Proposed Microbiology Syllabus

Berhampur University
Session: 2022-2024
(As per CBCS)

MSc. Microbiology

Paper code	Title	Credits	Internal marks	End sem Marks	Total Marks
SEMESTER-I					
MB-CC-101	General / Introductory Microbiology	4	20	80	100
MB-CC-102	Reproduction & Life Cycle of Microbes	4	20	80	100
MB-CC-103	Nutrition & Physiology of Microbes	4	20	80	100
MB-CC-104	Microbiological Techniques & Instrumentation	4	20	80	100
MB-CC-105	Seminar & Laboratory	6	0	100	100
	SEMESTER-I TOTAL	22	80	420	500
SEMESTER-II					
MB-CC-201	Microbial Genetics & Molecular Biology	4	20	80	100
MB-CC-202	Biochemistry & Enzymology	4	20	80	100
MB-CC-203	Fundamentals of Immunology & Diagnostic Microbiology	4	20	80	100
MB-CC-204	Viruses & Bacteriophages	4	20	80	100
MB-CC-205	Seminar & Laboratory	6	0	100	100
VAC	Summer Internship/Industrial Visit/ Swayam or NPTEL Courses	NC	NC	NC	NC
	SEMESTER-II TOTAL	22	80	420	500
SEMESTER-III					
MB-CC-301	Medical Microbiology	4	20	80	100
MB-CE-302	Industrial Microbiology	4	20	80	100
MB-CE-303	Microbial Biotechnology	4	20	80	100
MB-CT-304	Microbial Bioinformatics & Biostatistics	4	20	80	100
MB-CC-305	Seminar & Laboratory	6	0	100	100
VAC	Research Methodology & Scientific Communication Skills	NC	NC	NC	NC
	SEMESTER III-TOTAL	22	80	420	500
Paper code	**Title**	**Credits**	**Internal marks**	**End sem Marks**	**Total Marks**
SEMESTER-IV					
MB-CC-401	Environmental Microbiology	4	20	80	100
MB-CE-402	Soil & Agricultural Microbiology	4	20	80	100
MB-CE-403	Food Microbiology	4	20	80	100
MB-CE-404	IPR, Biosafety & Bioethics	4	20	80	100
MB-D-405	Dissertation (Thesis + Presentation)	6	0	100	100
	Cultural Heritage of South Odisha	NC	NC	NC	NC
	SEMESTER IV-TOTAL	22	80	420	500
	GRAND TOTAL	88	--	--	2000

Elective Papers

Recommended Elective papers for Semester-III

(1). Industrial Microbiology (2). Microbial Biotechnology (3). Microbial Bioinformatics & Biostatistics (4). Advanced Microscopy (5). Plant & Animal Viruses (6). Extremophiles & Evolution (7). Fungal & Algal Biotechnology (8). Therapeutics: Vaccine Technology (9). Pharmaceutical Microbiology

Recommended Elective papers for Semester-IV

(1). Soil & Agricultural Microbiology (2). Food Microbiology (3). IPR, Biosafety & Bioethics (4). Omics Concept in Biology (5). Molecular Diagnostics: Sensors, Biosensors and Other diagnostic Techniques (6). Cancer biology & Clinical Immunology (7). Manipulation/ Recombinant Technology (8). Environmental Pollution Monitoring and Waste Water Treatment (9). Nanobiotechnology

Semester One

MB-CC-101
GENERAL AND INTRODUCTORY MICROBIOLOGY
Credits- 4

Unit I Introduction, History and Scope	Introduction, History and Scope of Microbiology, Diversity of Microorganisms; controversy over spontaneous generation, Golden age of Microbiology, Development of Microscopy; Biogenesis vs. Abiogenesis; Contribution of Microbiologists namely: (A. V. Leeuwenhoek, Louis Pasteur, Robert Koch, Edward Jenner, Alexander Fleming, Winogradsky, Beijernick and Joseph Lister), Scope & Importance of Microorganisms
Unit II Structure& Function of Cell	Structure and function of prokaryotic and eukaryotic cell (bacteria, cyanobacteria & fungi). Locomotory Organs & Motility
Unit III Classification & t Taxonomy of Microorganisms	Classification of Microorganisms: Objectives and difficulties encountered in classification; Genetic methods of classification based on relatedness, intuitive, numerical, systematized natural i.e., 3 – and 5 – kingdom classification; based on cataloguing r – RNA and computer aided classification, Bergey's Manual of Systematic Bacteriology; Taxonomy of Microbial diversities: Taxonomic groups (Algae, Fungi, Protists, Virus and Bacteria including Archaea, Actinomycetes, Mycoplasma, Chlamydia, Rickettsia, Gracilicutes, Firmicutes, Tanericutes & Mendosicutes.
Unit IV Characterization & Identification of Microbial diversities	Characterization & Identification of Microbes: Morphological, Chemical, Cultural, Media Specific, Biochemical (IMVIC) & Staining, Metabolic, Antigenic, Genetic, Ecological and Pathogenic.

Recommended Textbooks and References:

1. Pelczar,M.J.,Reid,R.D.,&Chan,E.C.(2001).*Microbiology*(5thed.). New York:McGraw-Hill.
2. Willey,J.M., Sherwood,L., Woolverton,C.J.,Prescott,L.M., & Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai,W., Berg, C.Y., & Black,J.G.(2005). *Microbiology, Principles and Explorations*. Boston,MA:JohnWiley&Sons.
4. Brock Biology of Microorganisms –Madigan & Martinko

MB-CC-102

REPRODUCTION AND LIFECYCLE OF MICROBES

Credits-4

Unit I Life Cycle of Bacteria	Life cycle of Bacteria, Reproduction of Bacteria, Cell Cycle and Cell Division, Bacterial Endospore formation
Unit II Reproduction types in Fungi	Reproduction types in Fungi- sexual, Asexual, vegetative reproduction of molds and Yeasts. Life cycle of fungal microbes with reference to *Saccharomyces, Aspergillus, Penicillium, Puccinia &Phytophthera*. Fruiting bodies in Fungi, Degeneration of sexuality in fungi, Heterothalism in Fungi
Unit III Reproduction in Algae	Reproduction (Sexual, Asexual, Parasexual) and Life cycle of Algae including Brown algae, Red Algae, Blue Green Algae, Thallus organization in Algae.
Unit IV Life Cycle in Protozoa and Helminthes	Life Cycle in Protozoa and Helminthes species like: *Amoeba, Entamoeba, Plasmodium, Toxoplasma, Balantidium, Fasciola*

Recommended Textbooks and References:

1. Pelczar,M.J.,Reid,R.D.,&Chan,E.C.(2001).*Microbiology*(5thed.). New York:McGraw-Hill.
2. Willey,J.M.,Sherwood,L.,Woolverton,C.J.,Prescott,L.M.,&Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai,W.,Berg,C.Y.,&Black,J.G.(2005).*Microbiology,Principlesand Explorations*.Boston,MA:JohnWiley&Sons.
4. Brock Biology of Microorganisms –Madigan &Martinko

MB-CC-103
NUTRITION & PHYSIOLOGY OF MICROBES
Credits-4

Unit I **Nutrition and Cultivation of microorganisms**	Nutrition and Cultivation of microorganisms: Common nutrient requirements, Nutritional types of microorganisms, Growth factors, Nutritional uptake
Unit II **Measurement of Microbial Growth**	Growth Curve, Mathematics of growth curve; Measurement of microbial growth; Growth Yield, Generation time; Continuous and Synchronous culture of microorganisms Pigmentation in Microbes: Chlorophyll, Bacterial chlorophyll, Rhodospin, Carotenoid and Phycobillin
Unit III **Factors influencing Microbial Growth**	Influence of environmental factors on growth (Solute and water activities, temperature, oxygen concentration and radiation). Microbial growth in natural environment. Mechanism of tolerance to extreme conditions. Quorum sensing in Gram negative bacteria.Extremophiles (Sulfolobus, Methanogens, Psychrophiles, Thermophiles) and their importance
Unit IV **Metabolism**	Metabolism: Anabolism – Oxygenic and anoxigenic photosynthesis, autotrophic generation of ATP, Fixation of CO_2, Chemolithotrophy. Catabolism – aerobic and anaerobic respiration, glyoxylate pathway, phosphorylation. Fermentation – homo and hetero-lactic fermentation. Lipid metabolism in Bacteria: Metabolism of triglycerides. Nitrogen metabolism – N_2 assimilation (N_2, NO_3, NH_4). Basic concept of bioenergetics: entropy, enthalpy, high energy compounds, artificial electron donor, electron carrier inhibitors, ATP cycle and its role in metabolism.

