Post Graduate Department of Microbiology

Berhampur University

Bhanja Bihar, Berhampur, Ganjam, Odisha

Berhampur- 760007

From

M.Sc. Syllabus (2024-25)

M.Sc. Microbiology General Course Framework & Structure

Paper code	Title	Credits	Internal marks	End sem Marks	Total Marks
SEMESTER-I					
MSMB-C-101	General / Introductory Microbiology	4	30	70	100
MSMB-C-102	Reproduction & Life Cycle of Microbes	4	30	70	100
MSMB-C-103	Nutrition & Physiology of Microbes	4	30	70	100
MSMB-C-104	Microbiological Techniques & Instrumentation	4	30	70	100
MSMB-IKS-105	Indian Knowledge System	4	30	70	100
MSMB-P-106	Seminar & Laboratory	6	0	100	100
	SEMESTER-I TOTAL	26	150	450	600
SEMESTER-II					
MSMB-C-201	Microbial Genetics & Molecular Biology	4	30	70	100
MSMB-C-202	Biochemistry & Enzymology	4	30	70	100
MSMB-C-203	Fundamentals of Immunology & Diagnostic Microbiology	4	30	70	100
MSMB-C-204	Viruses & Bacteriophages	4	30	70	100
MSMB-P-205	Seminar & Laboratory	6	0	100	100
MSMB-VAC-206	Summer Internship/Industrial Visit	NC	NC	NC	NC
	SEMESTER-II TOTAL	22	120	380	500
SEMESTER-III					
MSMB-C-301	Medical Microbiology	4	30	70	100
MSMB-E-302	Industrial & Food Microbiology	4	30	70	100
MSMB-E-303	Microbial Biotechnology	4	30	70	100
MSMB-CT-304	CBCT courses (Interdisciplinary Electives)	4	30	70	100
MSMB-P-305	Seminar & Laboratory	6	0	100	100
MSMB-VAC-306	Research Methodology & Scientific Communication Skills	NC	NC	NC	NC
	SEMESTER III-TOTAL	22	120	380	500
Paper code	**Title**	**Credits**	**Internal marks**	**End sem Marks**	**Total Marks**
SEMESTER-IV					
MSMB-C-401	Environmental Microbiology	4	30	70	100
MSMB-E-402	Soil & Agricultural Microbiology	4	30	70	100
MSMB-E-403	Microbial Bioinformatics & Biostatistics	4	30	70	100
MSMB-E-404	IPR, Biosafety & Bioethics	4	30	70	100
MSMB-D-405	Dissertation (Thesis + Presentation)	6	0	100	100
MSMB-AC-406	Cultural Heritage of South Odisha	NC	NC	NC	100
	SEMESTER IV-TOTAL	22	120	380	500
	GRAND TOTAL	92	--	--	2100

C: Core; E: Elective; P: Practical, D: Dissertation; VAC: Value Added Course; AC: Add on course; CT: Interdisciplinary Elective (Choice Based Credit Transfer); IKS: Indian Knowledge system

Curriculum Overview (M.Sc.)

Distribution of Course (Semester wise)

- **Semester I:** Four (04) Core Courses and one Laboratory Course Work
- **Semester II**: Four (04) Core Courses, one Laboratory Course Work and one Value Added Course
- **Semester III:** One (01) Core Courses, Two (02) Electives, One (01) interdisciplinary choice elective, one (01) Laboratory Course Work and one (01) Value Added Course
- **Semester IV:** One (01) Core Courses, Three (03) Electives, Project, Dissertation and Viva, One (01) Add-on Added Course

 # Swayam/NPTEL courses: All PG students should complete one SWAYAM Course (minimum 02 credits) on or before completion of the 3rd semester. The Coordinator of the SWAYAM Course shall contact the departmental Nodal Officer and finalize the course to be opted for by students. The course credit shall be included in the 3rd-semester grade sheet.

CBCT (Inter-Disciplinary electives) Papers (Students have to choose one of the following courses offered by different departments of Berhampur University for MSMB-CT-304)

BIOT CT 300: Biotechnology in Human Welfare (offered by Dept. of Biotechnology)

BOTA CT 300: Economic Botany (offered by Dept. of Botany)

ENVS CT 300: Population & Environmental Issues (offered by Dept. of Environment studies)

ZOOL CT 300: Conservation Biology (offered by Dept. of Zoology)

CHEM CT 300: Environmental Chemistry (offered by Dept. of Chemistry)

Scheme of Evaluation:

Each theory paper carries 100 Marks. It is divided into 30 marks for internal evaluation (20 marks for written internal examination, 05 marks based on assignments and quizzes/group discussion, and 05 marks for attendance) and 70 marks for the final examination in each semester.

