Master of Science
in
MICROBIOLOGY

PROGRAMME STRUCTURE AND SYLLABUS
2019-20 ADMISSIONS ONWARDS

(UNDER MAHATMA GANDHI UNIVERSITY PGCSS REGULATIONS 2019)

EXPERT COMMITTEE IN MICROBIOLOGY (PG)
MAHATMA GANDHI UNIVERSITY

2019

THE EXPERT COMMITTEE IN MICROBIOLOGY (PG)

Chairperson:

Dr. S Mohan, Assistant Professor, Department of Microbiology, Sree Sankara College, Kalady

Members:

1. Dr. Soorej M Basheer, Assistant Professor and Head, Department of Molecular Biology, Kannur University. Nileeswaram Campus.
2. Dr. Manjula R, Associate Professor and Head, Department of Microbiology, Sree Sankara College, Kalady
3. Dr. Valsa A K, Associate Professor, Department of Microbiology, Sree Sankara College, Kalady
4. Dr. Sudha K., Assistant Professor and Head, Department of Biotechnology, St. Peter's College, Kolencherry
5. Dr. Ally C. Antony, Assistant Professor, Department of Biotechnology, MES College, Marampilly, Aluva
6. Dr. Manjusha K., Assistant Professor, Department of Microbiology, St. Xavier's College for Women, Aluva
7. Mr. Noby Mathew, Assistant Professor, Department of Applied Microbiology, St. Thomas College, Pala.
8. Mr. Sreejith K M., Senior Manager –QA, Innovative Foods Ltd., Ezhupunna P O., Aleppey 688537.
9. Mr. Manoj Mathew, Manager –QC, AVT McCormick Ingredients Pvt Ltd., Marampilly P O., South Vazhakulam, Aluva, Ernakulam 683105.

TABLE OF CONTENTS

M. Sc. Microbiology Programme

(Mahatma Gandhi University Regulations PGCSS-2019 from 2019-20 Academic Year)

1. Aim of the Programme:

Program Specific Outcome

Upon completing degree in M. Sc. Microbiology, students should have thorough understanding and knowledge of the core concepts in General Microbiology.

Microbiology postgraduates will be able to:

i. Describe the role and interaction of microorganisms in the ecosystem and its usefulness as a 'model system' to study basic biology, genetics, metabolism and ecology.
ii. Identify role of microorganism in disease and in the environment including elemental cycles, biodegradation, *etc*.
iii. Cite examples of the vital role of microorganisms in fermentation, biotechnology, medicine, and other industries important to human well being.
iv. Explain the reason for ubiquitous distribution of microorganism in wide range of ecological habitat including extreme environments in nature.
v. Attain laboratory skills in microbiological practices including immunological and molecular microbiological methods.

2. Eligibility for Admissions

A candidate seeking admission to M Sc. Microbiology must have at least 55%marks in biological sciences (Zoology, Botany, Biochemistry, Biotechnology, Microbiology, etc.,) or Chemistry at the graduate level.

The admission to M Sc. Microbiology PG Programme shall be as per the rules and regulations of the university.

3. Medium of Instruction and Assessment

The medium of instruction and assessment will be English.

4. Faculty under which the Degree is Awarded

Faculty of Science.

5. Specializations offered, if any

NIL

6. Note on compliance with the UGC Minimum Standards for the conduct and award of Post Graduate Degrees

The programme structure and syllabus of M Sc. Microbiology complies with the minimum standards prescribed by the University Grants Commission. The M Sc. Microbiology programme is under the Credit Semester Scheme, consisting of four semesters spread over a period of two years.

- Total credits are 80.
- Number of courses: Core courses - 12, Elective courses - 3, Laboratory courses – 4
- Evaluation: Internal assessment and external evaluation - 1:3 ratio.
- Grading: Direct grading system on a 7 point scale.

THE PROGRAMME STRUCTURE

Course Code	Title of the Course	Type of the Course	Hours per week	Credits
FIRST SEMESTER				
MG030101	Fundamentals of Microbiology	Core course	04	04
MG030102	Fundamentals of Biochemistry	Core course	04	04
MG030103	Analytical Techniques, Biostatistics and Bioinformatics	Core course	04	04
MG030104	Cell Biology	Core course	03	03
MG030105	Laboratory course I	Core course	10	04
Total			**25**	**19**
SECOND SEMESTER				
MG030201	Immunology	Core course	04	04
MG030202	Molecular Biology and Recombinant DNA Technology	Core course	04	04
MG030203	Enzymes	Core course	04	04
MG030204	Microbial Physiology and Metabolism	Core course	03	03
MG030205	Laboratory course II	Core course	10	04
Total			**25**	**19**
THIRD SEMESTER				
MG030301	Food and Industrial Microbiology	Core course	04	04
MG030302	Environmental and Agricultural Microbiology	Core course	03	03
MG860301	Microbial Diversity & Extremophiles	Elective -1	04	04
MG870301	Marine Microbiology	Elective -1		
MG880301	Physiology	Elective -1		
MG860302	Nanobiotechnology	Elective -2	04	04
MG870302	Microbial Quality Assurance, Biosafety and Intellectual Property Rights	Elective -2		
MG880302	Biostatistics and Research Methodology	Elective -2		
MG030303	Laboratory course III	Core course	10	04
Total			**25**	**19**

FOURTH SEMESTER				
MG030401	Systematic Bacteriology	Core course	05	04
MG030402	Medical Virology, Mycology and Protozoology	Core course	04	04
MG860403	Molecular Microbiology	Elective -3	04	04
MG870403	Clinical Microbiology	Elective -3		
MG880403	Microbial Genetics	Elective -3		
MG030403	Laboratory course IV	Core course	12	05
	Project			04
	Comprehensive Viva Voce			02
Total			**25**	**23**
Total Credits				**80**

GROUPS OF ELECTIVES

Semester	**GROUP A (MG86)**	**GROUP B (MG87)**	**GROUP C (MG88)**
Third Semester	MG860301 Microbial Diversity & Extremophiles	MG870301 Marine Microbiology	MG880301 Physiology
Third Semester	MG860302 Nanobiotechnology	MG870302 Microbial Quality Assurance, Biosafety and Intellectual Property Rights	MG880302 Biostatistics and Research Methodology
Fourth Semester	MG860403 Molecular Microbiology	MG870403 Clinical Microbiology	MG880403 Microbial Genetics

SYLLABUS

First Semester M.Sc. Microbiology

MG030101	Fundamentals of Microbiology
MG030102	Fundamentals of Biochemistry
MG030103	Analytical Techniques, Biostatistics and Bioinformatics
MG030104	Cell Biology
MG030105	Laboratory course I

MG030101 - FUNDAMENTALS OF MICROBIOLOGY

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

Course Outcome

By attending the course, the students will be able

- To understand the diversity of microbial world and their interactions with the environment.
- To know about the genetic materials and different genetic mechanisms in bacteria and their role in the transmission of characters.
- To emphasize the importance of sterilization and disinfection and the methods used in a microbiology laboratory and premises
- To categorize microorganisms based on their characteristics.

Module I

The historical foundations and development of microbiology. An overview of microbial world. - Prokaryotic and eukaryotic cell and organelles and its functions. Outline classification of microorganisms- Haeckel three Kingdom classification, Whittaker five Kingdom classification, and Woese three domain classification,

Principles of bacterial taxonomy- Numerical taxonomy, Identification characters- morphological, staining, physiological, biochemical and molecular (mol % G+C, nucleic acid hybridization, 16SrRNA sequencing) characters.

Bacterial classification as per latest edition of Bergey's Manual of systematic Bacteriology.

Module II

General characters of bacteria and the archaea. Cultivation of bacteria- culture media- Simple media, Differential media, Special media, enriched media, enrichment media and methods-aerobic and anaerobic media.

General properties of viruses. Morphology and structure of viruses, Bacteriophages, viroids, prions. Genetic modification of viruses. Virus multiplication. Cultivation of viruses.

General characters of fungi. Classification of fungi, Reproduction in fungi. Methods for the study of fungi. Cultivation of fungi.

Module III

Morphology and structure of bacteria-size shape, structure and arrangement, cultural characteristics. Surface structures and inclusions of bacteria-cell wall, cell membrane, cell organelles, genetic material, plasmid, spore, inclusion bodies. Microbial locomotion - flagellar motility, gliding motility and amoeboid motion. Chemotaxis, Phototaxis and other taxes. Identification of bacteria. Staining reactions. Simple staining, Differential staining, Special staining, Cultural, Morphological, physiological and biochemical properties. Molecular methods for identification. Isolation of DNA, electrophoresis, amplification of DNA -PCR technique,16SrRNA sequencing, Phylogenetic tree.

Module IV

Sterilization - Principles and methods, physical and chemical methods. Disinfectants - modes of action. Testing of disinfectants. dilution test, phenol- coefficient test. Antibiotics - Antibacterial, antifungal, antiviral, mechanism of action. Classification of antibiotics based on mechanism of action. Drug resistance in bacteria. Antibiotic sensitivity tests. disc method, well method and MIC.

Module V

Genetic materials in bacteria. Bacterial chromosome. Extrachromosomal genetic elements. Plasmid- copy number and incompatibility, Replication of plasmid. Episomes. Transposable element-IS element and transposon, Integrons and Antibiotic resistance cassettes, Multiple antibiotic resistant bacteria, Mutation- types of mutations, DNA repair-Photolysis, Excision repair, NER, SOS repair, Mutant selection. Mechanism of gene transfer - transformation, transduction and conjugation. Recombination- types, mechanism and enzyme involved. Gene mapping. Genetic system in Yeast & Neurospora.

References

1. Russell AD, Hugo WB, &Ayliffe GAJ (1999) *Principles and practice of disinfection, preservation, and sterilisation* (Blackwell Science, Oxford) 3rd ed
2. Bryan LE (1984) *Antimicrobial Drug Resistance* (Academic Press, Orlando
3. Topley WWC, Wilson GS, Parker T, & Collier LH (1990) *Topley and Wilson's Principles of Bacteriology, Virology and Immunology* .Edward Arnold, London. 8thed.
4. Davis BD (1990) *Microbiology* (Lippincott, Philadelphia) 4th ed
5. Zinsser H &Joklik WK (1992) *Zinsser Microbiology* (Appleton & Lange, Norwalk,CT) 20th Ed

6. Gerhardt P (1994) *Methods for General and Molecular Bacteriology*. American Society for Microbiology, Washington, D.C.
7. Pelczar MJ, Chan ECS, & Krieg NR (1993) *Microbiology: concepts and applications* McGraw-Hill.5th ed.
8. Prescott LM, Harley JP, & Klein DA (2005) *Microbiology* (McGraw-Hill, Boston;London) 6th ed.