Recommended Textbooks and References:

1. Pelczar,M.J.,Reid,R.D.,&Chan,E.C.(2001).*Microbiology*(5thed.). New York:McGraw-Hill.
2. Willey,J.M.,Sherwood,L.,Woolverton,C.J.,Prescott,L.M.,&Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
3. Matthai,W.,Berg,C.Y.,&Black,J.G.(2005).*Microbiology,Principlesand Explorations*.Boston,MA:JohnWiley&Sons.

MB-CC-104
MICROBIAL TECHNIQUES & INSTRUMENTATION
Credits-4

Unit I Control of Microorganisms	Control of Microorganisms: Sterilization (Autoclave, Hot Air Oven), Disinfectants (Physical and Chemical&), Pure Culture Isolation Methods, Microbial Growth Measurements: MPN techniques, Micrometry: Micrometers, Principles and Measurements of Cell Dimensions. Microtome and histological techniques, Enumeration/Counting of Microorganisms
Unit II Microscopy	Microscopy: Principle and concept, Types of Microscopes: Light (Bright field and Dark field microscope, Phase contrast microscope, Inverted Microscope, Fluorescence Microscope, DIC & Confocal); Electron Microscope (TEM and SEM)
Unit III Centrifugation, Spectrophotometry PCR & Hybridization	Centrifugation: Basic principles, Types of Centrifuges; pH meter, Colorimeter, Spectrophotometer (UV and Visible); Fluorescence, Infrared, NMR, X-ray Crystallography PCR, Nucleic Acid Hybridization, Electrophoresis (Agarose and SDS-PAGE), Blotting (Southern, Northern, Western) Techniques
Unit IV Chromatographic Techniques	Chromatographic Techniques: Thin layer Chromatography, Paper Chromatography, Chromatographic technique for macromolecule separation (Size Exclusion, Gel Permeation, Partition, Hydrophobic, Reverse Phase, Affinity Chromatography), Column Chromatography, Ion Exchange Chromatography, Gas chromatography, HPLC.

Recommended Textbooks and References:

1. Principles and Techniques of practical Biochemistry– Keith Wilson and John Walker
2. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology
3. Dr. Gurdeep R. Chatwal and Sham K. Anand, Instrumental Methods of Chemical Analysis

MB-CC-105
LABORATORY:
Credits- 6

Syllabus	1. Safety rules in Microbiology laboratories and good laboratory practices. 2. Microscopy: Principle, Procedure, Precautions detail of light microscopes. 3. Micrometry: Principle and application in measuring cell dimension. 4. Sterilization: Principle, Procedure and Validation. 5. Preparation of media for growth of microorganisms. 6. Isolation of microorganisms by plating, streaking and serial dilution methods. 7. Maintenance of microorganisms by slant and stab culture. 8. Isolation of pure culture from air, water and soil. 9. Microscopic examination of Yeast, Bacteria, Moulds using standard staining techniques. 10. Preparation of selective / enriched media for growth of specific microorganism. 11. Biochemical characterization of selected microbes – IMViC test, Sugar fermentation, Oxidase, Catalase etc. 12. Measurement of growth and mathematical expression. 13. Effect of oxygen, pH, Temperature, salt, sugar, N2 andVitamins on microbial growth. 14. Determination of ability of microorganisms to oxidize glucose. 15. Instrumentation: Autoclave, Hot air oven, Laminar air hood, Incubator (BOD), Spectrophotometer, pH meter and centrifuge. 16. Study of microbial biodiversities in slides / paper slides on: algae, fungi, protozoa, bacteria and virus. 17. Experiment to demonstrate the motility of microbes. 18. Chromatography technique: Paper, TLC. 19. Validation of Beer- Lambert's law by UV-Visible spectroscopy

Recommended Textbooks and References:

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: a Laboratory Manual. Benjamin-Cummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., &Falkinham III, J. (2004). Collins and Lyne's Microbiological Methods (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. Bailey & Scott's Diagnostic Microbiology
4. Prescott's Laboratory Exercises in Microbiology- 5th edition
5. Benson's Microbiological applications (Lab Manual, 14t Edn)

Semester Two

MB-CC-201
MOLECULAR BIOLOGY & GENETICS
Credits-4

Unit I Genome Organization Central Dogma Nuclear & Organellar Genomes, Genome Mapping	DNA –The Genetic material; Nucleic Acids: structure and function Prokaryotic, eukaryotic and viral genome. Replication of eukaryotic, prokaryotic and viral DNA. Transcription and Translation Plasmid and its virulence, Structure, classification and replication of plasmids, Transposable elements Nuclear and organellar genomes, genome diversity, genome complexity, Genetic Code, Gene Structure, DNA repair system, Genome mapping, Genome mapping including that in viruses. Denaturation and Renaturation kinetics (Cot Curve)
Unit II r-DNA Technology	Basics of r-DNA technology, Restriction endonuclease, Linkers and Adapters, Vectors (nature, uses and types: Bacteriophages, Cosmid, Plasmid, BAC and YAC). Isolation and purification of genomic and plasmid DNA, c-DNA synthesis, cloning in *E. Coli.* Selection and screening of recombinant clones: Insertional inactivation. Markers and reporter genes, blot techniques (Southern, Northern, Western dot and colony hybridization)
Unit III Mutation	Mutations: Spontaneous and induced (physical and chemical mutagens). Molecular basis of mutation. Point mutations, base substitution, transitions and transversions (frameshift mutations, deletion, addition), effects on the gene product, DNA repair mechanism. Recombinational repair- rec A, rec FOR, rec BCD, SOS. Gene mapping by recombination and complementation.
Unit IV Genetic Exchange & Gene Regulation	Genetic exchange: Mechanism of genetic exchange. Transformation; Conjugation and Transduction. Genetic exchange in nature and Lab. (horizontal transfer of genetic information). Barriers to genetic exchange (host restriction and modification. Transposable elements (Insertion sequences, transposons and integrons). Retrotransposons. Genetic regulation: Regulation of gene expression: Induction, activation and repression, attenuation and antisense control. Operons: Lac, trp. Genetic basis of cancer and cell death.