*InternalMarks : 20 + 5 + 5 = 30 (Internal Exam + Quizzes/Assignment+ Attendance)

Semester One

MSMB-C-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 & 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

MSMB-C-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

MSMB-C-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*(5th ed.). 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.

MSMB-C-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

MSMB-IKS-105
INDIAN KNOWLEDGE SYSTEM
Credits-4

Unit I **Indian Knowledge system: An Introduction** **Microbiology in Vedas**	Indian Knowledge system: An introduction "Sukshmjeevanu" in Vedas, Microbiology in Indian Vedic Knowledge; "Kanva" as father of Microbiology; Role of Microorganisms in Vedic Astrology
Unit II **Concept of Krimi, from Vedic and Ayurvedic perspective**	Concept of "Krimi", Classification and Nomenclature of "Krimi"; Prevention and treatment of "Krimi" as explained in Vedas; Ayurvedic concept of "Krimi"
Unit III **Alcoholic fermentation techniques in Early Indian tradition**	Alcoholic Fermentation in Vedic age; Fermented Foods (Dadhi, Madhuparka, etc.)
Unit IV **Microbial Infections & Pandemic Infections**	Clinical Consequences of Microbial Infections in Charaka Samhita; Ayurvedic aspect of bacteria and bacterial food poisoning; Sankramak roga: based on ayurveda samhitas

Recommended Textbooks and References:

1. Padhy SN (2016) Vedic Indians were aware of the microbial biodiversity, demanding 'Kannva' as the father of microbiology. J Biodiver 2:101–103.
2. Gavande SS, Josh AH, Sardeshmukh SP, Deshmujh VV (2020) Concept of Krimi, from Vedic and Ayurvedic perspective—a review. Nat J Res Ayurved Sci 8:1–10.
3. Jakhmola RK (2010) Micro-organisms in Vedas. Ayu31:114–120.
4. Jain AK, Jain JK, Diwedi OP (2018) Various historical aspect of communicable diseases described in ancient kala of veda and samhita. J Drug Deliv Ther 8:83–86.
5. Raghuveer Rao VN (2014) Ayurvedic concept of Krimi. J Biotechnol Biosaf 2:150–155.
6. Panja AK, Patra A, Chaudhuri S, Chattopadhyaya A (2011) Clinical consequences of microbial infections in Charaka Samhita. Int J Ayurvedic Med 2:107–114.
7. Urvashi K.; Gunjan G.; Maurya, P.K.; Kuhad, R.C. (2021) Sukshmjeevanu in Vedas: The Forgotten Past of Microbiology in Indian Vedic Knowledge. Indian J Microbiol (Jan–Mar 2021) 61(1):108–110.
8. Introduction to Indian Knowledge System: Concepts and Applications, Archak, K.B. (2012). Kaveri Books, New Delhi.ISBN-13:978-9391818203.
9. Introduction To Indian Knowledge System: Concepts and Applications, Mahadevan, B. Bhat, Vinayak Rajat, Nagendra Pavana R.N.PHI, ISBN: 9789391818203.
10. Nand Lal Singh, Ramprasad, P.K. Mishra, S.K. Shukla, Jitendra Kumar and Ramvijay Singh, 2010. Indian Journal of History of Science, 45.2, 163-173.
11. Rima Ghosh, Diptendu Chatterjee, Sanjit Dey (2023). Indian Fermented Food: Past, Present & Future.
12. Rima Ghosh, Diptendu Chatterjee, Sanjit Dey (2021). "Ethno-microbiology" of ethnic Indian fermented foods and alcoholic beverages. Journal of Applied Microbiology. Appl Microbiol. 2022;133:145–161.

MSMB-P-106
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, 14th Ed^{n})

Semester Two

MSMB-C-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

MSMB-C-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, 3rd Edn Nicholas C. and Lewis Stevens

MSMB-C-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.

MSMB-C-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: Cultivation of virus, Assay of virus, Purification and Characterization of viruses, Morphology and chemical composition of viruses.
Unit II **Viral Genetics and Physiology**	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*(5thed.).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

MSMB-P-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.

