pub House
3. Varley, H (1988) *Practical Biochemistry* CRC Press
4. S.K. Thimmaiah (ed). *Standard Methods of Biochemical Analysis*. Kalyani Publishers, Ludhiana ISBN 81-7663-067-5
5. Bernard L.Oser(ed) *Hawk's Physiological Chemistry.* TATA McGraw Hill Publishing Company LTD, New Delhi

MB 516
INDUSTRIAL VISIT

CREDITS: 1

SECOND SEMESTER

	SECOND SEMESTER			
MB 521	MOLECULAR BIOLOGY AND rDNA TECHNOLOGY	5	0	4
MB 522	IMMUNOLOGY AND IMMUNOTECHNIQUES	5	0	4
MB 523	FOOD AND INDUSTRIAL MICROBIOLOGY	5	0	4
MB 524	BIOSAFETY, QUALITY ASSURANCE AND IPR (ELECTIVES)	3	0	3
MB 525	LAB-3. rDNA TECHNOLOGY AND IMMUNOLOGY	0	3	4
MB 526	LAB-4. FOOD AND INDUSTRIAL MICROBIOLOGY	0	4	4
	TOTAL	18	7	20

MB 521
MOLECULAR BIOLOGY AND rDNA TECHNOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course outcome

By attending the course, the students will be able

- To understand about DNA replication.
- To understand transcription and translation.
- To understand various plasmids involved in rDNA technology.
- To demonstrate various techniques in rDNA.

UNIT I

Nucleic acids: purines and pyrimidines, Phosphodiester linkage, Structure of DNA, Higher order structure of DNA, chromatin structure, nucleosome, histones, RNA- types, structure and functions. DNA Replication – Process of DNA replication and models of DNA replication, Initiation of DNA replication, Unwinding of DNA, Elongation, Role of Topoisomerase, Gyrase, SSB, Helicase, Ligase and Primasome. DNA polymerases in eukaryotes and prokaryotes, Klenow fragment, Okazaki fragments, Process at DNA replication fork, Assembly of lagging strand fragments, termination of replication, modes of replication, theta, rolling circle, d-loop replication, Inhibition of replication.

UNIT II

Transcription - RNA polymerases in prokaryotes and eukaryotes, Transcription signals, Promoters and Enhancers, Initiation and Elongation of RNA synthesis, Rho dependent and Rho independent termination, Transcription factors in Eukaryotes, Prokaryotic and Eukaryotic Transcription, post transcriptional modifications, Splicing-Spliceosome, lariat structure, Group 1, II and III Introns, Ribozyme, RNase P, RNAse III, RNAse H. Trans-splicing, alternate splicing, RNA Editing, Guide RNA, inhibitors of transcription.

UNIT III

Translation- Stages in translation, genetic code, wobble hypothesis, eukaryotic and prokaryotic ribosomes, m-RNAs, t-RNAs, aminoacyl t-RNA synthetases, 30S preinitiation complex, 70S initiation complex, peptidyl transferase, elongation, prokaryotic and eukaryotic translation, inhibition of translation. Post translational modifications. Regulation of gene expression in prokaryotes and eukaryotes, operon - inducible and repressible operon, positive and negative regulation, Lac, Trp, Ara operon, catabolite repression, Attenuation. RNA interference, Antisense RNA, SiRNA, MicroRNA, Ribozwitches and their applications.

UNIT IV

Plasmids - desirable properties of plasmid cloning vectors (pBR322, PUC), Construction of prototype vector pBR322, Vectors derived from pBR322. Bacteriophages- λ, M13. Replication of phage λ DNA in lytic and lysogenic cycles, structure of bacteriophage λ cloning vectors EMBL3 and EMBL4, Packaging phage λ DNA *in vitro,* M13vectors, Cosmid vector - scheme for cloning in a cosmid vector, Phagemids, BAC, PAC, Shuttle Vectors, Ti plasmid and Binary vector system, Expression vectors, Promoters, and reporter systems, Prokayotic expression system, Fusion tagged expression system, Inducible expression system, Recombinant inducible systems. Purification of recombinant proteins. Vectors for Yeast expression, Yeast two hybrid system,

UNIT V

Techniques used in recombinant DNA research, blotting techniques -southern, northern and western, chromosome walking, chromosome jumping. PCR - principle and types, Chemical synthesis of DNA, DNA sequencing methods, Sangers dideoxy sequencing. Next Generation and Advanced sequencing technologies, pyrosequencing. Changing genes - site-directed Mutagenesis, SDM- methods, Overview of various steps involved in cloning, Construction, Screening and applications of genomic DNA and cDNA library. Cloning of full-length cDNA, RACE. Bacterial transformation, Selection of recombinants, Blue white screening, Antibiotic resistance selection, Gene transfer to animal cells. Gene transfer mechanisms. Electroporation and Biolistics, Agrobacterium mediated transformation, Advances in transgenic technology.