Recommended Textbooks and References:

1. Molecular Biology – Freifelder, D.
2. Molecular Genetics – Freifelder. D.
3. Molecular Biology of Gene – Watson J. D.
4. Biochemistry of Nucleic acid – Davidson. J. N.
5. Molecular Biotechnology – Primrose
6. Genetics – Strickberger
7. Fundamentals of Genetics – A.G. Gardener

MB-CC-202
BIOCHEMISTRY & ENZYMOLOGY
Credits-4

Unit I Biochemistry: Introduction	Physicochemical properties of water, pH, pKa, Acid, Base, Buffers; Handerson-Hasselbach equation, Inter and intra molecular forces: Vanderwaal and hydrophobic interactions, hydrogen bonding,Covalent and Non-covalent chemical bond and disulphide bridges Classes of organic compounds and functional groups
Unit II Carbohydrates Aminoacids Proteins	Carbohydrates: structure, function and classification: physical and chemical properties, reactivity of functional groups Amino acids: Structure, function, classification, types and properties. Proteins: structure, classification, protein folding, glycoprotein, mureins, Ramachandran Plot
Unit III Lipids	Lipid: Structure and biosynthesis of phospholipids and cholesterol, peptidoglycan synthesis, pattern of cell wall formation
Unit IV Enzymology	Enzymology: Classification and Nomenclature of Enzymes. Enzyme Kinetics: Michelis-Menton Equation, Lineweaver Burk Equation. Mechanism of enzyme action, Mode of enzyme reaction catalyzed by lysosome, RNase, chymotrypsin, Factors affecting enzyme kinetics and control of enzyme activities, Significance of V*max* and Km. Enzyme Inhibition and its types

Recommended Textbooks and References:

1. Fundamentals of Biochemisty – Lehninger
2. Biochemistry – J. L. Jain
3. Fundamentals of Biochemistry – Voet&Voet
4. Biochemistry- L. Stryer
5. Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins, 3rdEdn - Price Nicholas C. and Lewis Stevens

MB-CC-203

FUNDAMENTALS OF IMMUNOLOGY AND DIAGNOSTIC MICROBIOLOGY

Credits-4

Unit I Development & Scope of Immunology	Development and scope of Immunology; Immunoglobulin, Types of immunity (humoral and cellular); Complement system, Phagocytosis, Haematopoesis.
Unit II Organs & Cells of Immune System	Organs and cells of the immune system: Primary and secondary lymphoid organs; B& T-lymphocytes; Dendritic &NK cells; Macrophages; Granulocytes; Dendritic cells; Mast cells; Antigen-Antibodies and their interactions (*In Vivo & In Vitro*); Polyclonal and Monoclonal antibodies (Hybridoma Technology). Advanced immunological techniques: RIA, ELISA, ELISPOT assay, Immunoelectrophoresis.
Unit III Hypersensitivity & Types	Hypersensitivity & Types: I, II, III & IV. Allergies: Atrophy, allergens, mast cells degradation, detection and treatment of Type -1 Hypersensitivity. Autoimmunity: types & causes and treatment of auto immune diseases. Immunodeficiencies – primary and secondary.
Unit IV Diagnostic Microbiology	Methods of collection, handling and transport of samples; General methods of laboratory diagnosis by isolation and identification of microbial pathogens. Staining Techniques simple, differential, Giemsa staining

Recommended Textbooks and References:

1. Cellular & Molecular Immunology – Saunders
2. Immunology – Kuby
3. Immunology- Roitt
4. Elements of Immunology – Rastogi, S.C.
5. Manual of Clinical Laboratory Immunology – Rose, N.R.

MB-CC-204
VIRUS & BACTERIOPHAGES
Credits-4

Unit I Virus: Nature, Properties & Classification	Discovery of viruses, Nature and general properties of viruses, classification of viruses; methods in virology; purification and characterization of viruses, Morphology and chemical composition of viruses.
Unit II Viral Genetics and Physiology	Cultivation of virus, Assay of virus, Replication of virus, Viral genetics and variation. Serological properties of viruses, sub viral pathogens.
Unit III Bacteriophages	Historical developments and classification of bacteriophages. Structure and life-cycles of different DNA, RNA, lytic and lysogenic phages.
Unit IV Oncogenic viruses and viral oncogenesis	Oncogenic viruses and viral oncogenesis. Virus cell interaction. Interferon, Intracellular control of virus infection. Viral diversity & Ecology

Recommended Textbooks and References:

1. Introduction to modern Virology --- Dimmock
2. Text Book of Microbiology ---Narayan, A &Panikar, J.
3. Introduction to Viruses --- Biswas & Biswas
4. Medical Microbiology --- Greenwood.
5. Virology –Voyles
6. Pelczar,M.J.,Reid,R.D.,&Chan,E.C.(2001).*Microbiology*(5th ed.). New York:McGraw-Hill.
7. Willey,J.M.,Sherwood,L.,Woolverton,C.J.,Prescott,L.M.,&Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
8. Matthai,W.,Berg,C.Y.,&Black,J.G.(2005).*Microbiology,Principlesand Explorations*.Boston,MA:JohnWiley&Sons.
9. Brock Biology of Microorganisms –Madigan &Martinko

MB-CC-205
LABORATORY
Credits-6

Syllabus	1. Preparation of buffers 2. Determination of Blood group and Rh factor. 3. Demonstration of agglutination test (Slide & Tube). 4. Precipitation reaction (fluid / gel) between antigen and antibody using agarose gel. 5. Immunodiffusion, immunoelectrophoresis 6. Experiment for cultivation of virus using chick embryo. 7. Estimation of titre value by Haemaglutination and Haemaglutination inhibition test 8. Preparation of phage stocks and filtration of phages and bacteria. 9. Identification, standardization, qualitative analysis & quantitative estimation of Carbohydrates and Proteins. 10. Extraction and estimation of sugars from live source. 11. Isolation of genomic DNA 12. Isolation of plasmid DNA 13. Quantitative analysis of DNA by using UV Spectrophotometer 14. Agarose Gel Electrophoresis technique (run of Plasmid DNA & Genomic DNA) 15. Isolation of crude protein 16. Separation of proteins by SDS-PAGE. 17. Study of normal micro flora of human body: a. skin and b. mouth. 18. Isolation and identification of enteric pathogenic microbes from animal faecal samples. 19. Demonstration of antibiotic resistance of bacteria. 20. Determination of MIC of antibiotics against microorganisms. 21. Slides / Paper Slides of medically pathogenic microbial species.

Recommended Textbooks and References:

1. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

VALUE ADDED COURSE

SUMMER INTERNSHIP/INDUSTRIAL VISIT/ SWAYAM OR NPTEL COURSES
Credit-0

Summer Internship/Industrial Visit: **Project proposal preparation** **Poster presentation** **Oral presentation**	Selection of research lab/industry and research topic: Students should first select a lab wherein they would like to pursue their dissertation. The supervisor or senior researchers should be able to help the students to read papers in the areas of interest of the lab and help them select a topic for their project. The topic of the research should be hypothesis driven. Review of literature: Students should engage in systematic and critical review of appropriate and relevant information sources and appropriately apply qualitative and/or quantitative evaluation processes to original data; keeping in mind ethical standards of conduct in the collection and evaluation of data and other resources. Students will have to present the topic of their project proposal. They should be able to explain the novelty and importance of their research topic. At the end of their project, presentation will have to be given by the students to explain work done by them in detail. Along with summarizing their findings they should also be able to discuss the future expected outcome of their work. For Industrial Visit: Students should first select an industry wherein they would like to pursue their dissertation. Students should be able to submit a write up and presentation based on their learnings from the various processes/applications being followed in an industrial set up.
Swayam/NPTEL Courses	Students must select any course of their choice from the list of courses under Bioscience category of either Swayam or NPTEL. They should attend all the lectures and routinely appear for the exams being conducted.

