SEMESTER III

Paper 9: Environmental Microbiology (GMMB-301)

Course Objectives

On the completion of this course the students will be able to describe following subject matters:

1. Natural resources: Renewable and non-renewable resources: Forest resources; Water resources; Mineral resources; Food resources; Energy resource
2. Air pollution;Water pollution; Noise pollution; Waste Water treatment; Thermal Pollution; Marine pollution; Soil pollution, ; Global warming; Acid Rain; Ozone layer depletion
3. Microbiology of air – Sources of microorganisms in air
4. Ecosystems – Fresh water (ponds, Lakes, Streams, Marine, Esturies, Mangrooves, Deep sea).
5. After completion of this course students will learn about the application of biotechnology and microbiology in the environment and living system.

Course Contents

Unit I

Principles and concepts of Environmental Microbiology and its role in conservation and management of Natural Resources. Soil principles and properties – soil formation, texture, composition, characteristics, number and biomass of microbes in soil, terrestrial carbon cycles, soil fertility. Decomposition of organic matter – litter chemistry, carbon assimilation and immobilization, dynamics of organic matter (microbial succession), accumulated soil enzymes and their role in soil development. Bioremediation of polluted soils/sites – Degradation of xenobiotics with special reference to pesticides. Genetically Engineered Microorganisms (GEMs) in bioremediation. Microbial leaching and biomining(copper and uranium) - Dump, heap and agitated leaching, chemistry and microbiology of bioleaching, Biomining (ex situ and in stiu (hole-to-hole leaching), plasmids and genes in biomining.

Unit II

Biomonitoring of the aquatic environment – Biological indicators, Biosensors, Genosensors – Pollution indices (Odum, Nygaard, Palmer, Margalef, Kothe)-Selfpurification of aquatic systems – Oligotrophic,mesotrophic and eutrophic status.

Waste water treatment through aerobic micro-organisms – Biological filters, aeration tanks, Bological ponds, Irrigation fields (biofilms).

Waste water treatment through anaerobic microorganisms – Septic tanks, imhof's tank, upflow anaerobic sludge blanket (UASB), anaerobic filters, anaerobic attachment film expanded bed (AAFEB), anaerobic rotating biological contractor and sequential batch reactors.

Pollution control Biotechnology – Commercial blends of microoranisms and enzymes, immobilized cells and enzymes, biotechnological approaches for recovery of useful products from sewage and industrial wastes.

Unit III

Historical introduction – Nomenclature of atmospheric layers, microbes as source and sink of atmospheric pollutants, pollutant transformation by microbes. Air sampling techniques – The impactors : slit sampler, cascade impactor, hirst trap, anderson sampler, rotorod, vertical cylinder trap, burkard trap.The impingers: porton impinger and pre-impinger.

Air quality in Indian cities – mapping of the hot spots, air quality monitoring and measurement, impact of air-borne microorganisms on living beings – Allergy: immediate type of hyper sensitivity, atopic allergy, delayed type of hypersensitivity.

Emission control technology – typical cyclones, industrial fabric filters,electrostatic precipitators, liquid scrubbers, gravity settling chambers, special multifan units.

Air sanitation – Control of air borne pathogens – irradiation, chemical disinfection, dust control. Biotechnological methods for the abatement of environmental bio-pollution.

Unit IV

Environment and Bioenergy – Energy production and consumption, energy planning and conservation strategies – Maintenance and managemental practices.

Lignocellulosic material as bioenergy source – Biodelignification- Role of lignolytic and xylanolytic enzymes, separation of cellulose, development of cellulase minus mutants- Biobleaching and bio-pulping.

Bioethanol in social and scientific perspective –Alternate/renewable energy source - Bioetahnol vs. food crisis; Bioethanol vs. climate change, advantages and disadvantages. Biogas (Methane) – Biogas plant design, construction, process microbiology, production and applications. Methane vs. Green house effect.Hydrogen – production process of hydrogen from biomass, thermal gasification, pyrolysis, microbial conversions-Biotechnological production of hydrogen to reverse global warming.