REFERENCES: -

1. Berg,J.M., Stryer,L(2002) *Biochemistry* W.H Freeman & Company.
2. Nelson,D.L.,Cox,M(2008) *Lehninger's Principles of Biochemistry* Mac Millan.
3. Voet,D and Voet, J.G (2010) *Biochemistry* 4th edition Wiley Benjamin Lewin (2013) *Genes* IX . Jones and Bartlett publishers.
4. Watson,J.D., Hopkins,N .H ., Roberts, J.W., Steitz,J.A and Weiner,A.M(1987). *Molecular Biology of the Gene* . Benjamin-Cummings, Menlo Park California.
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6. Daniel L Hartl & Elizabeth W.Jones(2011) *GENETICS- Analysis of genes and Genomes* 8th edition, Jones and Bartlett publication.
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10. Dale, J.W(2004). *Molecular Genetics of Bacteria* 5th edition. Wiley publishers.
11. Larry, S.,Henkin,T.M., Peters,J.E.and Wendy,C(2012) *Molecular Genetics of Bacteria* 4th edition. ASM Press.

12. Friedberg, C., Graham, C., Wolfram, S(2009) . *DNA repair and mutagenesis* 2nd edition. ASM Press.
13. Nicholl D.S.T(2002) *An introduction to Genetic Engineering* 2nd edition. Cambridge University Press.
14. Glick,B.R., Pasternak, J.J.(2003) *Molecular biotechnology* 3rd edition. ASM Press.
15. Primrose,S.B., Twyman,R., Old,R.W.(2002) *Principles of Gene Manipulation* 6th edition. Wiley-Blackwell Publishers.
16. Brown T.A. (2010) *Gene Cloning & DNA Analysis* 6th edition. Wiley-Blackwell Publishers.
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MB 522
IMMUNOLOGY, IMMUNOTECHNIQUES AND CANCER BIOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course outcome

By attending the course, the students will be able

- To know how immunity plays a role in human beings.
- To introduce the various types of immune response.
- To know the significance of different types of immune cells.
- To understand various immuno techniques involved.
- To study on various types of cancer and cells involved in cancer.

UNIT I

Immunity - Types of immunity. Innate Immunity and Adaptive Immunity- Mechanisms of innate immunity. Cells and organs involved in immune system. Immune response- primary and secondary immune response- inflammation. Antigens, Antigenicity and Immunogenicity, Adjuvants, Epitopes, Hapten, Super antigens, Immunoglobulin – structure, classes and functions, Isotype,

Allotype, Idiotype, F_c receptors. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin Genes, Mechanism of variable gene rearrangement, Recombination Signal Sequences, V(D)J rearrangements, P-addition, N-addition, somatic hypermutation and affinity maturation, Class-switching. Monoclonal antibodies – production and applications, Antibody engineering.

UNIT II

Cell mediated Immune response, B cell- generation, activation, differentiation, B-cell coreceptor complex, B-cell surface molecule, Antigen binding molecules, signal transduction molecules, signal transduction molecules involved in antigen presentation and isotype switching. T-cell maturation, activation and differentiation- Receptors on T and B cells for antigens, Organization and Rearrangement of TCR genes, T-cell accessory membrane molecules (CD_4, CD_8), Co-stimulatory and adhesion molecules. MHC, HLA typing, MHC-restriction, Antigen processing and presentation of exogenous and endogenous antigen. Complement system, complement activation, Classical, Alternative and Lectin complement pathway, regulation of complement activation, biological effects of complements.

UNIT III

Synthesis of immunoglobulins, Antigen-antibody reactions, General features, Affinity, Avidity and Cross reactivity, Agglutination and Precipitation Reactions, Passive agglutination, Agglutination Inhibition reaction, Complement fixation, Radioimmuno assay, Immunofluorescence, ELISA- various types, Western blotting, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

UNIT IV

Immunological Tolerance, Autoimmunity- Mechanisms of autoimmunity, Classification of Autoimmune diseases. Hypersensitivity– immediate and delayed reactions, Types of hypersensitivity reactions and their features. Immunology of organ and tissue transplantation, types of grafts, Allograft reaction and GVH reaction. Immunosuppression, Factors influencing allograft survival. Immunodeficiency diseases- primary immunodeficiency and secondary immunodeficiency disease. Vaccines –types of vaccines, DNA vaccine and recent trends in vaccine development,

UNIT V

Cell cycle- different stages, check points, MPF, cyclins and cyclin dependent protein kinases, regulation of cell cycle, Role of Rb & p53. Cell cycle inhibitors, Cell death and cancer- Apoptosis and necrosis, apoptotic pathways, theories on apoptosis, etiology of cancer, mutagens. Oncogenic viruses, types of tumor, induction of cancer, properties of cancer cells, oncogenes, oncogene and signal transduction, tumor suppressors. Immunology of malignancy- Tumor antigens, TATA, Immune response in malignancy, Mechanisms of immune evasion by tumors, Immunotherapy of cancer, LAK cells, TILs.

