## MICROBIOLOGY
## Course Structure – at a Glance

| CODE | COURSE TITLE | CREDITS |
|---|---|---|
| MICRO 501* | PRINCIPLES OF MICROBIOLOGY | 3+1 |
| MICRO 502* | MICROBIAL PHYSIOLOGY AND METABOLISM | 3+1 |
| MICRO 503* | MICROBIAL GENETICS | 2+1 |
| MICRO 504*# | SOIL MICROBIOLOGY MICROBIAL | 2+1 |
| MICRO 505*@ | BIOTECHNOLOGY FOOD AND | 2+1 |
| MICRO 506* | DAIRY MICROBIOLOGY | 2+1 |
| MICRO 507 | BACTERIOPHAGES | 1+1 |
| MICRO 508 | ENVIRONMENTAL MICROBIOLOGY | 2+1 |
| MICRO 509** | PLANT-MICROBE INTERACTIONS | 3+0 |
| MICRO 510 | INDUSTRIAL MICROBIOLOGY | 2+1 |
| MICRO 511 | BIOFERTILIZER TECHNOLOGY | 1+1 |
| MICRO 512 | CYANOBACTERIAL AND ALGAL BIOTECHNOLOGY | 2+0 |
| MICRO 591 | MASTER'S SEMINAR | 1+0 |
| MICRO 599 | MASTER'S RESEARCH ADVANCES IN | 20 |
| MICRO 601** | FERMENTATION ADVANCED | 2+1 |
| MICRO 602** | MICROBIAL PHYSIOLOGY | 2+0 |
| MICRO 603** | REGULATION OF MICROBIAL BIOSYNTHESIS | 2+0 |
| MICRO 604** | CURRENT TOPICS IN SOIL MICROBIOLOGY | 2+0 |
| MICRO 691 | DOCTORAL SEMINAR I | 1+0 |
| MICRO 692 | DOCTORAL SEMINAR II | 1+0 |
| MICRO 699 | DOCTORAL RESEARCH | 45 |

*Compulsory for Master's programme;

**Compulsory for Doctoral programme

#Can be cross-listed with Soil Science;

@Can be cross-listed with Biotechnology

**Minor Departments** **9**

Plant Molecular Biology and Biotechnology

Biochemistry

Soil Science

Plant Pathology

Entomology

**Supporting Deparments** **5**

Statistics and Mathematics

Plant Molecular Biology and Biotechnology

Biochemistry

Soil Science

Plant Pathology

Entomology

**Non credit compulsory courses**

| CODE | COURSE TITLE | CREDITS |
|---|---|---|
| PGS 501 | LIBRARY AND INFORMATION SERVICES | 0+1 |
| PGS 502 | TECHNICAL WRITING AND COMMUNICATION SKILLS | 0+1 |
| PGS 503 (e-course) | INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE | 1+0 |
| PGS 504 | BASIC CONCEPTS IN LABORATORY TECHNIQUES | 0+1 |
| PGS 505 (e-course) | AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES | 1+0 |
| PGS 506 (e-course) | DISASTER MANAGEMENT | 1+0 |

**MICRO 501 PRINCIPLES OF MICROBIOLOGY 3+1**

**Objective**

To teach the students about basics in development of microbiology, differences in prokaryotes and eukaryotic cell and classification of prokaryotes.

**Theory**

**UNIT I**

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

**UNIT II**

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

**UNIT III**

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tenericutes and Mendosicutes.

**UNIT IV**

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans and animals.

**Practical**

Preparation of different media, evaluation of different sterilization methods, isolation of microorganisms from air, water, milk, food and soil. Purification and maintenance of microorganisms isolated from water, milk, food, soil and air. Enrichment culture technique, Isolation of nitrogen fixing bacteria, photosynthetic bacteria. Use of selective media for isolation of auxotrophs and antibiotic producing microorganisms. Morphological characterization of bacteria. Biochemical tests for identification of bacteria.