Recommended Books

1. Alexander M. Soil Microbiology
2. Anil Prakash (Ed.) Fungi in Biotechnology
3. Atlas & Batra Microbial Ecology
4. Benjamin Cunnings Microbial Ecology
5. Burns R.G & J.H.Slater Experimental Microbial Ecology -
6. Gabriel Bitton Wastewater Microbiology
7. Gilbert S. Omen Environmental Biotechnology
8. Gray T.R.G.&S.T.Williams Soil Microorganisms
9. Gregory P.H. The Microbiology of Atmosphere
10. Lautit M.W&C.M.Eds.Keuin Microbial Ecology Proc.
11. Lynch J.M The Rhizosrphere
12. Lynch J.M and N.J. Poole Microbial Ecology: A conceptual approach
13. Michael S.Switzenbaury(Ed) Anaerobic Treatment of Sewage
14. Mishra R.R Soil Microbiology
15. Odum E.P. Fundamentals of Ecology
16. Omenn G.S.& M. Alexander Genetic control of Environmental Pollutants
17. Ralph Mitchell Environmental Microbiology
18. Ratledge C. Biochemistry of Microbial degradation
19. Spani J.C. Biodeterioration of non-aromatic compounds
20. Subba Rao N.S. Soil Microbiology
21. Thomas D. Brook Thermophiles
22. Tilak S.T Environmental Biopollution
23. Williams G.C Biofilms

Paper 10: Biostatistics & Bioinformatics (GMMB -302)

Course Objectives

(i) After the competition of the course, the student will have a basic understanding on the type and management of biostatistical data.
(ii) The student will understand how to analyze bio-statistical data, and its real-life examples in Biological Sciences
(iii) The student will understand the basics of bioinformatics, various databases that can be used to analyze computational data and how to organize the database.
(iv) The student will learn the use of bioinformatics tools in protein-biology and its association with in-vivo techniques.
(v) The student will learn how to use bioinformatics databases to solve proteomics and genomics problems.

Course Content:

UNIT-I

Bioinformatics: definition, concept, scope, relevance of bioinformatics, development of bioinformatics, applications of bioinformatics. Genomics, proteomics, operating systems (Linux) and programming languages (Perl, CORBA) in bioinformatics.

Databases: Gene banks, objectives, types of databases- flat files, relational databases, objective oriented databases, hypertext databases, web interfaces ; Resource databases- Generalized (DNA, protein) and specialized databases. Search tools: Data mining, BLAST and FASTA. Sequence analysis of biological data: terminology, methods for alignment- pairwise & multiple sequence alignments, algorithm for alignment of sequencing fragments

UNIT-II

Phylogenetic analysis: Concept of phylogenetic trees, phylogenetic trees and multiple alignment methods - distance matrix, character based evaluation of methods, evaluation of phylogenies, steps in constructing alignments and phylogenies, working with phylogeny trees- with suitable software-EMBOSS

Gene prediction: Approaches and methods, tools- GRAIL, GenLang, BCM GeneFinder, Procrutes, GeneParser. Prediction of protein structure- Methods for structure prediction for known and unknown folds, prediction of protein function.
Genomics: Gene mapping, sequence assembly and gene expression, DNA microarrays, microarray design and data analysis.
Proteomics: Definition, proteome analysis; tools for proteome analysis, protein-protein interactions; metabolic and genetic networks, concept of E- cell.

UNIT-III

Biostatistics: definition, scope, applications in biology, terminology; sampling techniques- random and non-random methods.
Measures of central tendencies - Mean, mode, median, standard errors and standard deviations.
Probability - concepts, terminology, kinds of probabilities, theorems of probability, normal, binomial and poisson distribution. Skewness and kurtosis.
Chi Square test- characteristics, degrees of freedom, test of goodness of fit, null hypothesis.

UNIT-IV

Analysis of variance (ANOVA): Methods of ANOVA, one way and two way classifications, F-test, steps involved in ANOVA, importance of ANOVA.
Correlation: Definition, methods of studying the correlation, scatter diagram, Karl
Pearson's efficient of correlation and rank correlation methods, types of correlations.
Regression: Definition, types of regression analysis, regression equation, methods of studying regression, graphic and algebraic methods, importance of regression. Importance of statistical software in data analysis.