REFERENCES: -

1. Tizard, I. (1994) Immunology: An Introduction 4th edition. Cengage Learning Publishers.
2. Delves, P.J., Martin, S.J., Burton,D.R., Roitt,I.M. (2011) *Roitt's Essential Immunology* 12th edition. Wiley-Blackwell Publishers.
3. Chakravarthy,A.K.(2006) *Immunology and Immunotechnology.* Oxford University Press.
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MB 523
FOOD AND INDUSTRIAL MICROBIOLOGY

Number of Hours / Week: 5 **Credits: 4**

Course outcome

By attending the course, the students will be able

- To know the beneficial and harmful role of microorganisms present in food.
- To understand the beneficial effects of fermented foods.
- To know the significance of microbial community by understanding their responsibility in causing foodborne infections.
- To study various aspects of fermenters.
- To comprehend various types of fermentations.

UNIT I

Microbiology of food and milk- Microorganisms associated with food, Factors affecting the microbial growth in food – intrinsic, extrinsic, implicit and processing factors. Hurdle effect, Food contamination and spoilage. Microbial spoilage of cereals, poultry, fish, meat, egg, stored grains fruits and vegetables. Spoilage of canned foods. Microbiological examination of food. Food preservation, physical and chemical methods. Natural food preservatives.

UNIT II

Developments in the history of fermented foods, Nutritional value of fermented foods. Lactic acid bacteria, Genera of lactic acid bacteria and their properties, Homofermentative and Heterofermentative LAB, Heterolactic end products from pyruvate metabolism. Sugar Transport by Lactic Acid Bacteria, Proteolytic system in lactococci, Yeasts and mold used in manufacture of fermented food. Starter cultures used for fermented food and their properties. Fermented food products- making of pickles, fermented vegetables, cheese, yoghurt, kefir, sour cream (brief steps involved), Fermentation succession during sauerkraut fermentation. SCP- livestock feed- silage. Probiotics- health benefit and mechanism of action, prebiotics, and synbiotics. Hazard analysis and clinical control point system. Food borne infections and intoxications, bacterial and non-bacterial, pathogenesis, clinical features, isolation, identification and association with food, Mycotoxins and mycotic poisoning, Prevention measures, Food control agencies and their regulations. Indicator organisms- Coliforms, Enterococci, Bifidobacterium, Coliphages, Enteroviruses

UNIT III

Historical account of microbes in industrial microbiology, Sources and characters of industrially potent microbes. Isolation, purification and preservation of industrially useful microbes, Screening methods and methods for strain improvement. Industrial fermentations. Types of fermentations- Solid substrate fermentation (SSF) - Principles and application, Submerged Fermentation. Aerobic and anaerobic fermentation, Components of fermentation process, Media for industrial fermentation, sterilization, inoculum preparation, raw materials used in industrial fermentation media, antifoam agents, Problems in fermentation process and handling. Assay of fermentation products- physical chemical and biological.

UNIT IV

Microbial growth kinetics, Batch, continuous and fed batch culture, Monod's model and deviations from Monod's model. Batch culture - specific growth rate, substrate saturation constant, yield coefficient, substrate affinity. Continuous culture- Dilution rate and washing out. Applications and examples of fed batch and continuous system, comparison between various cultivation systems. Fermentor – parts, design, construction and types, pneumatically driven, hydrolytically driven, mechanically driven, CSTR, Airlift, Packed Bed, Fluidized Bed, cyclone, cylindro conical fermentors, Monitoring and control of fermenters, Control of physical and chemical conditions, online and off line instrumentation, pH, temperature, DO probes.

UNIT V

Methods used for down-stream processing and product recovery- filtration, centrifugation, cell disruption, extraction, dialysis, Purification, Drying, Packing and labelling. Good Manufacturing Practices, Fermentation economics. Microbiology and production of ethanol and alcoholic beverages, Beer manufacturing and production of distilled beverages. Microbial polyesters, biosurfactants, and recombinant products. Microbial process for the production of antibiotics (penicillin and streptomycin), vitamins (Vit. C, Vit. B12), organic acids (citric acid, lactic acid) amino acids, alkaloids, nucleotides and microbial transformation of steroids, Baker's yeast production, Bread manufacturing. Production of microbial enzymes - amylases and proteases and their applications. Immobilization of microbial cells and enzymes – methods and applications.

REFERENCES: -

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MB 524
BIOSAFETY, QUALITY ASSURANCE AND IPR

Number of Hours / Week: 3 **CREDITS: 3**

Course outcome

By attending the course, the students will be able

- To comprehend the basic issues Biosafety, Food safety and IPR.
- To understand current food safety programs that are used in the food industry in order to assure a safe food supply.
- To understand different types of Intellectual Property Rights.
- To know the rules for filing a patent.