MG030102 - FUNDAMENTALS OF BIOCHEMISTRY

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

Course Outcome

By attending the course, the students will be able

1. To understand the basic concepts and significance of Biomolecules
2. To understand the interactions between macromolecules
3. To analyse the structure-function relationships of biomolecules.

Module I

Carbohydrates: Composition, structural classification and functions.

Oligosaccharides: Glycosidic bonds; Classification: glycoproteins (O-linked and N-linked); glycolipids; Nature of carbohydrate moiety attached; Function- as cell recognition factors, in intracellular targeting.

Polysaccharides: Classification: Homopolysaccharides (Cellulose, Starch, Chitin and Glycogen), Heteropolysaccharides (bacterial peptidoglycans, glycosaminoglycans, hyaluronic acid, and heparin); Structural characteristics and functions of above mentioned polysaccharides; Synthetic polysaccharides and their uses. Characterization of Polysaccharides from biological systems.

Module II

Lipids: **C**omposition, structural classification and functions.

Glycerophospholipids: Structure and function of (Phosphatidic acid, cardiolipin, Phosphatidyl serine, Phosphatidyl ethanolamine, Phosphatidyl Glycerol, Phosphatidylcholine, Phosphatidyl inositol, plasmalogens) CDP-diacylglycerol, Lung surfactants. Lipoproteins.

Glycosphingolipids: Structure and function of (Sphingosine, ceramides & sphingomyelins, cerebrosides, globosides, gangliosides, sulfatides)

Eicosanoids: Prostaglandins, Leukotrienes and Thromboxanes: Chemistry and physiological function.

Steroids: Classification, structure and functions. Animal, plant and microbial steroids.

Module III

Proteins: Structure and function, Amino acids- Structure and reactions, Peptides. Primary, Secondary, Tertiary and Quaternary structure of Proteins - Fibrous proteins(Keratins and collagen) and Globular proteins (myoglobin and haemoglobin), Membrane Protein (ATP synthase); Structural implication of the peptide bond-rigid planar peptide unit-cis and trans configuration-conformations of a pair of linked peptide units- torsion angles: phi and psi- steric hindrance- allowed and disallowed conformation – Ramachandran diagram –conformational maps of glycine and other natural amino acids. Protein folding and dynamics– Molten globule state– Molecular chaperones– Heat Shock Proteins. Denaturation (pH, temperature, chaotropic agents) – refolding.

Module IV

Nucleic acid: Structure and function, Purines, Pyramidines, Nucleosides and Nucleotides. Types of DNA-A, B and Z. Super coiling of the DNA molecule; topoisomers and superhelices; Higher orders of DNA Structure: Chromatin Structure: Histones and Nucleosomes; Conformation of Chromatin fibers; Organization of the DNA Sequence: Genes, pseudo genes, extragenic regions (beta globin gene and gene family) duplicated genes; Reassociation kinetics, Repetitive DNA sequences.

RNA Structure: Types of RNA; structure of mRNA, tRNA, rRNA, with emphasis on importance of structure to its function.

Module V

Macromolecular interactions: Protein - DNA interaction-helix turn helix, helix loop helix, zinc fingers, homeo box. Other DNA binding proteins.

Protein RNA interaction- RNA recognition motif. Protein-protein interaction, leucine zippers, bHLH, bZip motifs, PTB, SH2 and SH3 domains. Protein lipid interaction – PH domain.

REFERENCES

1. Lehninger, Principles of Biochemistry, Fourth Edition by David L. Nelson Michael. M Cox Publisher: W. H. Freeman; Fourth Edition (April 23,2004) ISBN-10:0716743396 ISBN-13:978-0716743392

2. Biochemistry (2004) by Donald Voet, Judith G Voet Publisher: John Wiley &Sons Inc ISBN:04711935X ISBN-13: 9780471193500, 978-0471193500
3. Principles of Biochemistry,4/e (2006) by Robert Horton H, Laurence A Moran, Gray Scrimgeour K Publisher Pearsarson ISBN:0131977369, ISBN- 13:9780131977365, 9780131977365
4. Biochemistry (2008) by Rastogi, Publisher: Mcgraw Hill ISBN: 0070527954 ISBN-13:9780070527959, 978-0070527959
5. Genes IX by Benjamin Lewin (2008) Publisher: J&b ISBN: 07637 52223ISBN-13: 9780763752224,978-0763752224
6. Molecular Biology of the Gene 5/e(s)by James D Watson, Tania A Baker, Stephen P Bell (2008) Publisher: Dorling Kindersley (India) Pvt Ltd ISBN: 8177581813 ISBN-13: 9788177581812, 978-8177581812
7. Biochemistry – The clinical reactions of living cells -David E Metzler; Academic press New York

MG030103 - ANALYTICAL TECHNIQUES, BIOSTATISTICS AND BIOINFORMATICS

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

Course outcome

By attending the course, the students will be able

1. To understand the biochemical techniques used in research and industry
2. To handle various instruments used in laboratories
3. To appraise the role of statistics in research
4. To demonstrate the *in silico* analytical tools for biological data analysis

Module I

Microscopic and Spectroscopic techniques

Principle, instrumentation and applications of light microscopy, Bright field, darkfield, phase contrast, fluorescence microscopy and confocal microscopy. Scanning and transmission electron microscopy.

Principle, instrumentation, and applications of UV-Visible, Infra-red and Fluorescence spectroscopy. Matrix assisted LASER desorption/ionization- time of flight-mass spectroscopy (MALDI-TOF MS). Flow cytometry and applications.

Methods for studying the structure of macromolecules- X Ray crystallography, Nuclear magnetic resonance spectroscopy (NMR), Electron Spin Resonance (ESR).

Module II

Hydrodynamic techniques

Principle, instrumentation, methods and application of adsorption and partition chromatography- Paper chromatography, Thin layer chromatography. Gel filtration chromatography, Affinity chromatography, Ion–exchange chromatography, HPLC.

Centrifugation- Principle, methods and applications of Ultra-centrifugation; differential and density gradient centrifugation.

Module III

Electrophoretic and blotting techniques

Principle, instrumentation, methods and applications of electrophoresis; Gel electrophoresis- Polyacrylamide gel electrophoresis, SDS-PAGE, isoelectric focusing, agarose gel electrophoresis.

Principle, instrumentation, methods and applications of Western, Southern & Northern Blotting techniques.

Module IV

Biostatistics-

Introduction, scope, probability and probability distribution analysis, variables in biology, collection, classification and tabulation of data, graphical and diagrammatic representations, Descriptive statistics, measures of central tendency- Arithmetic mean, median, mode, geometric mean, harmonic means. Measures of Dispersion-Standard deviation, standard error, Variance, coefficient of variation. Correlation and regression. Principle component analysis test of significance, Basic idea of Significance test, hypothesis testing, levels of significance, Chi-square test and goodness of fit, comparison of means of two samples, three or more samples, statistical packages, use of statistical softwares, Excel, SPSS, Anova. Prism, graph pad software.

Module V

Bioinformatics

Scope of bioinformatics, History and development, major biological data bases and its classification - sequence databases, structural data bases, derived and specialized data bases, genomic databases, sequence and structure file formats, creating databases, Data organisation, Searching data bases.

Basic idea of sequence comparison- Pair wise and multiple sequence alignment, Applications of multiple sequence alignment. Sequence analysis softwares- BLAST, FASTA, CLUSTAL.

16 S rDNA sequencing and phylogenetic tree construction.

Applications of bioinformatics- Pharmaceutical industry, Drug designing, Immunology, Agriculture and Forestry.

REFERENCES

1. Practical Biochemistry-Principles and techniques. Keith Wilson and John walker(Eds), University press, Cambridge UK.
2. Modern Experimental Biochemistry. Rodney F Boyer. Benjamin/Cummings publishing company Inc. Redwood city, California.
3. Chromatographic methods. A Braithwate and FJ Smith. Chapman and hall, New York.
4. Gel Electrophoresis of Nucleic acids-A Practical approach. Rickwood D and BD Hames. IRL Press, New York
5. Spectrophotometry and Spectrofluorimetry: A Practical Approach. Harris DA and CL Bashford (Ed.) IRL Press, Oxford.
6. Introduction to Spectroscopy. Donald L. Pavia Gary M. Lipman, George S Kriz. Harcourt brace College Publishers, Orlands, Florida

MG030104 - CELL BIOLOGY

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

Course Outcome

By attending the course, the students will be able

- To understand the various organelles of a cell and its functions
- To know about the different cellular receptors and signal transduction pathways
- To understand the cell cycle and apoptosis
- To understand the etiology of cancer

Module I

Cell structure

Plant, animal and microbial cells. Nucleus, Cytoskeleton and cell organelles- Golgi Apparatus, ER, Lysosomes, Peroxisomes, Vacuoles, Glyoxysomes, Mitochondria and Chloroplast. Structure and functions. Specilized forms of membranes: brush border, flagella, pili, fimbriae, red cell membranes and microsomal membrane. Physical and biochemical methods to study the structure and function of membrane.

Module II

Plasma membrane

Structure and functions of Plasma membrane. Membrane Transport: Endocytosis and exocytosis; Transport across membranes; porins facilitated diffusion, Porter molecules: facilitated transport - symport, antiport, uniport. Anion porter, glucose porter; Active transport: proton pumps; Na^+ K^+ pumps, Ca+ pumps; Ion channels: Types and characteristics of ion channels. Gap and tight junctions, Quorum sensing

Module III

Signal transduction

Membrane receptors - Types, Structure and functions of receptors; Mechanism of signal transduction – signals, second messengers. Signalling pathways: GPCR, Ion channel-linked receptors, Enzyme-linked receptors- receptor and non-receptor tyrosine kinases, serine/threonine kinase coupled receptors, mitogen activated protein kinases, phospholipid

mediated signalling. Nuclear receptors. Kinases and Phosphatases. Cell –Cell interaction and cell matrix interaction. Prokaryotic signalling.

Module IV

Cell cycle and Cell death

Different phases - G1 S G2 and M phases (mitosis and meosis), checkpoints, regulations of cell cycle. Maturation Promoting factor, cyclins, ubiquitin, protein ligases, Anaphase Promoting complex, inhibitors of CdK.