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

MSMB-VAC-206
SUMMER INTERNSHIP or INDUSTRIAL VISIT
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.

Semester Three

MSMB-C-301
MEDICAL MICROBIOLOGY
Credits-4

Unit I **Medical Microbiology: Introduction**	Historical landmarks and chronological development of Medical Microbiology; Normal microflora 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, Principles and Explorations*. Boston, MA: John Wiley & Sons.
5. Brock Biology of Microorganisms –Madigan & Martinko

MSMB-E-302
INDUSTRIAL & FOOD 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: Types/process, Design and Method of operations of fermenters and application of Fermenter and Bioreactor. Downstream processing for recovery of different industrial products.
Unit II **Industrial Production** **Microbiological Assays**	Industrial production; Ethyl alcohol, beer, wine, vinegar, organic acids: Citric acid & lactic acid, amino acids: Lysine & Glutamic Acid Antibiotics: Penicillin & Streptomycin, Single cell protein and oil. Vitamin: Riboflavin, Enzymes: Amylase & Cellulase. Biofuels Microbiological assays: principle, methodology, Types with examples, Assay of antibiotics and amino acids. Sterility testing of pharmaceutical products.
Unit III **Introduction & Scope of Food Microbiology** **Microbial Spoilage of food**	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. 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 IV **Food Fermentation;** **Microbes as food** **Preservatives and Preservation Methods**	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). Probiotics Preservatives and preservation methods: Physical methods, chemical preservatives and natural antimicrobial compounds. Bacteriocins and their applications. 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. 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

MSMB-E-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 pathways 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
Unit III **Drug Designing**	Drug designing, Antimicrobial agents (Therapeutic drugs) and types, Narrow spectrum and broad-spectrum antibiotics, General characteristics, mode of action with special reference to Penicillin, Sulpha drugs, Cephalosporin, Tetracycline and Streptomycin. Anti-microbial drug susceptibility test (dilution, disc diffusion, E – test and its importance)
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

MSMB-CT-304

CBCT courses (Interdisciplinary Electives)

Credit-4

Refer to the page no. 26 for the details of the courses offered.

MSMB-P-305

LABORATORY:

Credits-6

Syllabus	1. Study of normal micro flora of human body: a. skin and b. mouth. 2. Isolation and identification of enteric pathogenic microbes from animal faecal samples. 3. Demonstration of antibiotic resistance of bacteria. 4. Determination of MIC of antibiotics against microorganisms. 5. Sterility testing of pharmaceutical products. 6. Screening of antibiotic products from soil samples. 7. Isolation of microbes from sweets amenable for spoilage. 8. Identification of coliforms from samples collected from road side food stalls. 9. Isolation of micro flora from spoiled / putrefied fruits / vegetables. 10. Gradation of purity of milk samples using MBRT test. 11. Qualitative test for production of enzymes by microbes: Amylase, Cellulase, Proteinase, Pectinase, Lipase and Gelatinase, Organic acids: Citric acid 12. Bacterial cell immobilization 13. Qualitative test for ethanol production by *S. cerevisiae* 14. PCR methods / advantages – Demonstration. 15. Slides / Paper Slides of medically pathogenic microbial species. 16. Experimental design to conduct biostatistical experiments like student t – test and χ^2test.

VALUE ADDED COURSE

MSMB-VAC-306
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). *Doing Science: Design, Analysis, and Communication of Scientific Research.* Oxford: Oxford University Press.
2. *On Being a Scientist: Guide to Responsible Conducting Research.* (2009). Washington, D.C.: National Academies Press.
3. Gopen, G.D., &Smith, J.A. *The Science of Scientific Writing.* American Scientist, 78 (Nov-Dec 1990),550-558.
4. Mohan, K., & Singh, N.P. (2010). *Speaking English Effectively*. Delhi: Macmillan India.

Semester Four

MSMB-C-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 Microbiology---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

MSMB-E-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 **Microbial Biofertilizers**	Microbial biofertilizers, biological nitrogen fixation (symbiotic and non-symbiotic), green manuring, mass cultivation of cyanobacteria biofertilizers.
Unit IV **Crop Protection**	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

MSMB-E-403
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 Analysis Levine, M. M. (2004)

MSMB-E-404

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, types of patent applications: provisional and complete specifications; international patenting-requirement, procedures and costs; financial assistance for patenting introduction to existing schemes; 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,
Unit III **Biosafety** **National & International Regulation**	Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; 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; 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; 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; 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

MSMB-D-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.