UNIT-I

Guidelines on biosafety in conducting research in biology / biotechnology; Ethics in use of animals for scientific research; Ethical clearance norms for conducting studies on human subjects; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC.

UNIT-II

Food laws and regulations- National food legislation/ authorities and their role, product certifications (ISI mark of BIS), international organization and agreements-food and agricultural organization (FAO), world health organization (WHO), codex alimentarius, codex India, world international organization for standardization (ISO).

UNIT-III

Food safety and quality management systems: general principle of food safety, risk management, hazard analysis critical control point system (HACCP), Food Packaging: Need, material used and labelling.

UNIT-IV

IPR -Introduction to IPRs, Basic concepts and need for protection of Intellectual Property Types of IP: International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement Procedure for filing a PCT application, forms of patents and patentability, The patentability of microorganisms, process and product patenting, Indian and international agencies involved in IPR & patenting, Patent Act of India Patent databases.

REFERENCES: -

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12. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India, New Delhi.
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MB 525
LAB 3- rDNA TECHNOLOGY AND IMMUNOLOGY

Number of Hours / Week: 3 **CREDITS: 4**

PART I - IMMUNOLOGY

1. Diagnosis for in vitro detection of CRP qualitative latex slide test.
2. RPR card test for syphilis.
3. WIDAL test.
4. ASO Latex agglutination test.
5. RA Latex agglutination test.
6. ELISA test.
7. Determination of blood group and Rh factor.
8. Pregnancy testing using the immunological methods.
9. Immunodiffusion in gel.

PART II - RECOMBINANT DNA TECHNOLOGY

1. PAGE- Protein separation.
2. DNA and RNA isolation from microbes.
3. Estimation of DNA and RNA.
4. Agarose gel electrophoresis of nucleic acids.
5. Extraction of DNA from agarose gel.
6. Gradient plate technique.
7. Replica plating technique.
8. UV induced auxotrophic mutant production and their isolation.
9. Bacterial transformation and blue white screening.
10. Plasmid isolation from microbes.
11. Restriction enzyme digestion.
12. Polymerase Chain Reaction of desired gene.

REFERENCES: -

1. Cheesbrough M (2006) *District Laboratory Practice in Tropical Countries. Vol.2.* Cambridge University Press. 2nd ed.
2. Collee JG & Mackie TJ (1996) *Mackie and McCartney Practical Medical Microbiology.* Churchill Livingstone, Edinburgh. 14th ed.
3. Gradwohl RBH, Sonnenwirth AC, & Jarett L (1980) *Gradwohl's Clinical Laboratory. Methods and Diagnosis* Mosby, St Louis, Mo.; London. 8th ed.

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MB 526
LAB 4- FOOD AND INDUSTRIAL MICROBIOLOGY

Number of Hours / Week: 4 **CREDITS: 4**

PART I - FOOD MICROBIOLOGY

1. Microbiological examination of foods.
    i) Isolation and enumeration of bacteria and fungi from fresh and spoiled fruits.
    ii) Isolation and enumeration of bacteria and fungi from fresh and spoiled vegetables.
    iii) Isolation and enumeration of bacteria from fruit juices.
    iv) Isolation and enumeration of bacteria and fungi from fresh and spoiled meat.
    v) Isolation and enumeration of bacteria and fungi from fresh and spoiled fish.
2. Detection of bacteria in spoiled tinned food.
3. Isolation of lipolytic microorganisms from butter.
4. Effect of food preservatives on the growth of microbes.
5. Isolation of *Aspergillus flavus* from spoiled food.
6. Analysis of mycotoxin (aflatoxin) in fungus contaminated food materials.

PART II- DAIRY MICROBIOLOGY

1. Direct microscopic count of milk.
2. Turbidity testing for checking efficiency on sterilization in liquid milk.
3. Quantitative analysis of milk by standard plate count method.
4. Determination of quality of milk sample.
    i) Methylene Blue Reduction Test.
    ii) Resazurin Test.
5. Alkaline phosphatase testing of raw and pasteurized milk

6. Microbial- bacteria and fungi, isolation from curd, idly batter, toddy, soy sauce.

PART III- INDUSTRIAL MICROBIOLOGY

1. Solid state and submerged fermentation
2. Production of wine from grapes.
3. Fermentation of yeast and quantitative estimation of ethanol produced during yeast fermentation.
4. Amylase production by bacteria and fungus.
5. Crowded plate technique for screening of industrially important microorganisms- microbes producing enzymes, antibiotics etc.
6. Citric acid production.
7. Cultivation of edible mushroom.

REFERENCES: -

1. Dubey, R.C and Maheswari, D.K (2002)*Practical Microbiology S*.Chand Ltd
2. Cappuccino, J.G., Sherman,S(2002) *Microbiology. A Laboratory Manual* Benjamin-Cummings Publishing Company
3. Aneja KR (2003) *Experiments In Microbiology, Plant Pathology And Biotechnology*. New Age International.