Semester Three

MB-CC-301
MEDICAL MICROBIOLOGY
Credits-4

Unit I Medical Microbiology: Introduction	Historical landmarks and chronological development of Medical Microbiology; Normal micro flora of human body (skin, oral cavity, respiratory, GI and urinogenital tracts); mechanism of bacterial adhesion, colonization and invasion, role of Aggressions; bacterial toxins (exo and endo). Infections, nonspecific defense mechanisms; physical / mechanical barriers, antagonism of indigenous flora; antibacterial substances (lysozome, bacteriocin, β- lysine and other polypeptides). Antiviral substances (interferon, reactive nitrogen intermediates, defensins); virulence: characteristics measurements and factors, attenuation.
Unit II Immunity in bacterial infections and immunopathology	Bacterial pathogens and associated diseases; Study of Gram +ve bacteria (*Staphylococcus, Streptococcus, Pneumococcus, Bacillus,* Actinomycetes with special reference to *Corynebacterium, Mycobacterium* and *Clostridium*); Study of Gram –ve bacteria (*Hemophilus, Vibrio, Pseudomonas, Neisseria, Bordetella, Salmonella, Shigella and E. Coli*). Study of *Spirochetes* and other bacteria such as: *Treponemes, Leptospira, Borrelia, Mycoplasma, Chlamydia, Rickettsia* and non-sporing anaerobes like *Legionella, Campylobacter and Helicobacter.*
Unit III Immunity in viral & fungal infections and immunopathology	Viral pathogens and associated diseases: DNA and RNA viruses including HIV, Oncogenic viruses, H1N1. Pathogenic Fungi: Thrush, Ring worm – Subcutaneous, Cutaneous and Systemic.
Unit IV Parasitic infections: Pathogenesis and immunity. Nosocomial Infection	Parasitic Pathogens: Protozoa (*Trypanosoma, Leishmania, Giardia*), Helminthes (*Wucheria, Taenia*). Nosocomial infection: Common types of hospital infections and their diagnosis and control.

Recommended Textbooks and References:

1. Text Book of Microbiology -- Narayan, A & Panikar, J.
2. Medical Microbiology -- Greenwood.
3. Willey,J.M.,Sherwood,L.,Woolverton,C.J.,Prescott,L.M.,&Willey,J.M.(2011). *Prescott's Microbiology*. New York: McGraw-Hill.
4. Matthai,W.,Berg,C.Y.,&Black,J.G.(2005).*Microbiology,Principlesand Explorations*.Boston,MA:JohnWiley&Sons.
5. Brock Biology of Microorganisms –Madigan & Martinko

MB-CE-302
INDUSTRIAL MICROBIOLOGY
Credits-4

Unit I Industrially important Microbes Fundamentals of Fermentation	History, development and scope of Industrial microbiology Industrially important microorganisms: Bacteria, Fungi, Actinomycetes, Microalgae. Fundamentals of fermentation, type, design and method of operations of fermenters. Application of Fermenter and Bioreactor, Microbial fermentation process, Types of fermentation processes, Downstream processing for recovery of different industrial products.
Unit II Alcoholic Production	Alcoholic production; ethyl alcohol, beer, wine, vinegar, organic acids: Citric acid & lactic acid, amino acids: Lysine & Glutamic Acid Antibiotics: Penicillin & Streptomycin, Single cell protein.
Unit III Industrial Production	Industrial production of Vinegar, Vitamin: Riboflavin, Enzymes: Amylase & Cellulase, Elementary idea about single cell oil production by microorganisms; Microbes in production of biofuels;
Unit IV Microbiological Assays	Microbes in production of biofuels; Microbiological assays: principle, methodology, types with examples, assay of antibiotics and amino acids. Sterility testing of pharmaceutical products.

Recommended Textbooks and References:

1. Industrial Microbiology – Cassida, J. R.
2. Industrial Microbiology – Patel, A. H.
3. Industrial Microbiology – Miller, B. M & Litsky
4. Industrial Microbiology – Prescott & Dunn
5. Advances in Applied Microbiology – Ed. Perlman
6. Principles of Fermentation Technology – Stanbury
7. Industrial Microbiology – Crooger & Crooger
8. Industrial Microbiology-M.J.Waites

MB-CE-303
MICROBIAL BIOTECHNOLOGY
Credits-4

Unit I Microbial Biotechnology: Introduction Microbial Strain Improvement Basic design & operation of Bioreactors	Introduction, scope and historical development; Isolation, screening and genetic improvement of Industrial strains, Strategies for its selection and improvements. Large scale production using recombinant microorganisms, Product recovery, Metabolic path ways and metabolic control mechanisms, Biotechnology innovations in chemical industries, biocatalysts in organic chemical synthesis, Design of fermenter/ bioreactors- Design aspects of flask, stirred tank reactor, Air-lift fermenter, Tower fermenter, Kinetics of operation of bioreactors, Batch, Fed-batch, Continuous processes, Design and operation of immobilized cell reactors.
Unit II Production, Recovery, Assay and Applications	Applications of r-DNA technology: Medicine (Hybridoma technology, vaccine development, Hormone production etc), Agriculture (Bio-fertilisers, bio-insecticides), Production, Recovery, Assay and Applications with Respect to Following Examples: Vitamin B and C, Antibiotics (Penicillin acylase, Cycloheximide, Tetracyclins), Microbial enzymes (Chitinase, Lipase), Polysaccharide (Xanthum gum and PHB), Citric acid, Ethanol, Wine, SCP, Recombinant and synthetic vaccines, Bioemulsifier/Biosurfactant, Biopolymers, Bioleaching; Bioremediation, biodegradation and its management, Mushroom production, Production of single cell protein
Unit III Drug Designing	Drug designing, Antimicrobial agents (Therapeutic drugs): Characteristics & Mode of action
Unit IV Molecular Biotechnology Advances in Microbial Technology	DNA sequencing: By Maxam-Gilbert and Sanger's methods, next-generation sequencing. DNA finger printing, RFLP, RAPD. Microarrays, Amplification of DNA, PCR, Multiplex PCR, Development and applications of Biosensor. Metagenomics and Meta transcriptomics: potential, methods to study and application/use

Recommended Textbooks and References:

1. Microbial Biotechnology -- Alexander Glazer
2. Microbial Biotechnology -- Yuan Kun Lee
3. Modern industrial microbiology and Biotechnology---Nduka Okafor

MB-CT-304
BIOINFORMATICS
& BIOSTATISTICS
Credits-4

Unit I Basics of Computer Application Bioinformatics: Scope & Application	Computer application: basics of computer, types of network, intra & internet, internet and the microbiologist Overview of Bioinformatics – Scope and Application.
Unit II **Databases**	Data base: types, NCBI, PDB, Expasy, Gene Bank; Genomics and genome project. NCBI Data model, DNA and Protein Sequence database, Genomics and genome project, Sequence submission to database, Literature database (PubMed, Biomed Central, Medline)
Unit III Sequence Alignment	Data base searching, Sequence alignment – pair wise and multiple; Practical aspects of multiple sequence alignment (Clustal w, Clustal x), phylogenetic tree,
Unit IV Biostatistics	Introduction to Biostatistics, terminology and symbols, applications of statistics in biological research, collection and representation of data, measures of central tendency (Mean, Median, Mode), Coefficient of variation, Standard Deviation, Analysis of variation (ANOVA), measures of dispersion, Tests of significance('t' test, 'f' test & chi-square test), probability, correlation and regression analysis, Introduction to statistical software and handling.