MSMB-AC-406 (Add on 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 ଦ୍ଷିଣ ଓଡ଼ିଶା ସମଗ୍ର ରାଜ୍ୟର ବୁଧହଂସ ପକଳିସର । ଏହାର କଳା-ସାହିତ୍ୟ-ସଂସ୍କୃତ୍ି-ପ ାକେରମ୍ପରା ସବବଭାରତ୍ୀୟ ସ୍ୱୀକୃତ୍ିପ୍ରାପ୍ତ । ଏହାକୁଦ୍ୃଷ୍ଟିପର ରଖି ବ୍ରହ୍ମପୁର ବିଶ୍ୱବିଦ୍ୟାଳପର ସ୍ନାପ୍କାଉର ପେଣୀର ସମସ୍ତ ଛାତ୍ରଛାତ୍ରୀଙ୍କୁକବିସମ୍ରାଟ ଉପେନ୍ଦ୍ର ଭଞ୍ଜଙ୍କ ସପମତ୍ ଦ୍ଷିଣ ଓଡ଼ିଶାର ଅନୟାନୟ ସାହିତ୍ିୟକ ପ୍ରତ୍ିଭା ଏବଂ ଏହିଅଞ୍ଚଳର କଳା, ସଂସ୍କୃତ୍ି, ପ ାକ େରମ୍ପରା ସମ୍ପକବପର ସାଧାରଣ ଧାରଣ ପ୍ରଦ୍ାନ କରିବା େଲାଇଁଏରିଅଧୟନ 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: ଦ୍ଷିଣ ଓଡ଼ିଶାର ଅନୟାନୟ ସାରସ୍ୱତ୍ ସାଧକ

ୟୁନଟି-୩: ଦ୍ଷିଣ ଓଡ଼ିଶାର ସାସ୍କୃତ୍ିକ ବିଭବ

ୟୁନଟି-୪: ଦ୍ଷିଣ 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 ଏହିେରିଏକ ଗୁରୁତ୍ୱପୂର୍ଣ୍ଣଦ୍ିଗପର େଲାଠଦ୍ାନ କରିବା ଦ୍ୱାରା ପକବଳ ପଯ କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ରଭଞ୍ଜ ଓ ଦ୍ଷିଣ ଓଡ଼ିଶାର କଳା-ସାହିତ୍ୟ-ସଂସ୍କୃତ୍ି-ଆଦ୍ିବାସୀ ପ ାକ ଜୀବନ ଓ ପ ାକ େରମ୍ପରା ସମ୍ପକବପର ବିଶ୍ୱବିଦ୍ୟାଳର ଛାତ୍ରଛାତ୍ରୀ ସପେନ୍ ପହାଇୋରିପବ; ତ୍ାହା ନୁପହଁ, କବିସମ୍ରାଟ ଉପେନ୍ଦ୍ରଭଞ୍ଜଙ୍କ ସହିତ୍ ଦ୍ଷିଣ ଓଡ଼ିଶାର ସାହିତ୍ିୟକେରିମଣ୍ଡଳ ଏବଂ ଏହି ଅଞ୍ଚଳର ସାଂସ୍କୃତ୍ିକ ବିଭବ ଓ ପ ାକେରମ୍ପରା ସମ୍ପକବପର ବିଶ୍ୱବିଦ୍ୟାଳୟର ଛାତ୍ରଛାତ୍ରୀମାପନ ମଧ ସମୟକ ଜ୍ଞାନ ଆହରଣପର ବ୍ରତ୍ୀ ପହାଇୋରିପବ ।

Recommended CBCT (Inter-Disciplinary) Elective for Semester III (BIOT-CT-300/ BOTA-CT-300/ENVS-CT-300/ CHEM-CT-300/ ZOOL-CT-300)

BIOT-CT-300 Biotechnology in Human Welfare

Credits: 4

Unit I **Basic Concepts Biotechnology** 12 lectures	Basic Concepts of Biotechnology and its applications**,** Recombinant DNA technology**;** gene cloning, human genome project, Tools of Bioinformatics
Unit II **Agricultural and Environmental Biotechnology** 12 lectures	Agricultural and Environmental Biotechnology: Application in Breeding, Nitrogen fixation, Transfer of pest resistance genes to plants, Interaction between plants and microbes, Qualitative improvement of livestock. Crop plant genome project Chlorinated and non-chlorinated organ pollutant degradation; degradation of hydrocarbons and agricultural wastes, stress management, development of biodegradable polymers
Unit III **Medical and Pharmaceutical Biotechnology** 12 lectures	Development of therapeutic agents, recombinant live vaccines, gene therapy, Diagnostics; Principle of DNA fingerprinting, Stem cell Biology, Ethical issues in Biotechnology research
Unit IV **Industrial Biotechnology** 12 lectures	Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.