THIRD SEMESTER

	THIRD SEMESTER			
MB531	ENVIRONMENTAL, AGRICULTURAL AND EXO MICROBIOLOGY	5	0	4
MB532	MEDICAL BACTERIOLOGY AND DIAGNOSTIC MICROBIOLOGY	5	0	4
MB533	MEDICAL VIROLOGY, MYCOLOGY AND PROTOZOOLOGY	5	0	4
MB534	LAB –5. ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY	0	4	4
MB535	LAB-6. MEDICAL BACTERIOLOGY, VIROLOGY, MYCOLOGY AND PROTOZOOLOGY.	0	5	4
MB536	HOSPITAL VISIT	0	1	1
	TOTAL	15	10	21

MB 531

ENVIRONMENTAL, AGRICULTURAL AND EXO MICROBIOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course Outcomes

By attending the course, the students will be able

- To know the beneficial and harmful role of microorganisms in agriculture and environment.
- To introduce the essential fundamentals of soil, water and environment
- To know the significance of microbial community by understanding their importance in various biogeochemical cycles occurring in soil
- To know the importance of microbe in enhancing and soil fertility and there by plant yield by interactions, plant – microbe interactions and microbe - microbe interactions in soil
- To comprehend various plant diseases caused by bacteria, fungi and viruses and their control measure.
- To study the value of genetically modified crops and their importance in various aspects such as pest resistance, high nutrient value, easy to grow under unfavorable weather conditions, etc.
- To have a basic idea on space microbes.

UNIT I

Aerobiology, Microbial contamination of air, Sources of contamination, Microbial indicators of air pollution. Enumeration of bacteria in air, Air sampling devices. Air sanitation. Effect of Air Pollution on plants and humans

UNIT II

Aquatic microbiology: Microbiology of drinking water, Water pollution and water borne pathogens, Bacteriological examination of water, Indicator organisms (*E. coli*, *Faecal Streptococci* and Enterococci). Purification and disinfection of water Microbiology of sewage, Waste water treatment (primary, secondary and tertiary treatment, Anaerobic treatment), BOD, COD, Molecular methods for detection of waterborne pathogens.

UNIT III

Microbial flora of soil and factors affecting them, Role of microorganisms in Nitrogen, Carbon, Phosphorus, Sulphur and Iron cycles. Microbial interactions – Plant-microbe, microbe-microbe interactions. PGPR, Plant Microbiome, Mycorrhiza, Lichens. Biological Nitrogen Fixers-

Symbiotic and free-living nitrogen fixers- physiology and genetics of nitrogen fixers, Phosphate solubilizers, Biofertilizers- Rhizobium, phosphobacteria Frankia, Azototobacter, Azospirillum. Phytopahtogens – Bacterial, fungal, Viral diseases. (Wilt, Blight, Canker, Mosaic, Rhizome rot of ginger.) – Control measures. Microbial control of pests and diseases- Biopesticides (B. thuringensis, *B.popilliae, B. spherius, Pasteuria penetrans*, BGA), Biocontrol- Trichoderma, *P.fluorescens,* Viruses- Baculovirus (NPV, CPV). Fungi- -*Entomophthora muscae* and *Baeuveria bassiana*. Integrated pest management. GM crops and its importance.

UNIT IV

Management of solid wastes – Composting – Landfilling, Biogas, Biodegradation- Treatment of tannery, Slaughter house waste, fish waste, paper, wood, Textile waste, Xenobiotics. Bioremediation of petroleum products and hydrocarbon- Bioleaching, Autoaggregation of Microorganisms- Flocs and biofilms, Development of biofilms and role of Flocs and biofilms, Monitoring of environmental process with Biosensors and biological indicators.

UNIT V

Space Microbiology: An Overview, Monitoring of astronauts' microbial flora: Alterations in the load of medically important microorganisms, ESA STONE experiment. Aims and objectives of space research.

REFERENCES: -

1. Mitchell R (1974) *Introduction to environmental microbiology* (Prentice-Hall, Englewood Cliffs, N.J.,)
2. Atlas RM & Bartha R (1998) *Microbial ecology: fundamentals and applications*, (Benjamin/Cummings, Menlo Park, Calif.; Harlow) 4th ed.
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5. Rheinheimer G (1991) *Aquatic microbiology* (John Wiley and Sons) 4th ed. Dart RK (1980) *Microbiological aspects of pollution control* (Elsevier Scientific, Amsterdam) 2nd ed.
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MB 532

MEDICAL BACTERIOLOGY AND DIAGNOSTIC MICROBIOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course Outcomes

By attending the course, the students will be able clinical

- To comprehend the concept of safe microbiology
- To study the infection caused by of bacteria and its effect on human body
- To know the morphology, culture, antigenic structure and virulence factors of major pathogenic bacteria
- To learn the epidemiology and pathogenesis, lab diagnosis and treatment of different infectious bacteria
- To set protocols to prevent the transmission of diseases in hospitals and community.
- To accumulate knowledge on clinical infection management
- To compare and evaluate serological and molecular diagnostic methods
- To understand antibacterial therapy and prophylaxis