Necrosis and apoptosis, stages of apoptosis, Role of mitochondria, DNA ladders, transglutaminase activity, programmed cell death in *Ceanorhabdtis elegans* and *Xenopus.* Proteins involved in apoptosis - Bcl2 family, caspases and death proteins - their role in apoptosis. Autophagy.

Module V

Molecular aspects of Cancer

Cancer- Stages in cancer development, causes, properties of cancer cells, tumour Viruses, oncogenes, functions of oncogene products. Oncogene and signal Transduction, oncogene and G proteins, oncogene and cell survival. Tumour Suppressor gene, functions of tumour suppressor gene products.

Cancer Pathways: MAPK, P13K, TP53 network, NFkB pathways; Signalling by TGF β factor, Diagnosis, prevention and treatment of cancer

REFERENCES

1. Cell Biology, Smith and Wood
2. Cell and Molecular Biology by Gerald Karp, Academic Press
3. Cell and Molecular Biology by Cooper
4. Biology of Cancer by Robert Weinberg

MG030105 - LABORATORY COURSE -I

Number of Hours/ Week: 10 **Credits 4**

Course Outcome

By attending the course, the students will be able

- To prepare molar, normal and percentage solutions
- To identify unknown samples by systematic analysis
- 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

1. Preparation of Solutions:

- Percentage solutions,
- Molar solutions,
- Normal solutions
- Dilution of Stock solutions

2. Spectrophotometric experiments:

- Determination of UV-Visible spectrum of compounds
- Determination of Concentration of molecules from Molar Extinction coefficient values.

3. Qualitative analysis of Carbohydrate mixtures (a combination of polysaccharide, disaccharide and monosaccharide) following systematic analysis.

4. Quantitative Analysis-Any five

- Quantitative estimation of reducing sugars by Dinitrosalicylic acid method
- Quantitative estimation of glucose by Nelsons Somogi method
- Quantitative estimation of glucose by orthotoluidine method
- Estimation of fructose by Roe and Papadopaulose method
- Estimation xylose by orcinol method
- Quantitative estimation of tyrosine by Folinsciocalteu method
- Estimation of Cholesterol by Zak's method
- Estimation of protein by biuret method.
- Estimation of protein by Lowry's method
- Estimation of albumin by BCG method
- Quantitative estimation of Methionine by Nitroprusside method

- Estimation of total aminoacids by Ninhydrin method

5. Chromatographic techniques

- Separation of amino acids by Paper chromatography (Descending or Ascending)
- Separation of Plant pigments/lipids/sugars by Thin layer chromatography
- Separation of any biomolecule by column chromatography

6. Demonstration of stages of mitosis, meiosis and counting chromosome numbers

7. Bioinformatics

- Familiarizing with the different data bank mentioned in the syllabus.
- Retrieve a document reporting recent work on a genomic analysis of human disease.
- Retrieve one sequence both DNA and protein from database retrieval systems.
- Retrieve nucleotide sequences and construct a distance tree.
- Phylogenetic tree construction.

REFERENCES

1. Introductory Practical Biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9, P195-303
2. Standard Methods of Biochemical Analysis, S.K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5, p 12-18
3. Hawk's Physiological Chemistry, Bernard L.Oser (ed) TATA McGraw Hill Publishing Company LTD, New Delhi, p 60-127, 1317-1334

SYLLABUS

Second Semester M.Sc. Microbiology

MG030201	Immunology
MG030202	Molecular Biology and Recombinant DNA Technology
MG030203	Enzymes
MG030204	Microbial Physiology and Metabolism
MG030205	Laboratory course II

MG030201 - IMMUNOLOGY

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

Course Outcome

By attending the course, the students will be able

- To conceptualize cellular and molecular basis of the immune system.
- To understand how the innate and adaptive immune responses coordinate to fight against invading pathogens.
- To appreciate the structure and functions of MHC molecules and Immunoglobulins.
- To understand the complement system, its activation and biological consequences of complement activation.
- To understand about the vaccines in use and the strategies to develop vaccines of the future.
- To understand and identify the genetic defects that lead to immunodeficiency diseases and their treatment as well as the current status of gene therapy.

Module I

History and scope of Immunology, Infection- Source of infection, Methods of transmission. Immunity, Types of immunity- innate, acquired, passive and active. Mechanisms of innate immunity- barriers, inflammation, phagocytosis- mechanisms, Pattern recognition receptors- Soluble (Antimicrobial peptides, CRP, MBL) and Membrane associated (TLR, Scavenger, NOD). Cells and organs of the immune system.

Module II

Antigens- types, haptens, epitopes, Immunoglobulin - structure, classes and functions Fc receptors. Monoclonal antibodies- production and application, Antibody engineering. Antigenic determinants on Ig- Isotype, Allotype, Idiotype. Genetic basis of antibody diversity, Organization and Expression of Immunoglobulin, Genes, V(D)J rearrangements; somatic hypermutation affinity maturation, and class-switching, Antigen-antibody reactions, Agglutination, Precipitation, Complement fixation, Radioimmuno assay, Immunoflourescence, ELISA, Western blotting.

Module III

Complement system, Complement activation, regulation, Biological effects of complements, MHC, Antigen processing and presentation, Receptors on T and B cells for antigen recognition, B cell- generation, activation, differentiation, Humoral Immune response- Primary and secondary immune response, Antibody formation, Clonal selection theory. T-cell maturation, activation and differentiation, Cell mediated Immune response, T-Cell subsets, Cytokines.

Module IV

Transplantation immunology: Immunologic basis of graft rejection, clinical manifestations of graft rejection, tissue typing, immunosuppressive therapy. Immunology of malignancy- Tumor antigens, Immune response in malignancy, Immunotherapy of cancer, Immunohematology- ABO and Rh blood group system, Immunology of blood transfusion, Hemolytic disease of new born.

Module V

Immunological Tolerance, Autoimmunity- Mechanisms of autoimmunity, Autoimmune disorders- Organ specific and systemic autoimmune diseases. Hypersensitivity- immediate and delayed reactions, Immunodeficiency diseases- Primary and secondary immunodeficiency diseases, Vaccines -types of vaccines.

References

1. Roitt IM & Delves PJ (2001) *Roitt's essential Immunology*.Blackwell Science, Oxford. 10th ed.
2. Kindt TJ, Goldsby RA, Osborne BA, &Kuby J (2006). *Kuby Immunology*.W.H. Freeman, New York. 6thed
3. Murphy K, Travers P, Walport M, &Janeway C (2008) *Janeway's Immunobiology*. Garland Science, New York. 7thed
4. Chapel H (2006) *Essentials of clinical Immunology*. Blackwell, Malden, Mass.; Oxford. 5thed
5. Kimball JW (1986) *Introduction to Immunology*. Macmillan, London 2nd ed
6. 6.Paniker CKJ (2006) *Ananthanarayan & Paniker's Textbook of microbiology*. Orient Longaman. 7thed.

MG030202 - MOLECULAR BIOLOGY & RECOMBINANT DNA TECHNOLOGY

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

Course Outcome

By attending the course, the students will be able

- To acquire knowledge on various molecular mechanism underlying the transmission of genetic information
- To understand the theoretical aspects of rDNA technology and genetic engineering
- To custom the different molecular tools and strategies explored in rDNA technology
- To interpret the outcome of various molecular biology experiments

Module I

DNA Replication- Chromosomes, Process of DNA replication, Semiconservative, discontinuous uni and bidirectional, Okazaki fragments, DNA polymerases in eukaryotes and prokaryotes, Klenow fragment, modes of replication, theta, rolling circle, D-loop replication, Primosome, SSB, Helicase, Ligase, methylation and control, repetitive DNA sequences, minisatellite, microsatellite, DNA protein interaction, DNA Linking number and topoisomerase, Inhibition of replication.

Module II

Transcription-Process of transcription, stages in transcription, RNA polymerases in prokaryotes and eukaryotes, sigma factor in prokaryotes, Rho dependent and Rho independent termination. Enhancers, Transcription factors in Eukaryotes, Differences in transcription between prokaryotes and Eukaryotes, post transcriptional modifications, Polyadenylation, capping, r-RNA processing, Splicing- Splicesome, lariat structure, Group I,II and III Introns, Ribozyme, Importance of ribozyme, properties, application, RNaseP, RNAse III, RNAseII, monocistronic and polycistronic m-RNA, Joint transcript of r-RNA and tRNA in prokaryotes and their processing. Transplicing, alternate splicing, inhibitors of Transcription.

Molecular mechanism of gene regulation in prokaryotes-Transcriptional regulation in prokaryotes; Inducible & repressible system, +ve, &-ve regulation; Operon concept, structure of operon, Lac, Trp, AraC operon, Catabolic repression, attenuation. Role of Hormones in gene regulation. RNA World, RNA based technology -Molecular mechanism of Ribozyme,

Antisense RNA, SiRNA, MicroRNA, Ribozwitches and their applications; Telomerase structure and function. Nucleic acid as therapeutic agent.

Module III

Translation - Process of translation. Stages in translation, genetic code, properties, wobble hypothesis, eukaryotes and prokaryotes ribosomes, mRNAs, tRNAs, aminoacyl t-RNA synthetases, protein factors initiation complex, peptidyltransferases, releasing factors, differences between prokaryotic and eukaryotic systems, inhibition of translation. Post translation modification by cleavage, self-assembly, assisted self-assembly chaperones, acylation, phosphorylation, acetylation and glycosylation. Histone acetylation and deacetylases, chromosome remodelling complex. Intein splicing. Protein targeting, cotranslational import, post translational import, SRP-structure and function, Blobel's concept, Lysosome targeting, M6P address Glycosylation, core glycosylation terminal glycosylation, Dolichol phosphate. Targeting to nucleus, peroxisomes, chloroplast and mitochondria.

Module IV

Tools and techniques for genetic Engineering - History of rDNA Technology, Cohen and Boyer Patents, Isolation of DNA and RNA from different sources, enzymes used in genetic engineering with special reference to restriction enzymes, ligases, and other DNA modifying enzymes. Modification of restriction fragments, vaccinia topoisomerases, TA cloning, and homopolymer tailing.