Recommended Textbooks and References:

1. Wayne W. Daniel, Biostatistics --- A foundation for Analysis in the Health Sciences
2. Prem S. Mann --- Introductory Statistics
3. Campbell and Heyer --- Discovering Genomice, Proteomics & Bioinformatics
4. John A. Rice --- Mathematical Statistics and Data AnalysisLevine,M.M.(2004).*New*

MB-CC-305
LABORATORY:
Credits-6

Syllabus	1. Sterility testing of pharmaceutical products. 2. Screening of antibiotic products from soil samples. 3. Isolation of microbes from sweets amenable for spoilage. 4. Identification of coliforms from samples collected from road side food stalls. 5. Isolation of micro flora from spoiled / putrefied fruits / vegetables. 6. Gradation of purity of milk samples using MBRT test. 7. Qualitative test for production of enzymes by microbes: Amylase, Cellulase, Proteinase, Pectinase, Lipase and Gelatinase, Organic acids: Citric acid 8. Bacterial cell immobilization 9. Qualitative test for ethanol production by *S. cerevisiae* 10. PCR methods / advantages – Demonstration. 11. Slides / Paper Slides of medically pathogenic microbial species. 12. Experimental design to conduct biostatistical experiments like student t – test and χ^2test.

VALUE ADDED COURSE

RESEARCH METHODOLOGY AND SCIENTIFIC COMMUNICATION SKILLS
Credit-0

Unit I **Research Methodology & Preparation for research**	Research Methodology: Processes, aims & objectives, Choosing a mentor, lab and research question; maintaining a lab notebook.
Unit II **Process of communication**	Concept of effective communication- setting clear goals for communication; determining outcomes and results; initiating communication; avoiding breakdowns while communicating; creating value in conversation; barriers to effective communication; non-verbal communication-interpreting non-verbal cues; importance of body language, power of effective listening; recognizing cultural differences; Presentation skills - formal presentation skills; preparing and presenting

	using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search; search engines and their mechanism of searching; hidden Web and its importance in scientific research; internet as a medium of interaction between scientists; effective email strategy using the right tone and conciseness
Unit III **Scientific communication**	Technical writing skills - types of reports; layout of a formal report; scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; plagiarism; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct, Use of search engines for scientific data mining, Use of reference management tools, statistical data analysis using software.

Recommended Textbooks and References:

1. Valiela,I.(2001).*DoingScience:Design,Analysis,andCommunicationofScientific Research.* Oxford: Oxford UniversityPress.
2. *OnBeingaScientist:aGuidetoResponsibleConductinResearch.*(2009). Washington,D.C.:NationalAcademiesPress.
3. Gopen,G.D.,&Smith,J.A.*TheScienceofScientificWriting*.AmericanScientist, 78 (Nov-Dec 1990),550-558.
4. Mohan,K.,&Singh,N.P.(2010).*SpeakingEnglishEffectively*.Delhi:Macmillan India.

Semester Four

MB-CC-401
ENVIRONMENTAL MICROBIOLOGY
Credit: 4

Unit I Aquatic Microbiology	Aquatic Microbiology: Water ecosystem (Fresh & Marine) and zonation, microbial assessment of water quality, Waste water treatment (Aerobic and Anaerobic Treatment), Case Studies: (Treatment schemes of various industries)
Unit II Aeromicrobiology	Aero-microbiology: Works on aero-microbiology in India (Aflatoxin by aero - fungi), aero- micro flora of hospitals, microbial aero-allergens, phylloplane micro flora and dispersal of spores.
Unit II Environmental Pollution & related diseases	Environmental Pollution: types & control; Major water borne diseases and prevention (Cholera & Typhoid), Major air borne diseases (Tuberculosis and Influenza), Major food borne diseases and prevention (Poliomyelitis and Amoebiasis).
Unit IV Bioremediation Process	Bioremediation process: Strategy, monitoring and efficacy. Types and Application of Bioremediation, Biodegradation of xenobiotics, plastics, oils & hydrocarbons, Solid waste Management; Biosensors and its role in environmental monitoring.

Recommended Textbooks and References:

1. Introductory Microbiology - R.P. Singh & B. D. Singh
2. A text book of Microbiology – Prescott.
3. Microbiology – Pelczar
4. Microbial Ecology – Atlas & Barth
5. Environmental Science – Cunningham
6. Microorganisms in Bioremediation – Dillip K. Markandey
7. Roles of M.O's in Management of Environmental Pollution – R. Tiwari
8. Microbial Ecology – R.Campbell
9. Environmental Micobiology---R.Mitchell.
10. Waste water Engineering—Treatment, Disposal and Reuse, Tata McGraw Hill
11. Environmental Chemistry ---A.K De
12. Environmental Microbiology--- Ian L. Pepper, Charles P. Gerba and Terry J. Gentry

13. Fundamentals of Ecology --- O.P. Odum

MB-CE-402
SOIL & AGRICULTURAL MICROBIOLOGY
Credit: 4

Unit I Soil & its Ecosystem	Discoveries in soil microbiology, Classification of soil and soil types, soil microbes (Algae, Bacteria, Actinomycetes, Nematodes and Fungi). Distribution of micro-organisms in different soil types, rhizosphere and rhizoplane microorganisms. Inter-relationships between plants and micro-organisms, rhizosphere concept, R: S ratio, rhizoplane, phyllosphere; their importance in plant growth. Mycorrhiza, Soil enzyme activities and their importance. Qualitative and quantitative estimation of micro-organisms in soil. Soil Microbial biomass, influence of environmental factors on soil microflora-moisture, PH temperature, organic matter etc,
Unit II Biogeochemical Cycling of Nutrients	Microbial biomass – An index for soil fertility. Organic matter decomposition, Humus formation, Biogeochemical cycling (C, N, S, P): carbon cycle, N2 cycle. Microbial transformation of phosphorus, sulphur, iron and manganese. Degradation of cellulose, hemicellulose, lignin, pectin and chitin.
Unit III	
Unit IV Microbial Biofertilizers & Crop Protection	Microbial biofertilizers, biological nitrogen fixation (symbiotic and non-symbiotic), green manuring, mass cultivation of cyanobacteria biofertilizers. Crop protection – microbial herbicides, bacterial insecticides (*Pseudomonas, Bacillus thuringiensis*), virus insecticides, entomo – pathogenic fungi. Microbial pesticides, biodegradation of pesticides. Effect of pesticides on soil micro-flora

Recommended Textbooks and References:

1. Soil Microbiology – Suba Rao
2. Soil Microbiology – Alexander Martin
3. Soil Microbiology – Mark, Coyne
4. Soil Biotechnology – Iynch, Martin
5. Soil Microbiology – Paul, E. Eiego

6. Introductory Microbiology - R.P. Singh & B. D. Singh
7. A text book of Microbiology – Prescott.
8. Microbiology – Pelczar

MB-CE-403
FOOD MICROBIOLOGY
Credits-4

Unit I Introduction & Scope of Food Microbiology	Introduction and scope of food microbiology. Perspective on food safety and food biotechnology. Common micro-organisms in food. Factors of special significance in food microbiology- Principles influencing microbial growth in foods; spores and their significance; indicator organisms and microbiological criteria.
Unit II **Microbial Spoilage of food**	Microbial spoilage of foods, meat, milk, fish, fruits, vegetables and their products; Food spoilage: process and its control, Food borne infection and intoxications, Food poisoning and food-borne pathogenic bacterial diseases.
Unit III Food Fermentation; Microbes as food	Food fermentation; Fermented diary, vegetable and meat products. Microbes as food (SCP, Fungi, Bacteria, Algae), Microbial Flora of milk and dairy products. Microorganisms on fermented foods, Microorganisms on foods and food amendments. Role of microorganisms in beverages – tea and coffee fermentations. Applications of microbial enzymes in dairy industry (Protease, Lipases).
Unit IV Preservatives and Preservation Methods	Preservatives and preservation methods: Physical methods, chemical preservatives and natural antimicrobial compounds Bacteriocins and their applications. Biologically based preservation system and probiotic bacteria Advanced techniques in detecting food-borne pathogens and their toxins. Critical control point systems in controlling microbiological hazards in foods