UNIT I

History of Medical Microbiology, Infections - Sources and classification, Mode of transmission of infections, Factors predisposing to microbial pathogenicity. Study on major infectious diseases- Identification characters- Morphological, cultural, pathogenicity, epidemiology and laboratory identification of *Staphylococci aureus, Staphylococcus epidermiditis, Streptococci pyogenes, meningitis disease-Neisseria meningitides, Haemophilus influenza, Corynebacterium diptheriae, Bordetella pertussis*, Mycoplasma

UNIT II

Study on Identification characters- Morphological, cultural, pathogenicity, epidemiology and laboratory identification- *Bacillus subtilis and Clostridium tetani, Clostridium perfinges, Mycobacterium tuberculosis, Mycobacterium leprae and non tuberculous mycobacteria,*

Pasteurella, Yersinia pestis, Francisella, Rickettsiae, Nosocomial infection. Actinomycetes-Nocardia, Actinomyces.

UNIT III

Study on Identification characters - Morphological, cultural, pathogenicity, epidemiology and laboratory identification of *E. coli, Proteus, Klebsiella pneumoniae, Shigella, (bacillary dysentery) Salmonella, Neisseria gonorrhea,* Chlamydiae (STD) Spirochetes- *Treponema palladium*, Leptospira, General characters and clinical importance of *Listeria monocytes, Helicobacter, Vibrio chloreae and Campylobacter (food poisoning).*

UNIT IV

Microbiology Laboratory Safety-General Safety Principles, Handling of Biologic Hazards, Disposal of Infectious waste, Biomedical waste management, infection control practice, Accreditation of laboratories, Diagnostic cycle, General concept of specimen collection, transport, processing and rejection of clinical specimens. Mailing of biohazardous materials.

UNIT V

Diagnosis of microbial diseases- immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis. Automation in Microbiology; Laboratory control of antimicrobial therapy; Immunoprophylaxis, Antimicrobial chaemotherapy (Mode of action of sulfonamide, Penicillin, Cepahalosphorin, Tetracyclin, Macrolides, Streptomycin, Sulfonmaides, Quinones), Human Microbiome, Human Microbiome Project.

REFERENCES: -

1. Greenwood, D., Slack, R.C.B., Peutherer, J.F., and Barer, M.R. (2007). *Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control*. Elsevier Health Sciences UK. 17th ed.
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12. Forbes, B.A., Sahm, D.F., Weissfeld, A.S., and Bailey, W.R.D.m. (2007). Bailey & Scott's diagnostic microbiology. Elsevier, Mosby, London. 12thed

MB 533

MEDICAL VIROLOGY, MYCOLOGY AND PROTOZOOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course Outcomes

By attending the course, the students will be able

- To understand the general characteristics and types of viruses
- To understand the pathobiology of different classes of viruses.
- To understand the emerging viral diseases and its causes
- To acquire knowledge on virus induced cancer and its Prophylaxis
- To learn lab diagnosis, prophylaxis and treatment of viral diseases.
- To learn different fungal infections and its laboratory diagnosis
- To learn different protozoal diseases and its laboratory diagnosis

UNIT I

General outline on viarl infection, Classification of medically important RNA, DNA viruses, Virus cultivation, Zoonotic viral diseases- (Rabies, hantaviruses, Arenaviruses, yellow fever virus, chikungunya virus, reservoirs and transimission - brief) Properties, clinical importance, pathogenesis and laboratory diagnosis of diseases caused by DNA viruses- Pox-, Varicola, Vaccinia, Herpes- Varicella Zoster, Herpes Zozter, Adeno, Papova (brief note) and Parvoviruses.

UNIT II

General properties, clinical importance, pathogenesis and laboratory diagnosis of diseases caused by RNA Viruses- common cold, influenza, SARS, MERS, COVID -19, Dengue virus, hepatitis C and E, West Nile fever, Ebola virus, Rabies, polio, mumps, measles and HIV, Norovirus- Hepatitis A and E, Rotavirus.

UNIT III

Viruses and cancer- Viruses implicated in the cancers of humans (HTL virus, Hepatitis B, Hepatitis C, papilloma virus, Epstein Barr Virus, human herpes virus 8), Slow virus infections, Prion diseases, Emerging viral infections- Nippah, Zikka, HINI, Swine flu, Avian flu. Prophylaxis of viral diseases- Immunological, Chemotheraphy, antiviral agents. Mechanisms of action Interferons.

UNIT IV

Classification of Mycoses in man, superficial mycoses – surface and cutaneous mycoses, Deep mycoses – subcutaneous and systemic mycoses, pathogenesis, clinical aspects and lab diagnosis of fungal infections. Opportunistic fungal infections.