**Suggested Readings**

Brock TD. 1961. *Milestones in Microbiology*. Infinity Books.

Pelczar MJ, Chan ECS & Kreig NR. 1997. *Microbiology: Concepts and Application*. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. *General Microbiology*. MacMillan.

Tauro P, Kapoor KK & Yadav KS. 1996. *Introduction to Microbiology*. Wiley Eastern.

**MICRO 502 MICROBIAL PHYSIOLOGY AND METABOLISM 3+1**

**(Pre-requisite Micro 501)**

**Objective**

To teach students about cell cycle, growth and practical training on methods to determine microbial growth.

**Theory**

**UNIT I**

Structure, function, biosynthesis and assembly of various cellular components of prokaryotes. Archea and fungi. Transport of solutes across the membrane.

**UNIT II**

Microbial growth. Cell cycle and cell division. EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism. Biosynthesis of macromolecules. Regulation of microbial metabolism.

**UNIT III**

Effect of chemicals and other environmental factors on growth. Morphogenesis and cellular differentiation.

**UNIT IV**

Important metabolic patterns in photoautotrophs, photoheterotrophs, chemoautotrophs and chemoheterotrophs.

**Practical**

Use of simple techniques in laboratory (Colorimetry, Centrifugation, Electrophoresis and GLC), Determination of viable and total number of cells, Measurement of cell size, Gross cellular composition of microbial cell, Growth – Factors affecting growth, Sporulation and spore germination in bacteria. Protoplasts formation. Induction and repression of enzymes.

**Suggested Readings**

Doelle HW. 1969. *Bacterial Metabolism.* Academic Press.

Gottschalk G. 1979. *Bacterial Metabolism.* Springer Verlag.

Moat AG. 1979. *Microbial Physiology*. John Wiley & Sons.

Sokatch JR. 1969. *Bacterial Physiology and Metabolism.* Academic Press.

**MICRO 503 MICROBIAL GENETICS 2+1**

**(Pre-requisite Micro 501)**

**Objective**

To acquaint the learners regarding molecular concepts of bacteria and viruses and impact of gene cloning on human welfare.

**Theory**

**UNIT I**

Prokaryotic, eukaryotic and viral genome. Replication of Eukaryotic, Prokaryotic and Viral DNA. Structure, classification and replication of plasmids.

**UNIT II**

Molecular basis of mutation. Biochemical genetics and gene mapping by recombination and complementation. Fine gene structure analysis. Fungal genetics.

**UNIT III**

Gene transfer in bacteria through transformation, conjugation and transduction; gene mapping by these processes. Transposable elements.

**UNIT IV**

Gene cloning and gene sequencing. Impact of gene cloning on human welfare. Regulation of gene expression. Recent advances in DNA repair and mutagenesis, Genetic basis of Cancer and cell death.

**Practical**

Inactivation of microorganisms by different mutagens. Production, isolation and characterization of mutants. Determination of mutation rate. Isolation, characterization and curing of plasmids. Transfer of plasmid by conjugation, electroporation. Tetrad and random spore analysis.

**Suggested Readings**

Birge EA. 1981. *Bacterial and Bacteriophage Genetics*. Springer Verlag.

Gardner JE, Simmons MJ & Snustad DP. 1991. *Principles of Genetics*.

John Wiley& Sons.

Lewin B.1999. *Gene*. Vols. VI-IX. John Wiley & Sons.

Maloy A & Friedfelder D. 1994. *Microbial Genetics*. Narosa.

Scaife J, Leach D & Galizzi A 1985. *Genetics of Bacteria*. Academic Press.

William Hayes 1981. *Genetics of Bacteria*. Academic Press.

**MICRO 504 SOIL MICROBIOLOGY 2+1**

**Objective**

Objective of this course is to teach students regarding basics of microbiology related to soil including biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.

**Theory**

**UNIT I**

Soil biota, Soil microbial ecology, types of organisms in different soils; Soil microbial biomass; Microbial interactions: unculturable soil biota.