Recommended Textbooks and References:

1. John E. Smith. Biotechnology (2009) 5th Edition, Cambridge University Press
2. S. Ignacimuthu Biotechnology: An Introduction (2012) 2nd Edition, Narosa Publishing House Ltd., India

OR

BOTA-CT-300
Economic Botany
Credits-4

Unit I **Cereals & Legumes** Lectures:12	Origin, history, domestication, botany, cultivation, production and use of: Cereals: Wheat, rice, maize, sorghum, pearl millet and minor millets. Pulses: Pigeon pea, chickpea, black gram, green gram, cowpea, soyabean, pea, lentil, horse gram, lab-lab bean.
Unit II **Oil seeds & Tree plants** Lectures:12	Origin, distribution, cultivation, production and utilization of economic plants of following groups such as Plant of agro-forestry importance: Teak, Sal Acacia, Sesbania, Neem etc. Fibres: cotton, silk cotton, jute, sunnhemp. Oilseeds: Groundnut, sesame, castor, rape seed, mustard, sunflower, safflower, niger, oil palm, coconut and linseed.
Unit III **Fruits & Vegetables** Lectures:12	Origin, distribution, classification, production and utilization of Fruits: mango, banana, citrus, guava, grapes and other indigenous fruits; apple, plum, pear, peach, cashewnut and walnut; Vegetables: tomato, brinjal, okra, cucumber, cole crops, gourds etc.
Unit IV **Medicinal Plants** Lectures:12	Important medicinal and aromatic plants: Sarpagandha, Belladonna, Cinchona, Nux-Vomica, Vinca, Mentha and Glycirrhiza, Plantago etc.; Narcotics: Cannabis, Datura, Gloriosa, Pyrethrum and opium. Important Spices and condiments Ginger, Garlic, Cinnamon, Cardamom, Cumin, Foeniculum etc.

Recommended Textbooks and References:

1. Economic Botany: S. L. Kochhar, Cambridge University Press
2. Economic Botany- Principle & Practices: G.E. Wickens, Kluwer Academic Publishers
3. Economic Botany & Ethnobotany: Afroz Alam, Willey

OR

ENVS-CT-300 Population & Environmental Issues

Credits-4

Unit I **Demographic Overview** Lectures:12	Introduction, History of human population growth, The demographic transition: India and World; Projections of population growth, Effects of human population growth, Unsustainable lifestyle – increased consumerism
Unit II **Energy Crisis** Lectures:12	Energy Crisis: Background, Possible causes (Energy demand and consumption, Production capacity and dependence on imports); Ecologically friendly alternatives and Possible Measures
Unit III **Environmental Contamination** Lectures:12	Ambient Air pollution, Indoor air pollution and Health Impacts Surface water pollution, Ground water pollution and Health Impacts. Solid Waste Pollution and Sustainable Solid Waste Management; Hazardous waste pollution, Radioactive waste, Electronic waste and Biomedical waste
Unit IV **Ecological Footprints and Carrying Capacity** Lectures:12	Ecological footprints: Concepts, perspectives, carbon footprint, water footprint, Overshoot of ecological footprint and biocapacity of planet Earth, Resources Depletion.