Vectors for E. coli with special reference to plasmid vectors pBR322, pUC, their development, features and selection procedures, direct selection plasmid vectors, low and high copy number plasmid vectors, Bacteriophages (λ and M13) with special reference to λEMBL, λZAP- their development, features, selection procedures, in vitro packaging mechanisms, cosmids, features, advantages and cosmid cloning schemes, phagemids with special reference to pBluescript, Construction of genomic libraries and cDNA libraries, procedures for recombinant selection and library screening, PCR enzymes, primer design, real time PCR, RT PCR, Nested PCR, Inverse PCR, Assymmetric PCR, applications of PCR Cloning, Chemical synthesis of DNA, DNA sequencing-plus and minus sequencing, Sangers dideoxy sequencing Maxam and Gilert method, advanced sequencing procedures – pyrosequencing, Illumina, ABI / SOLID and their applications.

Module V

Applications of Genetic Engineering - Applications of transgenic Technology Improving quality and storage life of fruits and vegetables. Plants with novel features, Pharming. Animal cloning, Ethics of cloning. Applications of Molecular Biology in forensic sciences, medical science, archeology and paleontology.

REFERENCES

1. REA's Problem Solvers in Genetics, Research Education Association, 61, Ethel Roadwest, New Jersey
2. Modern Genetic Analysis, Griffiths, Lewontin, Gilbert and Miller Freeman's and Co, New York
3. Principles of gene manipulation - Old, Twyman and Primrose
4. Gene cloning and DNA analysis - T. A Brown
5. Cell Biology, Smith and Wood
6. Cell and Molecular Biology by Gerald Karp, Academic Press
7. Cell and Molecular Biology by Cooper
8. Cell Biology by DeRobertis
9. Molecular Biotechnology-Glick and Pasternae
10. Genes-Benjamin Lewin

MG030203 - ENZYMES

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

Course Outcome

By attending the course, the students will be able

- To describe structure, functions and mechanism of action of enzymes
- To understand the classification of enzymes based on the reactions catalysed
- To understand kinetics of enzyme catalysed reactions and enzyme inhibitory and regulatory processes.

Module I

Introduction to enzymes - Holoenzyme, apoenzyme, and prosthetic group; Interaction between enzyme and substrate- lock and key model, induced fit model, Features of active site, activation energy, Rate Enhancement through Transition State Stabilization, Chemical Mechanism for transition state stabilization, Enzyme specificity and types; Enzyme Commission system of classification and nomenclature of enzymes (Class and subclass with one example). Ribozymes, Abzymes. Coenzymes and their functions- NAD, $NADP^+$, FAD, FMN, lipoic acid, TPP, Pyridoxal phosphate, biotin and cyanocobalamin.

Measurement and expression of enzyme activity, enzyme assays. Definition of IU, katals, enzyme turnover number and specific activity, Isolation, purification and characterisation of enzymes and criteria of purity.

Module II

Enzyme kinetics - Study of the factors affecting the velocity of enzyme catalyzed reaction- enzyme concentration, temperature, pH, substrate concentration, inhibitors and activators (explanation with graphical representation). Derivation of Michaelis Menten equation and Km value determination and its significance, Definition of V_{max} value of enzyme and its significance, Lineweaver-Burk plot; Bi- substrate reactions.

Module III

Enzyme inhibition - Reversible and irreversible-examples. Reversible-competitive, non-competitive and uncompetitive inhibition; Graphic determination of inhibitor type, Dose-response curves of Enzyme inhibition. Mutually Exclusive Binding of Two inhibitors; Structure-Activity Relationships and Inhibitor Design;

Module IV

Regulation of Enzyme activity - Covalently modulated enzymes with examples of adenylation and phosphorylation; Zymogen form of enzyme and zymogen activation; Multienzyme complexes and their role in regulation of metabolic pathways; Allosteric regulation: example of Aspartate trascarbamoylase, Isoenzymes- Lactate dehydrogenase and creatine phosphokinase.

Module V

Application of enzymes - Immobilisation of enzymes and methods of immobilisation. Industrial uses of enzymes: production of glucose from starch, cellulose and dextrans, use of lactase in diary industry, production of glucose fructose syrup from sucrose, use of proteases in food, leather and detergent industry. Diagnostic and therapeutic enzymes; Enzyme engineering

REFERENCES

1. Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis stevens (2000) Publisher: Oxford University Press, USA ISBN: 019850229x ISBN-13: 9780198502296, 978-0198502296
2. Enzyme Kinetics: A modern Approach Book: Enzyme Kinetics: A Modern Approach by Alejandro G. Marangoni (2003) Publisher: Wiley-interscience ISBN: 0471159859 ISBN_13:9780471159858, 978-0471159858
3. Enzyme Kinetics and Mechanisms by Taylor Publisher: Spring ISBN 8184890478 ISBN-13: 9788184890471, 978-8184890471
4. Enzyme Mechanism by P.K Sivaraj Kumar (2007) Publisher: RBSA Publishers ISBN: 8176114235 ISBN -13:9788176114233, 978-8176114233
5. Enzymes and Enzyme Technology by kumar (2009) Anshan Pub ISBN: 1905740875, ISBN-13:9781905740871, 978-1905740871
6. Enzymes in Industry: Production And Applications by Aehle W (2007) Publisher: John Wiley & Sons Inc ISBN: 3527316892 ISBN -13: 9783527316892, 9783527316892, 9783527316892
7. Enzymes: Biotechnology, Clinical Chemistry (second Edition) by Trevor Palmer, Philip Bonner (2007) Publisher: Horwood Publishing Limited ISBN: 1904275273 ISBN-13: 978-1904275275
8. Enzymology Dixon and Webb

MG030204 - MICROBIAL PHYSIOLOGY AND METABOLISM

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

Course Outcome

By attending the course, the students will be able

- To understand the principle of metabolic processes of growth and solute transport
- To comprehend various physiological adaptations and intracellular signaling
- To explain the energy yielding central metabolic pathways and its regulations
- To know the metabolic pathways of lipid, protein and nucleic acid

Module I

Growth, division and solute transport

Measurement of growth, growth physiology- nutritional types and factors influencing, cell division, growth yields, growth kinetics, steady state growth and continuous growth.

Primary and Secondary transport - Introduction, Kinetics, ABC transporters, Phosphotransferase system, Drug export systems, amino acid transport.

Module II

Physiological adaptations and intracellular signaling

Introduction to two component system, regulatory systems during aerobic- anaerobic shifts- Arc, Fnr, Nar, FhlA regulon, response to phosphate supply- The Pho regulon, Quorum sensing- A and C signaling system, Heat-Shock responses, pH homeostasis, osmotic homeostasis.

Module III

Central Metabolic pathways and regulation

Glycolysis, PPP, ED pathway, Citric acid cycle: Electron transport and oxidative phosphorylation, efficiency of aerobic and anaerobic respiration as energy yielding processes. Branched TCA and Reverse TCA, glyoxylate cycle. Fermentative pathways in specific group of microbes: alcoholic, lactic acid, formic, mixed, propionic, butyric, butanol, butanediol. Utilization of sugars other than glucose and complex polysaccharides. Photosynthesis: Major groups of photosynthetic prokaryotic microbes. Ultrastructure of reaction center, arrangements of light harvesting pigments, light reaction & electron flow in photosynthesis. CO2 fixation pathways.

Module IV

Metabolism of lipids

Lipid composition of microorganisms, Fatty acid synthesis (saturated and unsaturated), Fatty acid degradation (saturated and unsaturated), Cell wall lipid composition, Bacterial cell wall synthesis (+ve and –ve). lipid accumulation in yeasts, hydrocarbon utilization, PHA synthesis and degradation.

Module V

Metabolism of proteins and nucleic acids

Biosynthesis of amino acids, catabolism of amino acids (deamination, decarboxylation and transamination), lysine and glutamine overproduction, stringent response, polyamine biosynthesis and regulation. protein degradation – exo and endo proteases. Purine and pyrimidine biosynthesis, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleotide synthesis.

References

1. Microbiology. Lansing M Prescott, John P Harley, Donald A Klein. McGrawHill.
2. Microbial Physiology. Albert G Moat, John W Foster, Michael P Spector. Willey-Liss.
3. Bacterial Metabolism. Gerhard Gottschalk. Springer.
4. Lehninger's Principle of Biochemistry. Nelson L D and M M Cox. Macmillan Worth publication Inc.
5. Biochemistry. Jeremy M.Berg John and Tymoczko Lubert Stryer. W H Freeman & Co. NY.
6. Biochemistry with Clinical Correlation Thomas M Devlin.Wiley- Liss Publication.
7. Biochemistry. Donald Voet , Judith G Voet, Charlottew pratt. John Wiley and Sons.
8. Biochemistry. Jeoffrery Zubay. Wm C Brown Publ.
9. Biochemistry. Mathews C K and K.E. van Holde. Benjamin Cumming Publ.Co.
10. Biochemistry – The chemical reactions of living cells -David E Metzler; Academic press New York
11. Reddy and Reddy (2005). Microbial physiology.
12. Moat, A.G and J.W. Foster (1999). Microbial physiology
13. Caldwell, D.R.1995. Microbial Physiology and Metabolism
14. David White.1995. The Physiology and Biochemistry of Prokaryotes
15. Gottschalk, G. Bacterial Metabolism
16. Hans G. Schlegel. General Microbiology

MG030205 - LABORATORY COURSE -II

Number of Hours / Week: 10 **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 also understand various physical and chemical means of sterilization
- Master aseptic techniques and be able 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.
- To understand the principle and practices of immunological tests
- To know and practice basic technique in molecular biology

MICROBIOLOGY AND IMMUNOLOGY

- Microscopic examination of bacteria in living conditions
- Testing of motility
- Staining procedures- Gram's, Volutin, Spore, Capsule, Negative, Acid Fast, Fungal staining etc.
- Cultivation of bacteria and fungi
- Sterilization methods
- Study of cultural characteristics and biochemical reaction of bacteria
- Testing of disinfectants
- Bacterial growth curve
- Antibiotic sensitivity tests- disc diffusion, MIC
- Sterility testing of solution, vaccines, drugs and surgical methods
- Serological tests for the diagnosis of microbial infections
- Agglutination and precipitation tests
- Immunodiffusion in gel
- ELISA
- Bacterial identification using software based on morphological and biochemical characters

MOLECULAR BIOLOGY AND GENETIC ENGINEERING

- PAGE- Protein separation
- DNA and RNA isolation from different microbial sources
- Agarose gel electrophoresis of nucleic acids
- Estimation of DNA and RNA
- Polymerase Chain Reaction
- Restriction enzyme digestion
- Ligation, Bacterial transformation and blue white screening
- Expression and purification of recombinant proteins

References

1. Cheesbrough M (2006) *District Laboratory Practice in Tropical Countries. Vol.2* Cambridge University Press. 2nded.
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. 8thed
4. Dubey RC & Maheshwari DK (2002) *Practical Microbiology* (S. Chand & Company Limited
5. Aneja KR (2003) *Experiments In Microbiology, Plant Pathology And Biotechnology*. New Age International.
6. Sambrook J. and Russell D. 2001. *Molecular Cloning: A Laboratory Manual*, 3rd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
7. Sambrook J., Fritsch E.F., and Maniatis T. 1989. *Molecular Cloning: A Laboratory Manual*, 2nd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NewYork.