**UNIT II**

Microbiology and biochemistry of root-soil interface; phyllosphere, Biofertilizers, soil enzyme activities and their importance.

**UNIT III**

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and antimicrobials. Biochemical composition and biodegradation of soil organic matter and crop residues.

**UNIT IV**

Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development.

**Practical**

Determination of soil microbial population; Soil microbial biomass; Decomposition studies in soil, Soil enzymes; Measurement of important soil microbial processes such as ammonification, nitrification. $N_2$ fixation, S oxidation, P solubilization and mineralization of other micro nutrients; Study of rhizosphere effect.

**Suggested Readings**

Martin Alexander 1977. *Soil Microbiology*. John Wiley.

Paul EA. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd Ed. Academic Press.

Sylvia *et al.* 2005. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Edu.van

Elsas JD, Trevors JT & Wellington EMH. 1997. *Modern Soil Microbiology*. Marcel Dekker.

**MICRO 505 MICROBIAL BIOTECHNOLOGY 2+1**

**(Pre-requisite Micro 501)**

**Objective**

To teach students about industrially useful microorganisms and use of fermentor for the production of various primary and secondary metabolites.

**Theory**

**UNIT I**

Introduction, scope and historical development; Isolation, screening and genetic improvement of industrially important microorganisms.

**UNIT II**

Types of fermentation systems; production of various primary and secondary metabolities, e.g. amino acids, organic acids, alcohols, enzymes, organic solvents, antibiotics, etc.

**UNIT III**

Process scale up steps: laboratory, pilot plant and industrial scales. Down stream processing; Over-production of metabolities; Bioreactor operations, process control.

**UNIT IV**

Fermented beverages; Production of single cell protein; Steroid transformation; Immobilization of cells/enzymes; Silage production; Waste water treatment.

**UNIT V**

Use of genetically-engineered microorganisms in biotechnology; Bioinsecticides, biofertilizers, etc. Microbiologically-produced food colours and flavours. Retting of flax.

**Practical**

Isolation and Maintenance of industrially important microorganisms, Improvement of industrially important microorganisms, Production of (industrial compounds such as) alcohol, beer, wine,

citric acid and lactic acid and recovery, Study of types of bio-reactors and their operation , Production of bacterial biofertilizers:, Production of algal biofertilizer, Visit to Biofertilizer industries

**Suggested Readings**

Cruger W & Cruger A. 2004. *Biotechnology - A Textbook of Industrial Microbiology*. 2nd Ed. Panima.

Ward OP. 1989. *Fermentation Biotechnology*. Prentice Hall.

Wiseman A. 1983. *Principles of Biotechnology.* Chapman & Hall.

**MICRO 506 FOOD AND DAIRY MICROBIOLOGY 2+1**

**(Pre-requisite, Micro 501)**

**Objective**

To familiarize the students with recent advances in food microbiology including fermented foods, dairy, food preservation, detection of foodborne diseases, their control measures.

**Theory**

**UNIT I**

Introduction and scope; Food Microbiology – A many faceted science; Interrelationship of food microbiology with other sciences; Perspectives on food safety and Food Biotechnology.

**UNIT II**

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, fruits, vegetables and their products; Food poisoning and food-borne pathogenic bacteria.

**UNIT III**

Food fermentation; Fermented dairy, vegetable, meat products; Preservatives and preservation methods – physical methods, chemical preservatives and natural antimicrobial compounds. Bacteriocins and their applications; Biologically based preservation systems and probiotic bacteria.

**UNIT IV**

Advanced techniques in detecting food-borne pathogens and toxins. Hurdle technology and Hazard analysis. Critical control point systems in controlling microbiological hazards in foods.