Recommended Textbooks and References:

1. Food Microbiology – Doyle
2. Food Microbiology – Frazier
3. Food Microbiology – Adams & Moss
4. Modern Food Microbiology – Jav. I.M.
5. Food Microbiology – Neelam Khetarpaul
6. International Food Safety Handbook – K. V. Heijden
7. Text book of Microbiology – Prescott (TMH)
8. Outlines of Diary Technology – Sukumar De (Oxford)
9. Milk and Milk Products (4th edition) – C. H. Eckles (TMH).
10. Introductory Microbiology – R. P. Singh (C.B.D. Publication
11. Laboratory Manual for Milk Quality Control Testing – J. G. Davis

MB-CE-403

INTELLECTUAL PROPERTY RIGHTS, BIOSAFETY, AND BIOETHICS

Credits-4

Unit I **Introduction to IPR**	Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.
Unit II **Patenting**	Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives
Unit III **Biosafety** National & International Regulation	Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools. International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance

	documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).
Unit IV **Bioethics**	Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.

Recommended Textbooks and References:

1. IPR, Biosafety and Bioethics --- Goel & Parashar

MB-CC-405
DISSERTATION
Credits-6

Syllabus **Planning and performing experiments**	Based on the project proposal submitted in earlier semester, students should be able to plan, and engage in, an independent and sustained critical investigation and evaluate a chosen research topic relevant to biological sciences and society. They should be able to systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions. Senior researchers should be able to train the students such that they can work independently and are able to understand the aim of each experiment performed by them. They should also be able to understand the possible outcomes of each experiment
Syllabus **Thesis writing**	At the end of their project, thesis has to be written giving all the details such as aim, methodology, results, discussion and future work related to their project. Students may aim to get their research findings published in a peer-reviewed journal. If the research findings have application-oriented outcomes, the students may file patent application.

Non-Credit Course

Cultural Heritage of South Odisha

(ଦକ୍ଷିଣ ଓଡ଼ିଶାର ସଂସ୍କୃତିକ ବିଭବ)

Aim of the Course (ପାଠ୍ୟକ୍ରମର ଲକ୍ଷ୍ୟ)

Kabi Samrat Upendra Bhanja is the master-spirit of Odia Language and Culture during Medieval period. The campus of Berhampur University has been rightly named after Kabi Samrat Upendra Bhanja as 'BHANJA BIHAR'. South Odisha is the adorable storehouse of literary and cultural wealth of ancient and medieval Odisha which has elicited remarkable national acclaim. This course has been introduced with a view to familiarizing all the P.G. Students of Berhampur University with the excellent craftsmanship exemplified by the literary stalwarts including Kabi Samrat Upendra Bhanja along with the Arts, Culture and Folk Tradition of South Odisha. (ମଧ୍ୟଯୁଗୀୟ ଓଡିଆ ସାହିତ୍ୟ ଓ ସଂସ୍କୃତ୍ିର ମହାନାୟକ କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଭଞ୍ଜ । ବ୍ରହ୍ମପୁର ବିଶ୍ୱବିଦ୍ୟାଳୟ ତ୍ାଙ୍କ ନାମପର 'ଭଞ୍ଜବିହାର' ଭାବପର ନାମିତ୍ । ଗଞ୍ଜାମ ସପମତ୍ ଦ୍ିଣ ଓଡ଼ିଶା ସମଗ୍ର ରାଜ୍ୟର ବୁଧହଂସ ପକଳିସର । ଏହାର କଳା-ସାହିତ୍ୟ-ସଂସ୍କୃତ୍ି-ପ ାକେରମ୍ପରା ସବବଭାରତ୍ୀୟ ସ୍ୱୀକୃତ୍ିପ୍ରାପ୍ତ । ଏହାକୁଦ୍ୃଷ୍ଟିପର ରଖି ବ୍ରହ୍ମପୁର ବିଶ୍ୱବିଦ୍ୟାଳପର ସ୍ନାପ୍କାଉର ପେଣୀର ସମସ୍ତ ଛାତ୍ରଛାତ୍ରୀଙ୍କୁକବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଭଞ୍ଜଙ୍କ ସପମତ୍ ଦ୍ିଣ ଓଡ଼ିଶାର ଅନୟାନୟ ସାହିତ୍ିୟକ ପ୍ରତ୍ିଭା ଏବଂ ଏହିଅଞ୍ଚଳର କଳା, ସଂସ୍କୃତ୍ି, ପ ାକ ୋରମ୍ପରା ସମ୍ପକବପର ସାଧାରଣ ଧାରଣ ପ୍ରଦ୍ାନ କରିବା ୋଇଁଏରିଅଧୟନ ବୟବସ୍ଥା କରାଯାଇଛି।)

Details of the Course

This Paper consists of 50 marks with following 4 Units.

Unit- I : Literary works of Kabi Samrat Upendra Bhanja

Unit-II : Other Litterateurs of South Odisha

Unit-III: Cultural Heritage of South Odisha

Unit-IV: Folk and Tribal Traditions of South Odisha

ୟୁନଟି-୧: କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଭଞ୍ଜଙ୍କ କୃତ୍ି ଓ କୃତ୍ିତ୍ୱ

ୟୁନଟି-୨: ଦ୍ିଣ ଓଡ଼ିଶାର ଅନୟାନୟ ସାରସ୍ୱତ୍ ସାଧକ

ୟୁନଟି-୩: ଦ୍ିଣ ଓଡ଼ିଶାର ସାସ୍କୃତ୍ିକ ବିଭବ

ୟୁନଟି-୪: ଦ୍ିଣ ଓଡ଼ିଶାର ଆଦ୍ିବାସୀ ଓ ପ ାକ ୋରମ୍ପରା

Course Outcome (ପାଠ୍ୟକ୍ରମର ନିଷ୍କର୍ଷ)

The teaching imparted to the P.G. students of Berhampur University on the various dimensions of the literary and cultural heritage of South Odisha will help them to acquire a valuable understanding of the same. They will ପବ inspired adequately to take the positives learnt from the course and use them in future in their personal literary and cultural pursuits and thereby promote the literature and culture of Odisha on a global scale. (ଓଡ଼ିଆ ସାହିତ୍ୟ ଓ ସଂସ୍କୃତ୍ିର ଏହି ୋରିଏକ ଗୁରୁତ୍ୱପୂର୍ଣ୍ଣଦ୍ିଗପର ୋଠଦ୍ାନ କରିବା ଦ୍ୱାରା ପକବଳ ପଯ କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ରଭଞ୍ଜ ଓ ଦ୍ିଣ ଓଡ଼ିଶାର କଳା-ସାହିତ୍ୟ-ସଂସ୍କୃତ୍ି-ଆଦ୍ିବାସୀ ପ ାକ ଜୀବନ ଓ ପ ାକ ୋରମ୍ପରା ସମ୍ପକବପର ବିଶ୍ୱବିଦ୍ୟାଳର ଛାତ୍ରଛାତ୍ରୀ ସପେନ୍ ପହାଇୋରିପବ; ତ୍ାହା ନୁପହଁ, କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ରଭଞ୍ଜଙ୍କ ସହିତ୍ ଦ୍ିଣ ଓଡ଼ିଶାର