SYLLABUS

Third Semester M.Sc. Microbiology

MG030301	Food and Industrial Microbiology	Core course
MG030302	Environmental and Agricultural Microbiology	Core course
MG860301	Microbial Diversity & Extremophiles	Elective -1
MG870301	Marine Microbiology	
MG880301	Physiology	
MG860302	Nanobiotechnology	Elective -2
MG870302	Microbial Quality Assurance, Biosafety and Intellectual Property Rights	
MG880302	Biostatistics and Research Methodology	
MG030303	Laboratory course III	Core course

MG030301 - FOOD AND INDUSTRIAL MICROBIOLOGY

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

Course Outcome

By attending the course, the students will be able to

- Understand the beneficial role of microorganisms in fermented foods, dairy and food products. Principles involving various methods of food preservation
- Identify the spoilage mechanisms in foods and important microorganisms in spoilage of foods.
- Understand source for microorganisms of industrial importance from the environment
- Know about design of bioreactors, factors affecting growth and production, understand the rationale in medium formulation and the principles in downstream processing. Appreciate the different types of fermentation processes
- Identify techniques applicable for Improvement of microorganisms based on known biochemical pathways and regulatory mechanisms
- Appreciate how microbiology is applied in manufacture of industrial products

Module -I

Incidence and type of microorganisms in food and milk. Contamination and Spoilage of food and milk, Principles of food preservations. Analysis of microbial quality of food and milk. Preservation and preparation of milk products. Fermented food products and beverages.

Module -II

Lactic Acid Bacteria- homo and heterolactic fermentations and application. Probiotics, Prebiotics, Synbiotics, Nutraceuticals, Single cell protein, Production of edible mushroom, Food poisoning - Food borne diseases, Newer pathogens and emerging foodborne diseases. Indicators of food microbial quality: Coliforms, Enterococci, Bifidobacteria, Coliphages and Enteroviruses, Food safety management- HACCP.

Module -III

Introduction to microbes in industrial processes. Isolation and screening of industrially useful microorganisms, Primary and secondary screening, Strain improvement in industrial microbiology; improvement of characters other than product yield. Preservation of strains

Module -IV

Design of a fermentor, instrumentation and process control; Types of fermentors. Types of

fermentations: aerobic and anaerobic; Submerged and Solid State; Dual. Fermentation media formulation and modification. Kinetics of growth in batch, continuous, fed-batch fermentation, Fermentation process: Inoculum preparation, Scaling up of fermentation, Assay of fermentation products (physical, chemical and biological assay). Downstream processing.

Module -V

Microbes in the production (microbial strains, substrate, flow diagrams, product optimization, and applications) of the following: Industrial alcohol; organic acids, amino acids, alkaloids, vitamins; antibiotics. Microbial transformations of steroids.

References

1. Casida LE (1968) Industrial microbiology (Wiley, New York; London).
2. Doyle MP, Beuchat LR, & Montville TJ (2001) Food microbiology: fundamentals and frontiers (ASM Press)
3. Frazier WC &Westhoff DC (2004) Food Microbiology (Tata McGraw Hills Publishing Company Limited)
4. Rose AH (1983) Food microbiology (Academic Press, London)
5. Garbutt JH (1997) Essentials of food microbiology (Arnold, London)
6. Wood BJB (1998) Microbiology of fermented foods (Blackie Academic & Professional, London) 2 nd ed.

MG030302 - ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

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

Course Outcome

By attending the course, the students will be able to

- Know the beneficial and harmful role of microorganisms in agriculture and environment.
- Understand various biogeochemical cycles occurring in soil
- Know plant – microbe interactions and microbe - microbe interactions in soil and there by improve the fertility of soil and yield.
- Comprehend various plant diseases caused by bacteria, fungi and viruses and their control measures
- Appreciate genetically modified crops and their importance in various aspects such as pest resistance, high nutrient value, easy to grow under unfavorable weather conditions, etc
- Grasp the process of extraction of metals using microorganisms in an economic and ecofriendly manner
- Recognize the pollutants in the environment using microorganisms

Module -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 Human.

Module -II

Aquatic microbiology: Microbiology of water - Water pollution and water borne pathogens - Bacteriological examination of water - Indicator organisms. Purification and disinfection of water Microbiology of sewage - Waste water treatment - BOD, COD. Role of microbes in marine fouling

Module -III

Microbial flora of soil and factors affecting them, Bio geochemical cycling - Nitrogen, Carbon, Phosphorus, Sulphur cycles and its importance.

Module -IV

Microbial interaction - Plant-microbe, microbe-microbe interactions. Mycorhizzae, Biological Nitrogen fixers-Symbiotic and free living nitrogen fixers- physiology and genetics of nitrogen fixers, Phosphate solubilizers, Phytopathogens - Bacterial, fungal, Viral diseases. (Wilt, Blight, Canker, Mosaic) - Control measures. Biofertilizers, Microbial control of pests and diseases. Integrated pest management. GM crops and its importance.

Module -V

Recycling of liquid and soild wastes - Composting - Biogas - Biodegradation. Bioremediation, Xenobiotic degradation. Microbial corrosion- Biofilms degradation of petroleum products. Microbes in mineral leaching and metal concentration, Microbial enhanced oil recovery.

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.
3. Campbell RE (1983) *Microbial ecology* (Blackwell Scientific Publications, Oxford; Boston) 2nded
4. Rheinheimer G (1991) *Aquatic microbiology* (John Wiley and Sons) 4thed
5. Dart RK (1980) *Microbiological aspects of pollution control* (Elsevier Scientific, Amsterdam) 2nd ed.
6. Alexander M (1977) *Introduction to soil microbiology* (Wiley, New York; London) 2nd ed.
7. Rao NSS (1995) *Soil microorganisms and plant growth* (Science Publishers, Inc.; New Hampshire, U.S.A) 3rded

MG860301 - MICROBIAL DIVERSIY AND EXTREMOPHILES

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

Course Outcome

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

- Comprehend the extend of microbial diversity in the universe comprising archae, eubacteria and eukarya.
- Understand molecular techniques used to study the microbial diversity
- Explain the characteristics and uniqueness of extremophilic organisms
- Gain knowledge on intricate relationship between microbes and their extreme environments and to apply this knowledge to study the potential applications of extremophiles.
- Do scientific writing on the exceptional nature of microorganisms and their interactions to extreme environments.

Module -I

Introduction to Microbial biodiversity: distribution, abundance & ecological niche. Classes: Eubacteria, Archae and Eucarya. Molecular techniques for studying microbial biodiversity - use of DNA probes, markers, Expressed sequence tagging (EST), Denatured Gradient Gel electrophoresis, RFLP, RAPD, MALDI-TOF, Fluorescent in situ hybridization (FISH). Prospecting of marine microbial resources: Metagenomics.

Module -II

Psychrophiles and Thermophiles: characteristics and classification of Thermophiles: habitats and ecological aspects. Extremely Thermophilic Archaebacteria, Applications of thermozymes. Psychrophilic archaeal extremozymes.

Methanogens: Characteristics, classification, habitats and applications.

Module -III

Alkalophiles and Acidophiles: characteristics, classification, habitat and life in alkaline environments - soda lakes and deserts. Calcium alkalophily. Characteristics of acidophiles: classification, life at low pH, acidotolerence. Applications of alkalophiles and acidophiles.

Module -IV

Halophiles and Barophiles: characteristics, classification and habitat- Dead Sea, discovery basin. Mechanism of osmoadaptation & halotolerence: cell walls and membranes, Purple

membrane, compatible solutes. Applications of halophiles and their extremozymes. Barophiles: Classification, high-pressure habitats, life under pressure, barophily, death under pressure.

Module -V

Space Microbiology [Exomicrobiology]: Aims and objectives of space research. Life detection methods (a) Evidence of metabolism (Gulliver) (b) Evidence of photosynthesis (autotrophic and heterotrophic) (c) ATP production (d) Phosphate uptake (e) Sulphur uptake. Monitoring of astronauts microbial flora.

REFERENCES

1. Extremophiles by Johri B.N. 2000. Springer V erlag. , New York.
2. Microbial Diversity by Colwd , D. 1999, Academic Press.
3. Microbial Life in Extreme Environments. Edited by D. J. Kushner. Academic Press.
4. Microbiology of Extreme Environments. Edited by Clive Edward. Open University Press. Milton Keynes.
5. Microbiology of Extreme Environments and its potential for Biotechnology. Edited by M.S.
6. Da Costa, J.C. Duarate, R.A. D. Williams. Elsiever Applied Science, London. Extreme Environment. Mechanism of Microbial Adaptation. Edited by Milton R. Heinrich. Academic Press.
7. Thermophiles. General, Molecular and Applied Microbiology. Edited by Thomas D. Brock. Wiley Interscience Publication.
8. Microbiology: Dynamics and Diversity by Perry.
9. Microbial Ecology. Fundamentals and Applications by. Ronald M. Atlas and Richard Bartha. 2nd and 4th Edition. The Benjamin Cummins Publication Co. Inc.
10. Microbial Ecology. 2nd Edition. by R. Campbell. Blackwell Scientifc Publication.
11. Brocks Biology of Microorganisms. 8th Edition. (International Edition - 1997) by Michael T. Madigan, John M. Martinko. Jack Parker. Prentice Hall Internation Inc.
12. Advances in Applied Microbiology. Vol. 10. Edited by Wayne W. Umbreit and D. Pearlman. Academic Press.

MG870301 - MARINE MICROBIOLOGY

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

Course Outcome

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

- Understand the marine ecosystem and familiarize the structure and various habitat of marine environment.
- Comprehend water borne diseases and water borne pathogen.
- Understand various biotechnology applications of marine microbiology such as biosensor, transgenic, biosurfactant etc.
- Realize marine pollution and control measure, bio-corrosion and bioremediation.

Module -I

Marine Microbial flora: Marine environment - sea-benthic & littoral zone, salt pan, mangroves and estuarine microbes, microbial loop - marine microbial community - planktons, bacteria, fungi, protozoa Methods of collection and estimation of marine microbes. Influence of physical, chemical and biological factors on marine microbes.