**Practical**

Statutory, recommended and supplementary tests for microbiological analysis of Baby foods, Microbiological analysis of canned foods, Microbiological analysis milk and dairy products, Microbiological analysis of eggs and meat, Microbiological analysis of vegetables, fruits and cereals, Microbiological analysis of surfaces and containers in a food processing unit and environment in a food processing area, Microbiological analysis of water, Visit to Food & Dairy industry

**Suggested Readings**

Bibek Ray.1996. *Fundamentals of Food Microbiology*. CRC Press.

Frazier WC & Westhoff DC. 1991. *Food Microbiology*. 3rd Ed. Tata McGraw Hill.

George J Banwart. 1989. Basic Food Microbiology. AVI.

James M Jay. 1987. Modern Food Microbiology. CBS.

Peppler HJ & Perlman D.1979. *Microbial Technology*. 2nd Ed. Academic Press.

**MICRO 507 BACTERIOPHAGES 1+1**

**Objective**

To familiarize students about phages and phage- bacterial interactions.

**Theory**

**UNIT I**

Historical developments and classification of bacteriophages.

**UNIT II**

Physiology, biochemistry, enzymology and molecular biology of phagebacterial interactions.

**UNIT III**

Structure, functions and life cycles of different DNA, RNA, lytic and lysogenic phages.

**UNIT IV**

Phages in the development of molecular biology and genetic engineering.

**Practical**

Titration of phages and bacteria Absorption of phages, Preparation of phage stocks, Isolation of new phages and phage resistant bacteria, One step growth curve, phage bursts, Induction of lambda. Complementation of T4 *rII* mutants etc.

**Suggested Readings**

Birge EA. 2000. *Bacterial and Bacteriophage Genetics.* Springer-Verlag.

Mathew CK. 1972. *Bacteriophage Biochemistry*. Am. Chemical Soc.

Mathew CK, Kutter EM, Mosig G & Berget P. 1988. *Bacteriophage T4*. Plenum Press.

Nancy T & Trempy J. 2004. *Fundamental Bacterial Genetics*. Blackwell.

Stent SG. 1963. *Molecular Biology of Bacterial Viruses*. WH Freeman.

Winkler J, Ruger W & Wackernagel W. 1979. *Bacterial, Phage and Molecular Genetics - An Experimental Course.* Narosa.

Winkler U & Ruhr W. 1984. *Bacteria, Phage and Molecular Genetics*. ALA.

**MICRO 508 ENVIRONMENTAL MICROBIOLOGY 2+1**
**(Pre-requisite Micro 502)**

**Objective**

To teach and create awareness regarding environment, water, soil, air pollution and bioremediation.

**Theory**

**UNIT I**

Scope of environmental microbiology. An overview of microbial niches in global environment and microbial activities. Microbiology of air, outdoor and indoor environment in relation to human, animal and plant health and economic activities.

**UNIT II**

Microbiology of natural waters. Environmental pollution – Deleterious and beneficial role of microorganisms. Environmental microbiology in public health. Microorganism in extreme environments, Environmental determinants that govern extreme environment- Air water interface, extreme of pH, Temperature, Salinity, Hydrostatic pressure.

**UNIT III**

Microbial technology in pollution abatement, waste management and resource recovery in metal, petroleum and bioenergy fields. Biofuels. Global environmental problems

**UNIT IV**

Microbial upgradation of fossil fuels and coal gas. Microbial interaction in rumen and gastrointestinal tract. Biodeterioration and Bioremediation. Biodegradation and xenobiotic compounds

**Practical**

Analysis of natural waters, waste waters and organic waste in relation to water pollution assessment, pollution strength and resource quantification; Quality control tests, waste treatment and anaerobic digestion; Demonstration of waste water treatment processes such as activated sludge processes, biofilter and fluidized bed process. Visit to water / effluent treatment plants

**Suggested Readings**

Campbell R. 1983. *Microbial Ecology*. Blackwell.

Hawker LE & Linton AH. 1989. *Microorganisms Function, Form and*

*Environment*. 2nd Ed. Edward Arnold.

Mitchell R. 1992. *Environmental Microbiology*. John Wiley & Sons.