Recommended Books

1. Andreas D. Baxevanis, B.F. Francis Ouellette.2004Bioinformatics A practical guide to the analysis of genes and proteins,
2. Attwood, T.K. and D.J Parry-Smith.Introduction to Bioinformatics
3. Bishop, M. J.and C.J.Rawlings Nucleic acid and protein sequence analysis-A practical approach
4. Blicks, C.K 1967 Statistics in biology vol 1 Mc Graw Hill, New York
5. Brown, T.A Genomes John Wiley & Sons Asia Pte. Ltd. 1999
6. Campbell RC 1974 Statistics for Biologists Cambridge university press
7. Chritine Orengo, David Jones, Janet Thornton.Bioinformatics: genes, proteins and computers

Paper 11: Industrial & Food Microbiology (GMMB -303)

Course Objectives

At the end of this course the students will be able to describe:
• Biofuels: Biogas, Ethanol, butanol,hydrogen, biodiesel, microbial electricity, starch conversion Microbial insecticides; microbial flavours and fragrances, newer antibiotics,anti-cancer agents
• cell immobilization, Metabolic engineering, Secondary metabolism
• fermentation, batch and continuous culture, scale up production in the industry
• bioprocess technology

Course Content:

Unit- I

Isolation, Screening, Improvement and maintenance of industrial organisms, Fermenter design and instrumentation, immobilized cell reactor, solid state fermentation (SSF), substrates for industrial fermentation.
Fermentation System: Primary and secondary metabolites, batch, fed batch and continuous fermentation system, fermentation kinetics, chemostat, turbidostat, gas exchange and mass transfer.

Unit -II

Downstream processing (DSP) and product recovery, Production of Biofertilizers, Biopesticides, Edible Mushroom, Single Cell Protein (SCP), steroid conversion and biotransformation.

Unit -III

Microbes important in food microbiology, factors influencing food spoilage (intrinsic and extrinsic), Food poisoning and food borne infections, detection of microbial contamination of foods : Direct microscopic count (DMC), standard plate count, MPN method, reductase tests, membrane filters and molecular methods General principles of food preservation- Physical and Chemical methods.
Dairy microbiology: Normal flora of milk and milk products, Spoilage of milk and milk

products. Fermented milk products: acidophilus milk, bifidus milk ,yoghurt manufacture of cheese, Fermented beverages (fruit and cereal based) and fermented meat and meat products.

Unit – IV

Yeasts fermentation and a yeast products: Production of active dry bakers yeast, instant yeast, quality of bakers yeast, production of brewer's yeast, wine yeast food and fodders yeast. Biotechnological applications of microbes in the commercial production of alcoholic beverages, organic acids, microbial enzymes: amylases, proteases and lipases, antibiotics and amino acids, Biopesticides, biofertilizers, biopolymers, Biosurfactants and vaccines. Scope, utility and methodology of biotransformation and immobilization of enzymes and cells and their applications.

Suggested Readings:

1. Stanburry et al. (2011). Principle of fermentation technology Pergamon Press.
2. Reed G (2001). Industrial Microbiology CBS Publisher.
3. Cruger&Cruger, (2005), Microbial Biotechnology, Panima Press
4. Moo-Young M, Cooney CL &Humphery AE (1985). Comprehensive Biotechnology-The Principles, Applications & Regulations of Biotechnology in Industry, Agriculture & Medicine, Pergamon Press
5. Atlas RM, Park LC & Brown AL (1995).Laboratory Manual of Experimental Microbiology. Mosby-YearBook,Inc.,Missouri

ELECTIVE PAPER (ANY ONE)

Paper 12: Microbial Proteomics (GMMB -304)

Course Objectives

(i) After the competition of the course, the student will have a basic understanding on the type and management of biostatistical data.
(ii) The student will understand how to analyze bio-statistical data, and its real-life examples in Biological Sciences
(iii) The student will understand the basics of bioinformatics, various databases that can be used to analyze computational data and how to organize the database.
(iv) The student will learn the use of bioinformatics tools in protein-biology and its association with in-vivo techniques.
(v) The student will learn how to use bioinformatics databases to solve proteomics and genomics problems.

Course Content:

Unit -1 Whole genome analysis

Preparation of ordered cosmid libraries, bacterial artificial chromosomal libraries, shotgun libraries and sequencing, conventional sequencing (Sanger, Maxam and Gilbert Methods), automated sequencing.

UNIT - II Sequence analysis

Computational methods, homology algorithms (BLAST) for proteins and nucleic acids, open reading frames, annotations of genes, conserved protein motifs related structure / function (PROSITE, PFAM, Profile Scan). DNA analyses for repeats (Direct and inverted), palindromes, folding programmes. Use of Internet, public domain databases for nucleic acid and protein sequences (EMBL, GeneBank), database for protein structure (PDB).