Module -II

Marine Adaptability: Survival at extreme environments - starvation - adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms - hyperthermophiles and halophiles

Module -III

Marine Microbial Disease: Marine food borne pathogens & Water borne pathogens - Aeromonas, Vibrio, Salmonella, Pseudomonas, .

Module -IV

Marine Pollution: Microbial indicators of marine pollution and control - biofouling, biocorrosion, biofilms and bioremediation

Module -V

Marine Microbial Biotechnology: Marine natural products, valuable chemicals, bioactive compounds from marine microorganisms, marine bio-sensor and transgenic marine organisms. Biosurfactants, biopolymers and novel enzymes from marine organisms.

References:

1. Prescott LM, Harley JP, & Klein DA (2005) Microbiology (McGraw-Hill, Boston; London) 6thed
2. Maier RM, Pepper IL, & Gerba CP (2009) Environmental Microbiology (Elsevier Academic Press)
3. Nybakken JW & Bertness MD (2005) Marine biology: an ecological approach (Pearson/Benjamin Cummings)
4. Belkin S & Colwell RR (2006) Oceans And Health: Pathogens In The Marine Environment (Springer Science Business Media)
5. Gal YL, Ulber R, & Antranikian G (2005) Advances in Biochemical Engineering/ Biotechnology Advances in Biochemical Engineering / Biotechnology Series Vol 96. Marine Biotechnology Vol 1 Series
6. Bhakuni DS & Rawat DS (2005) Bioactive Marine Natural Products (Springer)

MG870301 - PHYSIOLOGY

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

Course Outcome

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

- demonstrate a fundamental knowledge of comparative vertebrate animal physiology and anatomy.
- use physiological and anatomical knowledge to enhance their personal lives.
- Understand the tissues and organs of the human body.
- Demonstrate the ability to differentiate physiology from the cellular and molecular level to the organ system.
- Evaluate laboratory experiments in physiology

Module -I

Nervous System - Overview of Nervous system- Organization and function of Central and peripheral nervous system, Neurons – Properties, Neuroglia, Electrophysiology of neurons, Synapses –Neurotransmitters, Chemical and electrical synapse, Synaptic transmission and cessation, Neural circuits.

Module -II

Respiratory System - Functional anatomy, Phases of respiration transport of gases, Exchange of gases, Neural and chemical regulation of respiration.

Circulatory System - Circulation. Composition and functions of blood. Haemopoiesis and formed elements. Plasma - function, Blood volume, Blood volume regulation, Blood groups, Haemoglobin, Haemostasis– mechanisms. Blood groups: ABO system, determination, importance, Rh. Structure of Heart, Myogenic heart, Specialized tissue, ECG – its principle and significance, Cardiac cycle, blood pressure, Neural and chemical regulation.

Module -III

Excretory System -Physiology of excretion, Kidney, Urine formation, Urine concentration, Micturition, Regulation of water balance, electrolyte balance, acid-base balance.

Module -IV

Photosynthesis -Light harvesting complexes, mechanisms of electron transport, photo protective mechanisms, CO2 fixation-C3, C4 and CAM pathways. **Respiration** – Citric acid

cycle; plant mitochondrial electron transport and ATP synthesis, photorespiration. Transpiration.

Module -V

Plant Physiology -Absorption and transport of water, Macro &micro nutrients, Plant hormones, plant movements, photoperiodism, vernalization, **Stress physiology** – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

References

1. Vander's Human Physiology- The Mechanism of Body function. Widmaier, Raff, Strang
2. Text book of Medical Physiology. Arthur. C. Guyton & John. E. Hall
3. Physiological basis of Medical Practice. John. B. west
4. Review of Medical Physiology. William. F. Ganong
5. Essentials of Medical Physiology. K. Sembulingam & Prema Sembulingam
6. Plant Physiology. Lincoln Taiz and Eduardo Zeiger
7. Fundamentals of Plant Physiology. V.K.Jain

MG860302 - NANOBIOTECHNOLOGY

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

Course Outcome

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

- Describe the basic science behind the properties of materials at the nanometre scale, and the principles behind advanced experimental and computational techniques for studying nanomaterials.
- Communicate clearly, precisely and effectively using conventional scientific language and mathematical notation.

Module -I

INTRODUCTION TO NANOWORLD - History and applications of Bionanotechnology in various fields, Terminologies: nanoparticles, Biogenic nanoparticles, nanowires, thin films, nanotechnology, bionanotechnology, nanomedicine, quantum Dots, nanocomposite, nanopores, nanospheres.. Colloidal Nanostructures. Examples of Nanostructures in nature.

Module -II

MOLECULAR NANOTECHNOLOGY - Biomolecules as nanostructures and their applications. Uses of nanoparticles - cancer therapy- manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Synthesis of nanoparticles - physical, chemical and biological. Biosynthesis of nanoparticles by various groups of microorganisms, Microorganisms synthesizing silver nanoparticles, Mechanism involved in silver nanoparticles biosynthesis, Process design for industrial scale synthesis of nanoparticles.Nanomachines-virus based.

Module -III

PROPERTIES AND CHARACTERISATION OF NANOMATERIALS - Functions and Biological applications of Silver, Gold and Titanium nanoparticles. Physical and chemical properties of nanoparticles. Interaction of nanoparticles with biomolecules- Interaction of nanomaterial with proteins and with cells, Characterization of nanoparticles - UV-Vis spectroscopy, Electron Microscopy - HRTEM, SEM, AFM, EDS, XRD, F-IR and DLS.

Module -IV

Applications of nanoparticles in biology: Drug delivery - protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays,Cell labelling. Nanotechnology and nanoparticles in health sectors. Toxicology of nanoparticles, Nanoparticles for Dosimetry.

Module -V

Advantages of nanoparticles - drug targeting, protein detection, MRI, development of green chemistry - commercial viability of nanoparticles. Disadvantages - health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

References:

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Books.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007) .Bionanotechnology. Volume 7 of Synthesis Lectures on Biomedical Engineering. Morgan & Claypool Publishers.
3. Bernd Rehm (Ed) (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Bioscience.
4. David E. Reisner, Joseph D. Bronzino (2009). Bionanotechnology: Global prospects. CRC Press.
5. Ehud Gazit (2007). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press, London
6. Sulabha K. Kulkarni, (2009 Revised edition) Nanotechnology: Principals and Practices, Capital Publishing company, New Delhi.
7. Biological Nanostructures and Application of Nanostructures in Biology by Michael A. Stroscio and Mitra Dutta (2004), Kulwer Academic Publishers

MG870302 - MICROBIAL QUALITY ASSURANCE, BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS

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

Course Outcome

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

- Comprehend the basic issues of Bioethics, Biosafety, Food safety and IPR.
- Understand the ethical underpinnings of bioethics and to develop ethical intuitions on bioethical issues.
- Recognize safety concerns and ethical issues on application of biotechnology
- Understand current *food safety* programs that are used in the *food* industry in order to assure a *safe food* supply.
- Understand different types of Intellectual Property Rights like patents, copy right, trademarks, designs, information Technology etc.

Module -I

Bioethics - Principles of Bioethics; Belmont Report on protection of human beings on biomedical and behavioural research: respect for persons, beneficence, justice, etc.; Bioethic committees; professional ethics- medical, euthanasia; Public perception of process of biotechnology involved in generation new forms of life; example: ethical issues related to creations of Dolly and on reproductive cloning- Human Fertilization and Embryology Act & Cloning Prohibition Bill 1997

Module -II

Biosafety and Genetically Modified Organisms - 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 etc. for GMO applications in food and agriculture; Biosafety regulatory framework for GMOs at international level: Cartagena protocol on Biosafety; Advanced Information Agreement (AIA) procedure - procedures for GMOs intended for direct use, risk assessment, handling, transport, packaging and identification of GMOs. National Environment Policy.

Module -III

Food safety and Quality assurance - Food safety- issues and factors affecting. Shelf life of Food Products- factors affecting shelf life and methods to check the shelf life. 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) 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.

Module -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, Patent Act of India

Module -V

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 databases, Patent infringement. Traditional knowledge and Patent law for protection; Geographical Indicators.

References:

1. Frederic H. Erbisch, Karim M. Maredia (2004). *Intellectual Property Rights in Agricultural Biotechnology,* CABI Publisher.
2. Mittal D.P. (1999*). Indian Patents Law*. Taxmann Allied Services (p) Ltd.
3. Christian Lenk, Nils Hoppe, Roberto Andorno (2007). *Ethics and Law of Intellectual Property: Current Problems in Politics, Science and Technology*, Ashgate Publisher (p) Ltd.
4. Felix Thiele, Richard E. Ashcroft (2005). *Bioethics in a Small World*. Springer.
5. John Bryant (2002) *Bioethics for Scientists*. John Wiley and Sons Publisher
6. World Health Organization, Geneva (2004) *Laboratory Biosafety* Manual, 3rd Edition (Revised)
7. Diane O. Fleming. (2006); *Biological safety: Principles and Practices*, 4th edition. ASM Press
8. Beier, F.K., Crespi, R.S. and Straus, T. (1985) *Biotechnology and Patent Protection-An International Review.* Oxford and IBH Publishing Co. New Delhi
9. Sasson A. (1988) *Biotechnologies and Development*, UNESCO Publications
10. Singh K (1993) *Intellectual Property rights on Biotechnology- A status report.* BCIL, New Delhi
11. *Regulatory Framework for GMOs in India* (2006) Ministry of Environment and Forest, Government of India, New Delhi

12. *Cartagena Protocol on Biosafety* (2006) Ministry of Environment and Forest, Government of India, New Delhi
13. Birch, G. and Campbell-Platt, G. (Eds.). (1993) *Food Safety - the Challenge Ahead*. Intercept Ltd., Andover, England
14. Finley, J., Robinson, S. and Armstrong, D. (Eds.). 1992. *Food Safety Assessment*. Vol. 484 of ACS symposium series. American Chemical Society, Washington D.C
15. Jones, J. (1992). *Food Safety*. 2nd ed. Eagen Press, St. Paul Minnesota
16. Sohrab.(2001) *A Practical Guide For Implementation Of Integrated ISO 9001 HACCP System For Food Processing Industries*. Allied Publishers.
17. Bhatnagar, D. and Cleveland, T. (Eds.). (1992). *Molecular Approaches to Improving Food Quality and Safety*. Van Nostrand Reinhold, New York
18. Hubbert. W and Hagstad, H. (1996). *Food Safety & Quality Assurance*. 2nd ed. Iowa State University Press, Ames, Iowa
19. Roberts, H. (Ed.). (1981). Food Safety. John Wiley & Sons, New York
20. Krammer, A. and Twigg, B.A. (1970). *Quality control for the food industry*. 3rd Ed., Avi Pub Co.,Westport.