Richards BN. 1987. *Microbes of Terrestrial Ecosystem*. Longman.

**MICRO 509 PLANT- MICROBE INTERACTIONS 3+0**

(Open for: Microbiology, Biotechnology & Molecular Biology, Genetics, Pl. Physiology, Biochemistry, Plant Breeding & Plant Pathology students; Pre-requisite Micro503/Equiv., Micro 504)

**Objective**

To familiarize the students with the biochemical and biophysical mechanisms, genetics, genomics, proteomics and advanced microscopy, spectroscopy of different interfaces of beneficial and pathogenic plant microbe interactions. Molecular analysis of relevant factors in the plant and microbes, and components that modulate plant-microbe interactions for soil and plant health for sustaining crop productivity.

**Theory**

**UNIT I**

Different interfaces of interactions - Plant-microbe, microbe-microbe, soil - microbe, soil-plant-microbe interactions leading to symbiotic (rhizobial and mycorrhizal), associative, endophytic and pathogenic interactions. Types of ecosystems: Concept and dynamics of ecosystem, Food chain and energy flow, Microbial communities in the soil. Community dynamics and population interactions employing DGGE, TGGE, T-RFLP.

**UNIT II**

Quorum-sensing in bacteria, flow of signals in response to different carbon or other substrates and how signals are recognized.

**UNIT III**

Methodology/resources to study plant-microbe interaction, recombinant inbred lines, biosensors, transcriptome profiling, metabolic profiling, genomics, proteomics and advanced microscopy, spectroscopy of different interfaces.

**UNIT IV**

Plant and microbial gene expression and signal exchange, global and specific regulators for different interactions. Molecular diversity of microbes, plants and their interactions including transgenic microbes and plants.

**Suggested Readings**

Kosuge T & Nester EW. 1989. *Plant-Microbe Interactions: Molecular and Genetic Perspectives*. Vols I-IV. McGraw Hill.

Verma DPS & Kohn TH. 1984. *Genes Involved in Microbe-Plant Interactions.* Springer Verlag.

*Molecular Plant-Microbe Interactions*. Journal Published by APS.

**MICRO 510 INDUSTRIAL MICROBIOLOGY 2+1**

(Open for: Microbiology, Biotechnology, Biochemistry, Soil Science, Agronomy, Plant Pathology, Horticulture students; prerequisite Micro 504, Micro 506)

**Objective**

To expose the students to the commercial exploitation of microorganisms for production of useful products. Focus will be on understanding of the techniques involved and the application of microorganisms for agribusiness purpose.

**Theory**

**UNIT I**

Biofermentor; Production of wine, beer, lactic acid, acetic acid (vinegar), citric acid, antibiotics, enzymes, vitamins and single cell proteins. Biofuels: Production of ethanol, biogas and hydrogen production.

**UNIT II**

Brief introduction to bacterial, fungal and insect diseases, Types of chemicals/pesticides used for disease control. Vaccines. Bioagents and Biopesticides Biocontrol agents and their scope in control of plant diseases, nematodes and insect pests.

**UNIT III**

Bioplastics and biopolymers: Microorganisms involved in synthesis of biodegradable plastics, other pigments, Biosensors: Development of biosensors to detect food contamination and environment pollution.

**UNIT IV**

Biofertilizers, Genetic engineering of microbes for enhanced pesticide degradation Mechanisms of pesticide degradation by microbes. Biomining: Coal, mineral and gas formation, prospecting for deposits of crude, oil and gas, recovery of minerals from low-grade ores.

**Practical**

Production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery. Detection of food-borne pathogens, pesticide degradation, Demonstration of biogas production, Production of biocontrol agents, Visit to industries

**Suggested Readings**


Alexander M. 1977. *Soil Microbiology*. John Wiley.

Hawker LE & Linton AH. 1989. *Microorganisms Function, Form and*

*Environment*. 2nd Ed. Edward Arnold.