UNIT V

Life cycle and pathogenesis of important Protozoan diseases- Entamoeabosis, Malaria, Trypanosomiasis and Lieshmaniasis. Clinical importance of *Giardia, Trichomonas, Toxoplasma, Cryptosporidium.*

REFERENCES: -

1. Fraenkel-Conrat, H., and Wagner, R.R. (1974). *Comprehensive virology* (New York, Plenum Press).
2. Kucera, L.S., and Myrvik, Q.N. (1985). Fundamentals of medical virology (Lea &Febiger, Philadelphia)2nded.
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6. Emmons, C.W. (1977). Medical mycology (Philadelphia, Lea &Febiger), 3rd ed
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9. Desselberger, U. (1995). Medical virology: a practical approach (IRL Press).
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MB 534

LAB - 5 ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Number of Hours / Week: 4 **CREDITS: 4**

PART I - Environmental Microbiology

1. Isolation of microorganisms from different sources – air and water.
2. Analysis of water
3. sample for total bacterial population by SPC.
4. Analysis of water samples – Biological parameters.
    i) Determination of dissolved oxygen.
    ii) Determination of BOD.
    iii) Determination of COD.
    iv) Bacteriological examination of water by - SPC, Presumptive, Confirmed and Complete test etc. (potability of water sample).
    i) Tests for coliforms by membrane filter technique.
    ii) IMViC tests for the identification of coliforms.
    iii) Estimation of Rhizosphere microbial population and calculation of R/S ratio.

PART II - Agricultural Microbiology

1. Isolation of microorganisms from soil (bacteria and fungi).
2. Isolation of microbes from crops infected with bacterial diseases and fungal diseases.
3. Isolation and identification of *Rhizobium* from root nodules.
4. Isolation of *Azotobacter* from rhizosphere soil.
5. Isolation of *Azospirrilum* from soil.
6. Isolation of Phosphobacteria from soil.
7. Isolation of blue green algae and their microscopic observation.
8. Microscopic examination of VAM infection.

9. Isolation of Actinomyceytes from soil
10. Isolation of biocontrol agent *P.fluorescens* and Trichoderma.

MB 535

LAB- 6- MEDICAL BACTERIOLOGY, VIROLOGY, MYCOLOGY AND PROTOZOOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

PART I - Bacteriology

1. Study of the morphology, staining characters, cultural characters and identification of *Staphylococci, E. coli, Klebsiella, Salmonella, Shigella, Proteus, Pseudomonas, Bacillus*
2. Isolation and biochemical identification of bacteria from mixed culture.
3. Study of common laboratory contaminants.
4. Study of common pathogens using selective or differential media- *E. coli, Salmonella, Shigella, Staphylococcus* from skin

PART II - Mycology

1. Culture methods for isolation and identification of fungi- KOH mount preparation,
2. Lactophenol cotton blue staining, Slide culture technique etc.
3. Gram staining and Germ tube test of *Candida albicans*

PART III - Virology and Parasitology

1. Cultivation of viruses in embryonated eggs different routes – harvesting
2. Examination of peripheral blood for hemoflagellates and malarial parasites

PART IV - Clinical Microbiology

1. Study of normal microbial flora of human beings from skin
2. Techniques for collection of clinical specimens for microbiological analysis- Macroscopic, microscopic examination of clinical samples. Culture methods identification and antibiotic sensitivity test of isolates- Kirby bauer test, E-test, MIC, MBC.

REFERENCES: -

1. Cheesbrough, M. (2006). *District Laboratory Practice in Tropical Countries.* Cambridge University Press.2nd ed.
2. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). *Mackie & McCartney practical medical microbiology*. Churchill Livingstone, 13th ed.
3. Godkhar,P.B., Darshan,P *Text book of Medical Laboratory Technology* Bhalani Publishers

MB 536

HOSPITAL VISIT

CREDIT-1

FOURTH SEMESTER

	FOURTH SEMESTER			
MB541	MARINE MICROBIOLOGY	5	0	4
MB542	PHARMACEUTICAL MICROBIOLOGY (ELECTIVES)	5	0	3
MB543	DISSERTATION AND VIVA-VOCE	0	15	2+2
	TOTAL	10	15	11

MB 541

MARINE MICROBIOLOGY

Number of Hours / Week: 5 **CREDITS: 4**

Course Outcomes

At the end of the course, students will be able to

- To Understand the dynamics marine ecosystem and familiarize the structure and various habitat of marine environment.
- To study the various marine microbial diseases and its rapid diagnosis.
- Realize the significance of bioluminescence and effect of marine pollution and its control measure, bio-corrosion and bioremediation.
- To get knowledge on the marine microbes as major sources of bioactive compounds and its biotechnological application.

UNIT I

Marine environment – sea-benthic and littoral zone, salt pan, mangroves and estuarine microbes, microbial loop – marine microbial community – phytoplanktons (Green algae, Red algae), Zooplanktons (Cadocera and copepods, rotifers) bacteria, virus, fungi, protozoa. Microbial endo symbionts- epiphytes- coral microbial association, sponge- microbe association. Methods of collection and estimation of marine microbes. Influence of physical, chemical and biological factors on marine microbes.