MG880302 - BIOSTATISTICS AND RESEARCH METHODOLOGY

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

Course Outcome

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

- Understand about biostatistics and apply it for data analysis in the field of biological research.
- Basic understanding of the underlying principles of quantitative and qualitative research methods.
- Provide learning opportunities to critically evaluate research methodology and findings.

Module -I

Definition- Scope of Biostatistics, Probability analysis, Variables in Biology- Collection, Classification and Tabulation of data. Frequency distribution. Diagrammatical and graphical representations- Bar diagram, Histogram, Pie diagram

Module -II

Measures of Central tendency- Arithmetic Mean, Median, Mode. Calculation of Mean, Median, Mode in series of discrete and continuous observations. Open end classification. Measures of dispersion- standard deviation, standard error etc. ANOVA- one way and two way classification.

Module -III

Correlation and regression- Karl Pearson's coefficient of correlation, Positive and Negative Correlation. Regression- linear and non-linear, regression coefficient

Module -IV

Basic ideas of significant tests- Testing of hypothesis, Level of significance, tests based on - z-test, Student's t-test, Chi square test. Testing of goodness of fit.

Module -V

Problem, selection and project designing. Review of literature, Collection, processing and presentation of data. Interpretation of results. Editing the final draft. Presentation of research project.

References:

1. Gupta SP (2010) *Statistical Methods.* Sultan Chand & Sons. 28th ed.
2. Palanisamy. S and Manoharan M.(1994). Statistical methods for Biologists. Palaniparamount

3. Khan I.A, Khanum.A, (2008) Fundamentals of Biostatistics. Ukaas Publications, Hyderabad. 3rded.
4. George W. Snedecor, William G. (1989) Cochran ***Statistical*** *Methods*. Iowa State University Press. 8thed.
5. Kothari CR (2008) *Research Methodology: Methods and Techniques*. New Age International Limited. 2nded.

MG030303 - LABORATORY COURSE -III

Number of Hours / Week: 10 **Credits: 4**

Course Outcome

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

- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization
- Acquire, discover, and apply the theories and principles of food microbiology in practical
- Learn various methods for their isolation, detection and identification of microorganisms in food
- Identify ways to control microorganisms in foods and thus know the procedures for the microbiological analysis of food
- Get equipped with a theoretical and practical understanding of industrial microbiology

Agricultural and Environmental Microbiology

- Isolation and Study of common soil bacteria, fungi and actinomycetes
- Enumeration of soil microbes by plate culture methods
- Study of antagonistic activities among soil microbes
- Estimation of rhizosphere microbial population and calculation of R:S ratio
- Isolation of non-symbiotic nitrogen fixing bacteria
- Isolation of *Rhizobium* from nodules of leguminous plants
- Study of common plant pathogens
- Isolation of phosphate solubilizing microorganisms
- Isolation of mycorrhizal spores and its identification
- Azolla cultivation
- Bacteriological examination of air
- Bacteriological examination of water- SPC, Presumptive, Confirmed and Complete test etc.
- Determination of BOD, DO & COD

Food and Industrial Microbiology

- Bacteriological examination of food- vegetables, meat products, traditional foods etc
- Bacteriological analysis of milk, standard plate count, presumptive test for coliforms, methylene blue reduction test and phosphatase test.
- Cultivation of edible mushrooms.

- Crowded plate technique for screening of industrially important microorganisms- microbes producing enzymes, antibiotics etc.
- Production of ethyl alcohol, Alcoholimetry
- Production of wine
- Production of citric acid
- Solid state and submerged fermentation

References

1. Practical Microbiology (2002) Dubey R.C. and Mahaswari D.K. S. Chand & Company Ltd. New Delhi.
2. Experiments in Microbiology, Plant pathology and Biotechnology. (1996) K. R. Aneja, New Age International (P) Limited, New Delhi. 2nded

SYLLABUS

Fourth Semester M.Sc. Microbiology

MG030401	Systematic Bacteriology	Core course
MG030402	Medical Virology, Mycology and Protozoology	Core course
MG860403	Molecular Microbiology	Elective -3
MG870403	Clinical Microbiology	
MG880403	Microbial Genetics	
MG030403	Laboratory course IV	Core course

MG030401 - SYSTEMATIC BACTERIOLOGY

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

Course Outcome

By attending the course, the students will be able

- To know the morphology, culture, antigenic structure and virulence factors of microorganisms of medical importance and the diseases they produce
- To understand the identifying characteristics of major classes of bacteria
- To learn the epidemiology and pathogenesis, lab diagnosis and treatment of different classes of bacteria.
- To assimilate and apply the information on lab diagnosis and treatment of different classes of bacteria

Module I

Study of identifying characters- morphological and cultural; pathogenicity, epidemiology and laboratory identification, prophylaxis, treatment of -Aerobic cocci such as Staphylococci, Streptococci, Pneumococci and Neisseriae

Module II

Anaerobic cocci, Gram positive bacilli. Corynebacterium, Bacillus, Anaerobic rods- Clostridia, Nonsporing anaerobes

Module III

Gram negative bacilli. Enterobacteriaceae- *E.coli*, Proteus, Klebsiella, Shigella Salmonella etc. Pseudomonas. Haemophilus. Pasteurella, Yersinia, Francisella, Bordetella. Brucella. Vibrios.

Module IV

Spirochetes. Mycoplasma. Rickettsiae. Chlamydiae. Miscellaneous Bacteria- Listeria, Campylobacter, Helicobacter, Legionella, Acinetobactor.

Module V

Acid fast bacilli- Mycobacteria- *M.tuberculosis, M.leprae*, Non tuberculous mycobacteria. Actinomycetes- Nocardia, Actinomyces, Introduction to Metagenomics

References

1. J.G.Holt, (Ed) Bergey's Manual of Systematic Bacteriology, Vol.1-4 (1984-1989) Williams and Wilkins, Baltimore.
2. Greenwood, D., Slack, R.C.B., Peutherer, J.F., and Barer, M.R. (2007). Medical
3. Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. Elsevier Health Sciences UK. 17thed
4. Topley, W.W.C., Wilson, G.S., Parker, T., and Collier, L.H. (1990). Topley and Wilson's Principles of Bacteriology, Virology and Immunology (Edward Arnold)
5. Zinsser, H., and Joklik, W.K. (1992). Zinsser microbiology (Lange) 20th ed. Ananthanarayan, R., and Paniker, C.K.J. (2006). Textbook of microbiology (Orient Blackswan) 7thed
6. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13thed
7. Jawetz, E., Melnick, J.L., and Adelberg, E.A. (1987). Review of medical microbiology (Appleton & Lange)
8. Talaro, K.P., Cowan, M.K., and Chess, B. (2009). Foundations in Microbiology (McGraw-Hill Higher Education
9. Page, R.D.M., and Holmes, E.C. (1998). Molecular Evolution: A Phylogenetic Approach (Blackwell Science)
10. Adolph, K.W. (1996). Microbial Genome Methods (CRC Press)
11. Dunham, I. (2003). Genome Mapping and Sequencing (Horizon Scientific)
12. Brendan Wren (Ed), Nick Dorrell (2002) Functional Microbial Genomics. Volume 33, Methods in Microbiology, Academic Press, UK.
13. Primrose, S.B., and Twyman, R. (2009). Principles of Genome Analysis and Genomics (John Wiley & Sons) 3rded.

MG030402 - MEDICAL VIROLOGY, MYCOLOGY AND PROTOZOOLOGY

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

Course Outcome

By attending the course, the students will be able

- To understand the general characteristics and pathobiology of different classes of viruses.
- To learn lab diagnosis, prophylaxis and treatment of viral diseases.
- To describe different fungal infections
- To describe protozoal diseases

Module I

Systematic study of medically important DNA viruses - Pox, Herpes, Adeno, Papova, Parvo, Hepadna viruses.

Module II

Systematic study of medically important RNA viruses. Entero, Myxo, Arbo, Rhabdo, Hepatitis, Oncogenic and HIV. Emerging viral infections – Nipah, Hendra, zika .

Module III

General methods for the laboratory diagnosis of viral diseases. Prophylaxis of virus diseases- immuno and chemoprophylaxis. Antiviral agents.

Module IV

Fungal infections in man. Superficial- pityriasis versicolor, piedra, dermatophytosis subcutaneous mycosis- mycetoma, rhinodpirodiosis, sporotrichosis, chromoblastomycosis and systemic mycoses- Histoplasmosis, blastomycosis, cryptococcosis, paracocidioidomycosis and coccidioidomycosis. Opportunistic fungal infections- aspergillosis, candidiasis, penicillosis, zygomycosis. Common laboratory contaminants.

Module V

Protozoa- General features and classification. Medically important protozoans. *Entamoeba histolytica*, *Giardia lamblia, Trichomonas*, Trypanosomes, Leishmania, Plasmodium, Toxoplasma and Pneumocystis.

References

1. Molyneux, D.H., and Ashford, R.W. (1983). The biology of Trypanosoma and Leishmania, parasites of man and domestic animals (New York, International Publications Service)
2. Garraway, M.O., and Evans, R.C. (1991). Fungal nutrition and physiology (Malabar, FL, Krieger Pub. Co.).
3. Fields, B.N., Knipe, D.M., and Howley, P.M. (2007). Fields virology, 5th edn (Philadelphia, Wolters Kluwer Health/Lippincott Williams & Wilkins)
4. Fraenkel-Conrat, H., and Wagner, R.R. (1974). Comprehensive virology (New York, Plenum Press).
5. Topley, W.W.C., Wilson, G.S., Parker, T., and Collier, L.H. (1990). Topley and Wilson's Principles of Bacteriology, Virology and Immunology (Edward Arnold)
6. Medical Mycology a practical approach by Evans and Richardson (Ed). IRL Press at Oxford University Press, Oxford.
7. Emmons, C.W. (1977). Medical mycology (Philadelphia, Lea &Febiger) , 3rd ed
8. Rippon, J.W. (1988). Medical mycology : the pathogenic fungi and the pathogenic actinomycetes, (Saunders ,Philadelphia) 3rd ed
9. Chatterjee, K.D. (2009). Parasitology (CBS Publishers & Distributors) 13thed
10. Kucera, L.S., and Myrvik, Q.N. (1985). Fundamentals of medical virology (Lea & Febiger, Philadelphia) 2nd ed.
11. Beaver, P.C., Jung, R.C., Cupp, E.W., and Craig, C.F. (1984). Clinical parasitology (Lea &Febiger, Philadelphia) 9th ed
12. Desselberger, U. (1995). Medical virology: a practical approach (IRL Press)
13. Ananthanarayan, R., and Paniker, C.K.J. (2006). Textbook of microbiology (Orient Blackswan) 7th ed.