UNIT - III DNA Microarray

Printing or oligonucleotides and PCR products on glass slides, nitrocellulose paper. Whole genome analysis for Global patterns of gene expression using fluorescent-labelled cDNA or end labeled RNA probes. Analyses of single nucleotide polymorphism using DNA chips.

UNIT - IV Proteome analysis

Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by Mass Spectroscopy. Protein microarrary advantages and disadvantages of DNA and protein microarrays.

Books recommended

1. Bioinformatics. 1998 by Baxevanis
2. Bioinformatics 2000 by Higgins and Taylor OUP.
3. Nucleic acid Research 2001. Jan. Genome database issue.
4. The Internet and the new Biology: Tools for Genomics and Molecular Research by Peruski, Jr. and Peruske (ASM) 1997.
5. Functional Genomics. A Practical Approach Edited by Stephen P Hunt and Rick Liveey (OUP) 2000.
6. DNA microarrays: A practical approach edited by Mark Schena (OUP)
7. Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins. 2nd Edition by Baxevanis.
8. Bioinformatics: Sequence, structure and Data Bank: A Practical Approach by Higgis.
9. Bioinformatics - from Genomes to drug. 2 volumes by Lenganer.
10. Bioinformatic Methods and Protocols - Misener.
11. Bioinformatics: Sequence and Genome analysis.
12. Introduction to Bioinformatics by Altwood.
13. Proteome Research: New Frontiers in Functional Genomics: Principles and Practices.
14. Genomics: The Science and Technology behind the human project.
15. Protein Biotechnology. Edited by Felix Franks. Humana Press, Totowa, New Jarsey.
16. Protein Engineering: Principles and Practice by Cleland.
17. Computer analysis of sequence data by Colte.
18. Web sites for Proteomics and Genomics
Www.geneprot.com,
www.hybrigenis.com,
www.mdsproteomics.com,
www.stromix.com,
www.syrrx.com.

Paper 12: Diagnostic Microbiology & immunology (GMMB -304)

Course Objectives

1. Immunoassays, conjugation of enzymes, Homogeneous and heterogeneous enzyme immunoassays, Applications of enzyme immunoassays in diagnostic
2. Applications of PCR, RFLP, Nuclear hybridization methods
3. Rrapid diagnostic approach including technical purificationand standardization of antigen and specific antibodies
4. Familiar with various techniques like HPLC, Flowcytometry, Immunoflorescence, cell sorting etc.
5. Students will able to perform various diagnostic tests in the laboratory, which will be helpful for their future job prospective.

Course Contents

Unit 1:

Fixation of smears for Microscopy by different methods; different staining techniques: Simple (Loeffer's polychrome methylene blue and negative staining), Gram's Staining, Ziehl-Neelsen method for AFB, Fluorchrome staining, Leishman's staining, special staining methods to demonstrate granules, capsules and spores.

Unit 2:

Preparation of culture media, simple culture methods of growing different pathogenic microorganisms.
Conventional and rapid methods of isolation and identification of pathogenic bacteria, fungi. anaerobic culture method

Unit 3:

Principles of automated methods for diagnostic microbiology, isolatiuon of pure culture and preservation techniques, drug susceptibilitry testing by various methods (Precipitation method, agglutination method, ELISA method, immunodiffusion, immunoelectrophoresis, Widal Test, Haemagglutination).

Unit 4:

Separation of serum proteins by electrophoresis, separation and characterization of lymphocytes from blood, demonstration of lymphocyte sub-population.

Recommended Books

1. Ananthanarayanan R. and C.K. JayaramPanicker Orient Longman Text of Microbiology, 1997.
2. Mackie and McCartney Medical Microbiology Vol.1: Microbial Infection.
3. Vol.2: Practical Medical Microbiology Churchill Livingstone, 1996.
4. Shanson D.C., Wright PSG, Microbiology in Clinical Practice., 1982.

5. Baron EJ, Peterson LR and Finegold SM Mosby, Bailey and Scott's Diagnostic Microbiology, 1990.
6. Smith, C.G.C. "Epidemiology and Infections' (1976): Medowfief Press Ltd., Shildon, England.