James M Jaq 1987. *Modern Food Microbiology*. CBS.

Paul EA. 2007. *Soil Microbiology, Ecology and Biochemistry*. 3rd Ed Academic Press.

Stanbury PF & Whitaker A. 1987. *Principles of Fermentation Technology.* Pergamon Press.

Sylvia DM, Fuhrmann JJ, Hartlly PT & Zuberer D. 2005. *Principles and Applications of Soil Microbiology*. 2nd Ed. Pearson Prentice Hall Edu.


**MICRO 511 BIOFERTILIZER TECHNOLOGY 1+1**

**Objective**

To familiarize the students and farmers with mass scale production of different agriculturally important microorganisms which are being used as biofertilizers for maintaining the soil and plant health for sustaining crop productivity and their importance in organic farming.

**Theory**

**UNIT I**

Different agriculturally important beneficial microorganisms – free living, symbiotic (rhizobial, actinorhizal), associative and endophytic nitrogen fixers including cyanobacteria, taxonomic
classification, nodule formation, competitiveness and quantification of $N_2$ fixed.

**UNIT II**

Different agriculturally important beneficial microorganisms – phosphate solubilizing bacteria and fungi, including mycorrhiza.

**UNIT III**

Different agriculturally important beneficial microorganisms – plant growth promoting rhizobacteria.

**UNIT IV**

Different agriculturally important beneficial microorganisms – Biocontrol microbial inoculants.

**UNIT V**

Different agriculturally important beneficial microorganisms for recycling of organic waste and compositing, bioremediators and other related microbes.

**UNIT VI**

Different agriculturally important beneficial microorganisms - selection, establishment, competitiveness, crop productivity, soil & plant health, mass scale production and quality control of bio inoculants. Biofertilizer inoculation and microbial communities in the soil.

**Practical**

Isolations of symbiotic, asymbiotic, associative nitrogen fixating bacteria, Development and production of efficient microorganisms, Determination of beneficial properties in important bacteria to be used as biofertilizer, Nitrogen fixing activity, indole acetic acid (IAA), siderophore production etc, Bioinoculant production and quality control, Visit to industty

**Suggested Readings**

Alexander M. 1977. *Soil Microbiology*. John Wiley.

Bergerson FJ. 1980. *Methods for Evaluating Biological Nitrogen Fixation.*

John Wiley & Sons.

Sylvia DM, Fuhrmann JJ, Hartlly PT & Zuberer D. 2005. *Principles and Applications of Soil Microbiology.* 2nd Ed. Pearson Prentice Hall Edu.

van Elsas JD, Trevors JT & Wellington EMH. 1997. *Modern Soil Microbiology*. CRC Press.

**MICRO 512 CYANOBACTERIAL AND ALGAL BIOTECHN0OLOGY 2+0**

**Objective**

To teach students about this upcoming fascinating field of microbes developed at a faster pace, mainly due to photoautotrophic nature of Cyanobacteria, their ability to survive under a variety of habitats and wide diversity of thallus structure and functions. Their importance for mankind is enormous including their role as biofertilizers, nutraceuticals, experimental models, dyes, biofuels and a variety of biochemicals. regarding structure, molecular evolution and properties of cyanobacteria and algae

**Theory**

**UNIT I**

*Introduction to Cyanobacteria and algae*. Definition, occurrence and distribution, thallus structure, reproduction, life cycles, origin and evolution of Cyanobacteria, molecular evolution; role of algae in evolution of land plants and horizontal transfer of genes**.**

**UNIT II**

Algal pigments, storage products, carbon metabolism, photosynthesis. Algal culturing and cultivation. Culture types, culture conditions, culture vessels, culture media, sterilization,

culture methods, synchronous cultures, photobioreactors, algal density and growth, seaweed cultivation.

**UNIT III**

Cyanobacterial and algal fuels, Fine chemicals (restriction enzymes etc) and nutraceuticals from algae; UV absorbing pigments Industrial products from macro algae - seaweed biotechnology, sustainable aquaculture.