ସାହିତ୍ିୟକେରିମଣ୍ଡଳ ଏବଂ ଏହି ଅଞ୍ଚଳର ସାଂସ୍କୃତ୍ିକ ବିଭବ ଓ ପ ାକେରମ୍ପରା ସମ୍ପକବପର ବିଶ୍ୱବିଦ୍ୟାଳୟର ଛାତ୍ରଛାତ୍ରୀମାପନ ମଧ୍ୟ ସମୟକ ଜ୍ଞାନ ଆହରଣପର ବ୍ରତ୍ୀ ପହାଉୋରିପବ ।

Recommended Electives for Semester III

ADVANCED MICROSCOPY

Credits-4

Unit I **Confocal Microscopy**	Principles of confocal fluorescence microscopy, resolution and point spread function, Light sources in fluorescence microscopy, The advanced fluorescence microscope optical train, pinhole and signal channel configurations, detectors, pixels and voxels, contrast, spatial sampling: temporal sampling: signal-to-noise ratio, multichannel images.
Unit II Multiphoton Microscopy Advanced Fluorescence Microscopy Techniques	Multiphoton microscopy, Image deconvolution and quantification, Advanced fluorescence microscopy techniques: Foerster Resonance Energy Transfer (FRET) microscopy, Fluorescence Lifetime Imaging microscopy (FLIM) and Fluorescence Correlation Spectroscopy (FCS), Total internal Reflection Fluorescence (TIRF) microscopy, Breaking the diffraction barrier: Concept of optical superresolution, Stimulation Emission Depletion (STED) microscopy, Single molecule localization microscopy: Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivation Localization Microscopy (PALM).

PLANT & ANIMAL VIRUSES

Credits-4

Unit I **Animal Virology**	Life cycles: DNA viruses with special reference to herpes, pox, adeno, SV40; RNA viruses with special reference to measles, rabies, polio, influenza, retroviruses; Oncoviruses and Lentiviruses (HIV). 2. Slow and persistent viruses. 3. Mechanism of virus persistence, Genetic stability of viruses,

	Influence on host cell growth control, Immune response against viruses. 4. Antiviral drugs and virus vaccines
Unit II Plant Virology	Classification and nomenclature. 2. Effects of viruses on plants: Appearance of plants, histology, physiology and cytology of plants. 3. Diagnostic techniques to detect viruses: In seeds, seed stocks, and diseased plants (seed morphology, seedling symptomatology, indicator plants, serological methods, histo-chemical tests and fluorescence microscopy) 4. Behaviour of viruses in plants: Early stages of infection, biochemistry of virus replication, cellular sites of virus replication and assembly and accumulation of virus particles. 5. Transmission of plant viruses: With vectors (insects, nematodes, fungi, etc.) without vectors (contact, seed and pollens). 6. Prevention of crop losses due to virus infection: Virus free planting material, vector control, disease forecasting. 7. Life cycle: TMV, Cauliflower mosaic virus etc

EXTREMOPHILES & EVOLUTION

Credits-4

Unit I **Extremophiles**	Isolation, classification and properties of extremophiles (Hyperthermophiles, Psychrophiles, Halophiles, Acidophiles, Methanogenic extremophiles, etc.) 2. Adaptation mechanisms of extremophiles, biotechnological applications of extremophiles Life cycles: DNA viruses with special reference to herpes, pox, adeno, SV40; RNA viruses with special reference to measles, rabies, polio, influenza, retroviruses; Oncoviruses and Lentiviruses (HIV). 2. Slow and persistent viruses. 3. Mechanism of virus persistence, Genetic stability of viruses, Influence on host cell growth control, Immune response against viruses. 4. Antiviral drugs and virus vaccines
Unit II Evolution	History and development of evolutionary theory, Neo Darwinism: Spontaneous mutation controversy, evolution of rates of mutation, types of selection, levels of selection, group selection and selfish gene. 2. Sociobiology, kin selection, evolutionary stability of cooperation, sociality and multicellularity in microorganisms, Game theory. Co-evolutionary strategies, host parasite co-evolution, Neutral evolution and molecular clocks, phylogeny and molecular distances. 3. Molecular evolution: origin of life, the origin of new genes and proteins. Evolution of life histories, ageing, evolutionary trade offs, r and k selection, Evolutionary origin of biochemical disorders: The case of insulin resistance.

FUNGAL & ALGAL BIOTECHNOLOGY

Credits-4

Unit I **Fungal enzymes & Fungal Products**	Fungal enzymes-Conversion of biomass to bioenergy and high value products. Fungal products in agricultural management and other biological applications Pharmacologically active compounds produced using fungi. Fungal genetics- post genomic prospective. 4. Pharmacologically active compounds produced using fungi.
Unit II Biotechnological Application of Algae	Biotechnological applications of algae: Nutrient based supplements-lipids and polyunsaturated fatty acids (PUFA), protein rich cattle feed, phytosterols, polysaccharides, pigments, antioxidants, biofuels.

THERAPEUTICS: VACCINE TECHNOLOGY

Credits-4

Unit I **Immune response to vaccination**	Vaccination and immune response; Adjuvants in Vaccination; Modulation of immune responses: Induction of Th1 and Th2 responses by using appropriate adjuvants and antigen delivery systems - Microbial adjuvants, Liposomal and Microparticles as delivery systems; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and Mucosal Immunity.
Unit II **Vaccine types and design**	History of vaccines, Conventional vaccines; Bacterial vaccines; Viral Vaccines; Vaccines based on routes of administration: parenteral, oral, mucosal; Basic principles of a vaccine action, a short history of vaccination, Mechanism of vaccine action, Active and passive immunization, General immunization practices, Live, killed, attenuated, sub unit vaccines, Toxoid vaccines, Role and properties of adjuvants, Recombinant DNA and protein based vaccines, plantbased vaccines, Reverse vaccinology, Peptide vaccines, Conjugate vaccines, Licensed vaccines, Viral Vaccine (Poliovirus vaccine-inactivated and Live, Rabies vaccines, Hepatitis A and B vaccines), Bacterial Vaccine (Anthrax vaccines, Cholera vaccines, Diphtheria toxoid), Parasitic vaccine (Malaria Vaccine), Vaccination of immunocompromised hosts.

Unit III **Vaccine technologies**	New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for targeted delivery (Vaccine Delivery systems); Disease specific vaccine design: Tuberculosis Vaccine; Malaria Vaccine; HIV/AIDS vaccine; New emerging diseases and vaccine needs (Ebola, Zika).

PHARMACEUTICAL MICROBIOLOGY

Credits-4

Unit I Antimicrobial agents & Chemotherapy	Antimicrobial assays in liquid and solid media, susceptibility testing in liquid and solid media. Antibiotics that inhibit peptidoglycan biosynthesis, Drugs that interfere with the biosynthesis of the cell wall of mycobacteria, Fungal cell wall as a target for antimicrobial drugs, Ionophoric antibiotics, Antifungal agents that interfere with the function and biosynthesis of membrane sterols, Inhibitors of nucleic acid biosynthesis, Inhibitors of protein biosynthesis. Nitroheterocyclic antimicrobial agents, A unique antifungal antibiotic-griseofulvin, antiviral agents, antiprotozoal agents. Attack and defense: drug transport across cell walls and membranes.
Unit II **Pharmaceutical Microbiology**	Study of major groups of pharmacologically active molecules of plant, animal and microbial origins (Extraction and purification). Physical and chemical properties, metabolic activity, identification of drug target/receptors, elucidation of the mechanism of drug action, Drug interactions, toxicity and adverse reactions, toxicity testing, assays for mutagenicity, carcinogenicity, Pyrogenicity and allergy testing. Steps towards commercialization of drug 4. Regulations on drug, FDA.