UNIT II

Marine microbes in extreme environment- Adaptability: adaptive mechanisms in thermophilic, alkalophilic, osmophilic, barophilic, psychrophilic microorganisms -hyperthermophiles and halophiles- halorhodopsin, microbes of deep sea and hydrothermal vents.

UNIT III

Pathogenic marine microbes- fish and human pathogen, pathogenic human viruses in coastal waters. Fish Disease caused by microbes: Bacterial diseases- Columnaris, Pseudomonas scepticemia, haemorrhagic septicemia, Enteric red mouth diseases, Furunculosis, Fin rot/ tail rot, Dropsy, Vibriosis, Shrimp diseases caused by virus- White spot syndrome virus (WSSV)- Monodon Baculovirus MBV- Rapid diagnosis of contamination in sea foods and aquaculture products.

UNIT IV

Microorganisms responsible for bioluminescence in marine environment. Uses of bioluminescence. Mechanism of quorum sensing in *Vibrio fischeri*. Marine pollution: Microbial indicators of marine pollution and control, biofouling, biocorrosion, biofilms, biodegradation and bioremediation of marine pollutants. Use of genetically engineered microorganisms in biodegradation.

UNIT V

Marine Microbial Biotechnology- Marine natural products from marine microorganisms- Antibiotics, toxins, organic acids, Biosurfactants, pigments, biopolymers and enzymes marine bio-sensor and transgenic marine organisms

REFERENCES: -

1. Karl,D & Buckley,M (2005) Marine Microbial Diversity
2. David L.Kirchman, (2008). Microbial Ecology of the Ocean, 2 nd edition, John Wiley & sons
3. Colwell,R & Belkin,(2010) Ocean & health: Pathogens of the Marine Environment Springer
4. Miller, C., Wheeler,P.A (2012) Biological Oceanography Wiley-Blackwel
5. Bhakuni DS & Rawat DS (2005) Bioactive Marine Natural Products. Anamaya Publishers, New Delhi.
6. Coiln Munn (2009) Marine Microbiology: Ecology & Application 2 nd, Garland Science, Taylor & Francis, ISBN;978-0815365174

MB 542

PHARMACEUTICAL MICROBIOLOGY

Number of Hours / Week: 3 **CREDITS: 3**

Course Outcomes

By attending the course, the students will be able

- To understand process involved in Drug discovery and development
- To carryout toxicological evaluation of drugs
- To emphasize the importance of sterilization and prevention of contamination of pharmaceutical products
- Understand various natural raw materials as resources for the drug production
- To carry out antimicrobial activity testing of herbal extracts

UNIT I

History; contributions of Paul Ehrlich, Edward Jenner, Alexander Fleming. Bioactive molecules – extraction, purification and characterization; safety profile, toxicological evaluation of drugs, mutagenicity, carcinogenicity and teratogenicity.

UNIT II

Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization.

UNIT III

Biosensors in pharmaceuticals. Application of microbial enzymes in pharmaceuticals. Immobilization procedures for pharmaceutical applications (liposomes).

UNIT IV

Antimicrobial activity testing of herbal extracts of the following plants – *Adathoda vasica, Rauolfia serpentina, Curcuma longa, Ocimum sanctum*

REFERENCES: -

1. Hugo W.B. & A.D.Russell (2011) Pharmaceutical Microbiology Sixth edition. Blackwell scientific Publications.

2. Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II. Academic Press New York.

3. Agarwal S. S. and Paridhavi M., (2007), *Herbal Drug Technology*, Universities Press (India) Pvt. Ltd

4. Bentley's Textbook of Pharmaceutics, Editior E. A. Rawlins, 8th Ed. (2002), Bailliere Tindall, London

5. Chatwal G. P. (2003) *Biopharmasceutics and Pharmacokinetics*, Himalaya Publishing House, Mumbai.

6. Kokate C. K., Purohit A. P., Gokhale A. B. (2000) *Pharmacology*, 4th Ed., Nirali Prakashan.

7. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). Methods for dilution antimicrobial susceptibility testing for bacteria that grows aerobically. Approved Standards M7-A4. Villanova, PA: NCCLS, 1997.

8. National Committee for Clinical Laboratory Standards (now Clinical and Laboratory Standards Institute, CLSI). Performance standards for antimicrobial susceptibility testing; 12th information supplement (M100-S1). Villanova, PA; NCCLS: 2002.

9. Satoskar R. S. & S. D. Bhandarkar (1991) Pharmacology and Pharmacotherapeutics, 12th Ed., Vol. 1 & 2, Popular Prakashan, Mumbai.

10. Vyas S. P and Dixit V. R. (2002), Pharmaceutical Biotechnology, CBS Publishers and Distributors, New Delhi.

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DISSERTATION AND VIVA VOCE