Ecology of algae- distribution in soil and water; primary colonizers, carbon sequestration and cycling in soil and water. Cellular differentiation and nitrogen fixation, nitrogen metabolism.

**UNIT IV**

Algae in pollution - as pollution indicators, eutrophication agents and role in Bioremediation. Cyanobacterial and algal toxins, allelopathic interactions, Algae in global warming and environmental sustainability. Cyanobacteria and selected microalgae in agriculture – biofertilizers & algalization; soil conditioners; reclamation of problem soils.

**Suggested Readings**

Ahluwalia AS. 2003. *Phycology: Principles, Processes and Applications*. Daya Publ.

Barsanti L & Gualtieri P. 2006. *Algae: Anatomy, Biochemistry and Biotechnology*.

Taylor & Francis, CRC Press.

Carr NG & Whitton BA. 1982. *The Biology of Cyanobacteria*. Blackwell.

Herrero A & Flores E. 2008. *The Cyanobacteria Molecular Biology,*

*Genomics and Evolution*. Calster Academic Press

Kumar HD. 2005. *Introductory Phycology.* East West Press.

Linda E Graham & Lee W Wilcox. 2000. *Algae*. Prentice Hall.

Robert A Andersen. 2005. *Algal Culturing Techniques.* Academic Press.

Venkataraman LV & Becker EW. 1985. *Biotechnology and Utilization of Algae: the Indian Experience*. DST.

**MICRO 601 ADVANCES IN FERMENTATION 2+1**

**Objective**

To teach students regarding fermentation industry using industrially useful microorganisms including yeast technology.

**Theory**

**UNIT I**

An overview of fermentation - current status of fermentation industry. Fermentor design, high performance bioreactors, mass and energy transfer in bioreactors. Instrumentation and control in fermentors – on line measurements systems, computer application.

**UNIT II**

Media for microbial fermentation; Criteria in media formulation. An overview of downstream processing.

**UNIT III**

New strategies for isolation of industrially important microbes and their genetic manipulations; Microbial production of health care products. Antibiotic fermentation research; steroid transformation.

**UNIT IV**

Recent developments on production of primary and secondary metabolites, Treatment of biological wastes, microbial inoculants and enzymes for waste treatment.

**UNIT V**

Yeast technology – classification, genetics, strain improvement for brewing, baking and distilleries and topics of current interest in fermentations.

**Practical**

Industrially important microbes and their genetic manipulations, Fermentation by improved strains of yeast for production of alcohol and beer, Microbial production of important antibiotics, enzymes and organic acids, Bioremediation of industrial effluents

**Suggested Readings**

Peppler HJ & Perlman D. 1979. *Microbial Technology*. 2nd Ed. Academic Press.

Reed G. 1987. *Presscott & Dunn's Industrial Microbiology.* 4th Ed. CBS.

Stanbury PF & Whitaker A. 1987. *Principles of Fermentation Technology*. Pergamon Press.

Wiseman A. 1983. *Principles of Biotechnology.* Chapman & Hall.

**MICRO 602 ADVANCED MICROBIAL PHYSIOLOGY 2+0**

**(Pre-requisite Micro 502)**

**Objective**

To acquaint students with current topics in molecular microbiology

**Theory**

**UNIT I**

Origin, evolution, structure, function and molecular aspects of various cell components.

**UNIT II**

Differentiation in bacteria, slime molds, yeasts.

**UNIT III**

Molecular biology of bioluminescence, bacterial virulence. Heat shock response. Extracellular protein secretion in bacteria.

**UNIT IV**

Topics of current interest in molecular microbiology.

**Suggested Readings**

Selected articles from journals.

**MICRO 603 REGULATION OF MICROBIAL BIOSYNTHESIS 2+0**
**(Pre-requisite Micro 502, Micro 503)**

**Objective**

Course imparts thorough knowledge about the synthesis of biomolecules in microorganisms by various pathways and their regulation.