Recommended Electives for Semester IV

OMICS CONCEPT IN BIOLOGY

Credits-4

Unit I Introduction to Genomics	Introduction to Genomics: Pre and Post Genomic era, Major advancements in Genomic approaches, Epigenetics and Metagenomics, Forward versus reverse Genomics, Genome analysis-Genome editing approaches and their applications, Gene expression approaches and their applications. Next Generation Sequencing (NGS)-Illumina (Solexa), Roche 454, Sequencing by Oligonucleotide Ligation and detection (SOLiD), Ion Torrent Technology etc. Parallel sequencing, Nanopore sequencing, Sequence analysis and their applications: Human Genetics and Human Genome Project, Genomic insights into evolution, advantages of comparative genomic analysis, Analysis of microarray data.
Unit II Proteomics	Introduction, types of proteomics investigation and importance of proteomics Tools of proteomics-Separation technology (SDS PAGE, 2D PAGE), Liquid chromatography, Mass Spectrometry (Ionizers, analyzers and detectors), Protein and peptide microarray-based technology, Protein identification by peptide mass fingerprinting. Polymerase chain reaction (PCR)-directed protein in situ arrays, Structural proteomics, Applications of proteomics: Host-pathogen interaction, proteinprotein interaction, drug discovery.
Unit III Metabolomics	Basic concept of metabolomics, Metabolic fingerprinting, and metabolic profiling, Tools of metabolomics: Capillary electrophoresis, Gas chromatography (GC), Electrochemical detectors, Applications of Metabolomics in Biology

MOLECULAR DIAGNOSTICS: SENSORS, BIOSENSORS AND OTHER DIAGNOSTIC TECHNIQUES

Credits-4

Unit I Biosensors	Biosensors: Basic principles and operations, types of biosensors and applications of biosensors. Point of care medical diagnostic devices.
Unit II **Medical Diagnostic Techniques**	Biochemical, analysis, DNA / RNA based analysis, etc., Necessity for rapid and in situ medical analysis, Miniaturization of medical diagnostic devices-Microfabrication (Materials, processes, techniques for detection).
Unit III **Microfluidics**	Concept, Procedure, Applications and Challenges, Integrated microfluidic devices: Lab-ona-chip, system-on-a-chip, micro-total analysis system (μTAS), Present research scenario and future prospects.

CANCER BIOLOGY & CLINICAL IMMUNOLOGY

Credits-4

Unit I Cancer Biology	Cellular transformations during neoplastic growth, Classification of tumors based on histological, physiological, biochemical and immunological properties, Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease). 2. Different mechanism of cancer cell adaptations, Hallmarks of cancer, Tumor suppressor genes and oncogenes, Tumor microenvironment and cancer cell heterogeneity, Physical and biological factors associated with tumorigenesis, Cancer cell heterogeneity and cancer stem cells, Molecular mechanism of metastasis, Epithelial to mesenchymal transition, mitogenic cell signaling (Ras-Raf-MAPK, ErbB, c-myc, signaling pathways), Concept of tumor associated and tumor specific antigens, role of immune system in cancer, Immunosurveillance and immunoediting.
Unit II Cancer Diagnostics	Cancer Diagnostics: Conventional and molecular methods, Clinical grading of tumors, Cancer therapy: basic principles of chemotherapy and radiation

	therapy, Emerging concepts in cancer therapy- Cancer immunotherapy, Passive and adoptive cancer immunotherapy, hyperthermia
Unit III Immunological Disorders	Pathophysiology, diagnosis, prognosis and therapeutic approaches to: a. Immunodeficiency disorders – Phagocytic deficiencies, humoral deficiencies, Cell mediated deficiencies, combined deficiencies and complement deficiencies. Autoimmune disorders (Immunopathological mechanisms and theories of autoimmunity) - Rheumatoid arthritis, Systemic Lupus Erythomatosus (SLE), Multiple myeloma, Myasthenia gravis.

GENE MANIPULATION/RECOMBINANT TECHNOLOGY

Credits-4

Unit I **Introduction to Recombinant DNA Technology**	General Strategies for Recombinant DNA Technology and Gene Cloning: genomic libraries, cDNA libraries, single gene cloning.
Unit II Tools of Recombinant DNA Technology	Enzymes - DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatise, Vectors - Plasmids, cosmids, lambda phage, shuttle vectors, YACs, BACs, Baculovirus and Pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors, Cohesive and blunt end ligation, Linkers, Adaptors, Homopolymeric tailing.
Unit III **Screening & Characterization of Transformants**	Hybridization techniques, probe preparation using radioactive and nonradioactive ligands, detection of hybrids, site directed mutagenesis. 5. Genetic manipulation of animals. 6. Purification of recombinant proteins: His-tag, GSTtag, MBP-tag etc.

ENVIRONMENTAL POLLUTION MONITORING & WASTE WATER TREATMENT

Credits-4

Unit I **Environmental Pollution Monitoring: Basic Concepts** **Natural resources**	Environmental Pollution Monitoring: Basic concepts. Natural Resources: Water and Land. Components and structure of the environment, Levels of organization in nature - Food chain and Trophic structure, Biogeochemical Cycles, Interdependence of man and environment.
Unit II Concepts, Causes and Consequences of Human Impact on the Natural Environment:	Concepts, Causes and Consequences of Human Impact on the Natural Environment: Definition and sources of pollution, Different types of pollution and their global, regional and local aspects: Air (Global warming, Green-house effect), Water, Radiation, Ewastes, Biomedical wastes
Unit III **Waste Water Technology**	Wastewater treatment system (unit process): Physical screening, flow equalization, mixing, flocculation, flotation, granular medium filtration, adsorption, Chemical precipitation, 02 03 10 15 02 M.Sc. Microbiology, SPPU: Syllabus 2019 Page 7 of 12 Semester III Subject Code Subject Title No. of Lectures/ Practical No. of Credits disinfection, Dechlorination, Biological: (aerobic and anaerobic, suspended and attached growth processes.) Working treatment systems and their analysis (reactions and kinetics, mass balance analysis, reactor types, Hydraulic character of reactors, selection of reactor type,) Critical operating parameters like DO, hydraulic retention time, mean cell residence time, F/M ratio etc, Effluent disposal, control and reuse. Water pollution control, Regulation and limit for disposals in the lakes, rivers, oceans, and land. Direct and indirect reuse of treated effluents and solid wastes, Current industrial wastewater treatment and disposal processes (Textile, food and dairy, paper and pulp manufacturing industries).

NANOBIOTECHNOLOGY

Credits-4

Unit I **Introduction to nanobiotechnology**	Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specific cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.
Unit II **Nano-films**	Thin films; Colloidal nanostructures; Self Assembly, Nanovesicles; Nanospheres; Nanocapsules and their characterization
Unit III **Nano-particles**	Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.
Unit IV **Applications of nano-particles**	Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development
Unit V **Nano-materials**	Nanomaterials for catalysis, development and characterization of nanobiocatalysts, application of nanoscaffolds in sythesis, applications of nanobiocatalysis in the production of drugs and drug intermediates
Unit VI **Nano-toxicity**	Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, containment.