MG860403 - MOLECULAR MICROBIOLOGY

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

Course Outcome

By attending the course, the students will be able

- To comprehend the phylogenetic status of bacteria and principles of molecular typing methods
- To know the genetic principles behind the adaptive nature of bacteria in adverse environments
- To learn the molecular basis of bacterial virulence and detection methods of pathogens
- To understand the concepts of gene and chromosome and basics of genetic engineering

Module I

Phylogenetic overview of bacteria and archaea, Molecular biology of microbial evolution, rRNA sequence and cellular evolution, Signature sequences and phylogenetic probe. Identification and characterization of microorganisms. Molecular typing methods: Bacterial strain typing, Pulsed Field Gel Electrophoresis, PCR-based microbial typing, Genotyping by Variable Number Tandem Repeats, Multilocus Sequence Typing, Automated Ribotyping, Molecular subtyping for epidemiology.

Module II

Genome wide approach to study prokaryotic biology, Microbial genome - comparison of genome size, Insight from genome of *E.coli, Streptomyces coelicolor* and *Neurospora crassa*. Unculturable bacteria and Metagenomics. Bacterial differentiation and molecular basis of endospore formation, Microbial stress response, Microbes in special habitat: Bacterial biofilm, molecular basis of biofilm development, biofilm dispersal strategies, biofilm in infection, quorum sensing. Extremophiles, molecular adaptation to extreme environment. Endophytes -metabolite diversity.

Module III

Molecular basis of microbial virulence. Bacterial adherence: basic principles, effects of adhesion on bacteria and host cells. Bacterial invasion of host cells; mechanism. Bacterial toxins: classification based on molecular features, Identification of novel toxins by genome mining, Application of bacterial toxin in cell biology and pharmacology.

Module IV

Microbial induction of apoptosis. Molecular and visual clinical diagnosis methods. Molecular detection and characterization of bacterial pathogens, detection of bioterrorism. Laboratory controls and standards in molecular diagnostics.

Module V

Microbial production of recombinant proteins : expression, purification and applications, Microbes in plant transformation, *Agrobacterium tumefaciens* T-DNA transfer process, Manipulation of *Agrobacterium* for genetic engineering, vectors for *Agrobacterium* mediated transformation, Microbial production of plant metabolites; engineering *E.coli* for the productionof curcumin. Combinatorial and engineered biosynthesis, Microbial polyketides and their applications.

References:

1. Persing DH (2011) *Molecular microbiology : diagnostic principles and practice* (ASM Press, Washington, DC) 2nd ed
2. Madigan MT, Martinko JM (2006) *Brock biology of microorganisms* (Pearson Prentice Hall, Upper Saddle River, NJ ; London) 11th ed
3. Moat AG, Foster JW, & Spector MP (2002) *Microbial physiology* (Wiley-Liss, New York ; [Chichester]) 4thed

MG870403 - CLINICAL MICROBIOLOGY

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

Course Outcome

By attending the course, the students will be able

- To comprehend the concept of safe microbiology
- To elicit the infections of various organs and systems of the human body
- To learn etiology, pathogenesis and laboratory diagnosis of local infections
- To understand and analyse various infections of skin, soft tissue and wound
- To compare and evaluate serological and molecular diagnostic methods
- To understand antibacterial therapy and prophylaxis

Module I

Microbiology laboratory safety - Biological Safety Cabinets; Biosafety Levels Biocontainment; Laboratory and associated infections. Good microbiological practices. Classification of biological agents based on hazards. Mailing of biohazardous materials.

Module II

Diagnostic cycle; General concepts for specimen collection, transport and processing. Emerging infections; Quality assurance & quality control in microbiology, Accreditation of laboratories; Microbiome of the human body.

Module III

Etiology, pathogenesis and laboratory diagnosis of- Blood Stream infections, Respiratory Tract infections, Central Nervous System infections, Gastrointestinal Tract infections, Urinary Tract infections, Genital Tract infections. Sexually transmitted diseases. Nosocomial infections.

Module IV

Skin, soft tissue and wound infections. Burn infections. Infections of sinuses, bone and bone marrow. Infections of eye and ear. Pyogenic infections. Infections in immunocompromised and immune-deficient patients. Infections in foetus and neonates.

Module V

Serodiagnosis of infectious diseases; Molecular techniques in diagnostic microbiology. Automation in Microbiology; Laboratory control of antimicrobial therapy; Immunoprophylaxis.

References

1. Blair, J.E.e., Lennette, E.H.e., and Truant, J.P.e. (1970). Manual of clinical microbiology. American Society for Microbiology, Bethesda, Md.
2. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L.(1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London.8th ed
3. Lennette, E.H., Balows, A., Hausler, W.J., and Shadomy, H.J. (1985). Manual of clinical microbiology. American Society for Microbiology, Washington, D.C. 4th ed.
4. Topley, W.W.C., Wilson, G.S.S., Parker, T., and Collier, L.H. (1990b). Topley and Wilson's principles of bacteriology, virology and immunology.Edward Arnold,8th ed
5. 5. Mukherjee, K.L. (2010)Medical Laboratory Technology .Tata McGraw-Hill Education.2nd ed.
6. Sood, R. 1999. Medical Laboratory Technology- Methods and Interpretations. Jaypee Brothers Medical Publishers(P) Ltd. New Delhi. 5th ed.
7. Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries.Cambridge University Press.2nd ed.
8. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13th ed
9. Black, J.G. (1999). Microbiology: principles and explorations. Prentice Hall International, London. 4th ed.
10. Kindt, T.J., Goldsby, R.A., Osborne, B.A., and Kuby, J. (2006). Kubyimmunology.W.H. Freeman, New York. 6th ed.
11. Forbes, B.A., Sahm, D.F., Weissfeld, A.S., and Bailey, W.R.D.m. (2007). Bailey & Scott's diagnostic microbiology. Elsevier, Mosby, London. 12th ed

MG880403 - MICROBIAL GENETICS

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

Course Outcome

By attending the course, the students will be able

- To understand the central dogma of molecular biology
- To understand the basic principle of gene expression and regulation
- To learn the concepts of genetic mutation and repair
- To understand the basic principles of gene transfer techniques
- To comprehend the concept, methods and application of r DNA technology

Module I

Introduction to microbial genetics, DNA as genetic material, Flow of genetic information, Nucleic acid structure, DNA replication, Gene Structure

Module II

Gene Expression and Regulation: Transcription in Bacteria and archaea. Genetic code. Translation. Levels of Regulation of Gene Expression- transcriptional (lac, trp and ara operon, Two-component signal transduction systems, phosphorelay system, trp attenuation, Riboswitches), translational (sRNAs, antisense RNAs, miRNAs) and post translational .Global regulatory system. Quorum sensing.

Module III

Mutation : Types and induction by various agents. Site directed mutagenesis. Detection and isolation of mutants.DNA Repair. Transposable elements. Bacterial plasmids.

Module IV

Gene Transfer methods - Conjugation, Transformation, Transduction. Bacterial genome mapping Gene variation by Recombination- homologous recombination, site-specific recombination, and transposition. Horizontal Gene transfer. Recombination and genome mapping in viruses.

Module V

Introduction to DNA technology, Cloning vectors, Restriction enzymes, Techniques used in molecular biology, Restriction Fragment Length Polymorphism, Randomly Amplified Polymorphic DNA, PCR, DNA finger printing, DNA sequencing and Gene therapy.

References

1. Snustad, D.P. (2010). *Principles of Genetics*, 5th ed., International student edn (Hoboken, N.J., Wiley)
2. Prescott, L.M., Harley, J.P., and Klein, D.A. (2005). *Microbiology*, 6th ed. edn (Boston ; London, McGraw-Hill
3. Madigan, M.T., Martinko, J.M., Stahl, D.A., and Clark, D.P. (2011). *Brock Biology of Microorganisms* (Pearson Education) 13thed.

MG030403 - LABORATORY COURSE -IV

Number of Hours / Week: 12 **Credits: 5**

Course Outcome

By attending the course, the students will be able

- To learn standard laboratory procedures in clinical microbiology
- To understand how to handle and identify medically important bacteria
- To learn to culture, isolate and identify fungi
- To understand and practices the procedures of viral cultivation
- To identify haemoflagellates and malarial parasites from blood smears
- To perform antimicrobial sensitivity tests

Experiments

- Study of the morphology, staining characters, cultural characters and identification of medically important bacteria *Staphylococci, Streptococci, Neisseria, Pneumococcus, E. coli, Klebsiella, Salmonella, Shigella, Proteus, Pseudomonas, Vibrio, Bacillus and Mycobacterium sp.*
- Isolation and identification of bacteria from mixed culture.
- Study of common laboratory contaminants.
- Culture methods for isolation and identification of fungi- KOH mount preparation, Lactophenol cotton blue staining, Slide culture technique etc.
- Gram staining and Germ tube test of *Candida albicans*
- Cultivation of viruses in embryonated eggs different routes - harvesting
- Examination of peripheral blood for haemoflagellates and malarial parasites
- Study of normal microbial flora of human beings
- Techniques for collection of clinical specimens for microbiological analysis Macroscopic, microscopic examination of clinical samples. Culture methods identification and antibiotic sensitivity test of isolates

References

1. Cheesbrough, M. (2006). District Laboratory Practice in Tropical Countries. Cambridge University Press.2nded.
2. Mackie, T.J., McCartney, J.E., and Collee, J.G. (1989). Mackie & McCartney practical medical microbiology. Churchill Livingstone, 13thed
3. Gradwohl, R.B.H., Sonnenwirth, A.C., and Jarett, L. (1980). Gradwohl's clinical laboratory methods and diagnosis. Mosby, London.8thed
4. Cappuccino, J.G., and Sherman, N. (2008). Microbiology: A Laboratory Manual (Pearson/Benjamin Cummings. 9thed