**Theory**

**UNIT I**

Regulation of initiation, termination and anti-termination of transcription. Global regulation and differentiation by sigma factor. Regulatory controls in bacteria - inducible and biosynthetic pathways.

**UNIT II**

Ribosomal RNA and ribosomal proteins regulation under stress condition. Specific regulatory systems; SOS regulatory control; Antisense RNA regulation of gene expression.

**UNIT III**

Oxidative stress control. Fermentative and respiratory regulatory pathways. Regulation of cell cycle. Lytic and lysogenic cascade.

**UNIT IV**

Global nitrogen control and regulation of nitrogen fixation and other recent topics of regulatory systems of current interest.

**Suggested Readings**

Selected articles from journals.

**MICRO 604 CURRENT TOPICS IN SOIL MICROBIOLOGY 2+0**
**(Pre-requisite Micro 504)**

**Objective**

To make students learn the latest trends in soil microbiology like diversity, biological control and bioremediation.

**Theory**

**UNIT I**

Molecular ecology and biodiversity of soil microorganisms; Survival and dispersal of microorganisms.

**UNIT II**

Microbial successions and transformation of organic matter; Role of microorganisms in soil fertility.

**UNIT III**

Bioremediation of polluted soils; Biological control.

**UNIT IV**

Other topics of current interest.

**Suggested Readings**

Selected articles from journals.

## List of Journals

Advances in Microbial Physiology
Annual Review of Genetics/Biochemistry
Annual Review of Microbiology
Applied and Environmental Microbiology
Biology and Fertility Soils
Indian Journal of Microbiology
Journal of Bacteriology
Journal of Basic Microbiology
Microbiology and Molecular Biology Reviews
Nature/Science/EMBO Journal
Reviews in Microbiology and Biotechnology
Soil Biology and Biochemistry
Trends in Biotechnology
Trends in Microbiology
Trends in Plant Sciences

**e-Resources**

**Books**

http://www.aw-bc.com/microplace/
http://www.personal.psu.edu/jel5/micro/index.htm
http://microbiology.ucsc.edu/

**Details of sites related to Microbiology**

http://www.suite101.com/links.cfm/microbiology
http://www.microbeworld.org/resources/links.aspx
http://www.asm.org/
http://www.microbiologyiworld.com/
http://www.sciencemag.org/cgi/collection
http://www.latrobe.edu.au/microbiology/links
www.uwstout.edu/lib/subjects/microbi
http://www.aemtek.com

**Journal related to Microbiology**

http://www.fems-microbiology.org/website/nl/default.asp

http://www.blackwellpublishing.com/journal

http://www.springer.com/

http://www.e-journals.org/microbiology/

http://pubs.nrc-cnrc.gc.ca/

http://www.elsevier.com/

http://www.academicjournals.org/ajmr/

http://www.horizonpress.com/gateway/journals.html

http://www.scielo.br/bjm

http://www.jmb.or.kr/

**Latest in microbiology- Microbiology News**

http://microbiologybytes.wordpress.com/

http://www.topix.net/science/microbiolog

**Suggested Broad Topics for Master's and Doctoral Research**

**Molecular Microbiology**

Microbial diversity

Meta genomics

Improvement of beneficial microorganisms

**(Nitrogen fixers, Phosphate solubilizers etc.)**

**Environmental Microbiology**

Biocontrol

PGPR, Termite control, Pathogenic fungi control

**Biofuels**

Biogas, alcohol production

**Bioremediation**

Waste management, Bioremediation of industrial effluents and

**agrochemicals**

Composting

**Microbial Biotechnology**

Biofertilizers

(Nitrogen fixers, Phosphate solubilizers, PGPR, BGA, composting etc)

Secondary metabolites including industrially important enzymes, amino acids

Citric acid and lactic acid fermentations

**Food Microbiology**

Improvenment and industrial exploitation of microorganisms

Fermented foods