Recommended Textbooks and References:

1. Cunningham WP and Cunningham MA (2002). Principles of Environmental Science: Inquiry and Applications. McGraw Hill Publications, New Delhi, 418 pp.
2. Johri R (2009). E-Waste: Implications, regulations, and management in India and current global best practices. TERI Press, New Delhi. 330 pp.
3. McKillop A and Newman S (2005). The Final Energy Crisis. Pluto Press, London. 325 pp.
4. Miller GT Jr. (1996). Living in The Environment: Principles, Connections, and Solutions. 9th Edition. Wadsworth Publishing Company, New York. 727 pp.
5. Park C (2001). The Environment: Principles and Applications. 2nd Edition, Routledge Publishers, London and New York, 598 pp.
6. Galli A (2010). Stomping on biodiversity: humanity's growing Ecological Footprint. In: Commonwealth Ministers Reference Book. Pp. 156-159.
7. McKinney ML and Schoch RM (1998). Environmental Science: Systems and Solutions. Jones and Bartlett Publishers, Boston. 639 pp.
8. MoEF (2009). State of Environment Report, India – 2009. Ministry of Environment and Forests, New Delhi
9. Sengupta B (2000). Environmental standards for ambient air, automobiles, fuels, industries and noise. Central Pollution Control Board, New Delhi, India. 78 pp.
10. WHO (2006). World Health Report 2006, World Health Organization, Geneva.

OR

CHEM-CT-300

Environmental Chemistry

Credits-4

Unit I **Basic Concepts** Lectures:10	Environment and its classification, Environmental Impact Assessment and management, Factors influencing environment, Components of Environment; Environmental degradation, Biogeochemical cycles; Hydrological cycle, Gaseous cycles (Oxygen cycle, CO2 cycle, Nitrogen cycle), Sedimentary cycles (Sulfur cycle, Phosphorous cycle)
Unit II **Natural Resources** Lectures:10	Introduction, classification of resources; land resources, formation of soil, soil erosion, Water resources, Sources of fresh water, Uses of water, causes for the depletion of water resources; mineral resources, Forest resources, Deforestation, consequences of deforestation; affords to control deforestation, Renewable and non-renewable resources, Conventional and nonconventional energy resources
Unit III **Environmental pollution** Lectures:10	Introduction, Pollutants, Types of pollutants, Classification of pollution, effects of pollution, Radiation pollution: sources, effect and control of radiation pollution, Thermal pollution: sources, effects and its control, Industrial pollution, Sewage and sewage treatment
Unit IV **Air Pollution and its control** Lectures:10	Atmosphere; structure and composition of atmosphere, Classification of air pollutants, Consequences of air pollution (Ozone layer depletion, Greenhouse effect, Global climate, Smog, Acid rain), Control of air pollution, air quality and standards.

References & Recommended Textbooks:

1. Environment and Ecology: Dr. Sunakar Panda
2. Environmental Chemistry: A.K. De
3. Air Pollution: Wark & Werner
4. Environmental Pollution Control in Process Industries: S.P. Mahajan
5. Environmental Chemistry: B.K. Sharma & H. Kaur
6. Introduction to Air Pollution: P.K. Trivedi
7. Environmental Pollution Analysis: By S.M. Khopkar
8. A Textbook of Environmental Pollution: D.D. Tyagi, M. Mehre
9. Environmental Pollution Engineering and Control: C.S. Rao

OR

ZOOL-CT-300 Conservation Biology

Credits-4

Unit I **Basic Concepts** Lectures:16	Biodiversity (genetic diversity, species diversity, ecosystem diversity) and its use, Causes of biodiversity losses, IUCN red list of threatened species, Invasive species, Alien species, Indicator species, Keystone species, Umbrella species, Flagship species, Charismatic species
Unit II **Measuring Biodiversity** Lectures:16	Alpha, Beta and Gamma diversity, Species Richness(S), Evenness(E), Simpson index(D), Shannon-Weiner Index (H'), idea on biodiversity calculator software
Unit III **International and National efforts for conserving biodiversity** Lectures:16	National Act and International Act related to Biodiversity Conservation: Biological diversity Act 2002, National Biodiversity Authority, People Biodiversity Registrar, Convention on Biological diversity, Cartagena Protocol and Nagoya Protocol, Sustainable Development Goal and Biodiversity, Aichi Biodiversity Targets, CITES, WWF
Unit IV **Conservation Measures and Molecular Phylogeny** Lectures:16	In-situ conservation (Indian context) (Sanctuaries, National and Biosphere reserves) and Ex-situ conservation (Indian context) (Botanical gardens, zoos, cryopreservation, gene bank), NCBI data base, basic idea on phylogenetic tree, Construction and interpretation of molecular phylogeny tree based on COI and 16s rRNA gene sequences using MEGA and other tools

Recommended Textbooks and References:

1. Fundamental of Ecology: O.P Odum
2. Campbell Biology: Reece, Urry, Cain et al.