Paper 12: Plant-Microbes Interaction (GMMB -304)

Course Objective

After the completion of this course, the students understand in advanced level of the diversity in plant life can be understood from the following topics of diversity: Diversity on The Basis of Habitat, plants classified into following groups students understand the geographical understanding respectfully: Hydrophytes: These plants may be: Hygrophytes: Halophytes: Mesophytes: Xerophytes: Geological time scale, theories of fossil formation, types of fossils, fossil gymnosperms. Life histories of Cycas &Pinus"

Course Content

Unit I

Significance of global nitrogen cycle. Microbiology and ecological significance of ammonification, nitrification and denitrification.

Biology of nitrogen fixation: Diversity of nitrogen fixers, mechanism of symbiotic and asymbiotic nitrogen fixation: signaling, interaction, initiation and nodule formation, genetic regulation of nitrogen fixation.

Rhizosphere – Nature, extent, influence of root exudates on microflora, plant growth promoting rhizobacteria and siderophore production. Ecology of phyllosphere microflora.

Nature and ecological significance of ectotrophic and endotrophic mycorrhizal associations- Role of microorganisms in transformation of phosphorus, sulphur and iron.

Unit II

Principles of plant pathology: entry and establishment of pathogens in plants, host and parasite interaction, role of toxins and enzymes in pathogenesis.

Disease resistance in plants – protection and defense, mechanisms of resistance (performed and induced defense, local signals, programmed cell death, induced structural barriers, phytoalexins)

Biochemical basis of disease resistance – Systemic Acquired Resistance (SAR) and Local Acquired Resistance (LAR) – Pathogenesis Related Proteins (PR proteins)-chitinases and glucanases.

Transgenic Resistance: Gene-to-gene resistance (horizontal and vertical), functions of plant resistance genes, features and classification of cloned resistance genes.

Transformation for disease resistance: Resistance to viruses, fungi, bacteria and insects, the Bt genes and the resistance to insects.

Unit III

Plant diseases – Epidemiology and plant disease forecasting- Principles, symptoms and control measures of the following diseases:

Plant diseases caused by fungi – late blight of potato, downy mildew of grapes, Loose smut of wheat, smut of bajra, covered smut of barley, blast disease of rice, red rot of sugarcane.

Plant diseases caused by bacteria – bacterial blight of paddy, angular leaf spot of cotton, common scab of potato.

Plant diseases caused by viruses – tobacco mosaic, leaf curl of tomato, yellow vein mosaic of bhindi.

Unit IV

Plant disease control – Cultural methods, Agronomic practices (crop rotation, field and crop sanitation), Chemical control (fungicides, fumigants, inorganic copper/ sulphur compounds, dithiocarbamates) - Organic agriculture and disease control.

Biological control – Principle, concepts and environmental safety– bio-pesticides (bacterial, fungal and viral).

Plant disease assessment methods – visual method in the field, scales for estimating disease intensity, yield losses, multiple point model and remote sensing techniques.

Post-harvest diseases – microbial spoilage of fruits, vegetables, stored seeds/grains,

mode of infection and factors influencing post-harvest diseases, strategies for postharvest disease control (fungicides, irradiation, fumigation and VHT - Vapour Heat Treatment).

Recommended Books

1. Agrio, G.N. Plant pathology
2. Alexander, M Soil Microbiology
3. Benjamin Cunnings, Merio pank. California 1987 Microbial ecology, fundamentals an application
4. Bilgrami,K.S. and H.C. Dube Modern Plant pathology
5. Biofertilizedrs by N.S. Subba Rao
6. Lynch J.M.Soil Biotechnology
7. Lynch Poole Microbial ecology : A conceptual approach
8. Mehrotra,R.S. Plant Pathology
9. Microbial ecology: Principles, methods & applications & Biological nitrogen fixation.
10. R.S. Singh An introduction to principles of plant pathology
11. Rangaswami, G. and A. Mahadevan Diseases of crop plants
12. Rangaswamy,G and. Bhagyaraj D.J .Agricultural Microbiology by
13. Richard, B.N. An introduction to soil ecosystem
14. Singh,R.S. Plant diseases R
15. Stolop H. Microbial ecology : Organisms, habitats, Activities
16. Subba Rao N. S Advances in Agriculture Microbiology by
17. Subba Rao, N.S. Soil microorganisms and plant growth
18. Tarr,S.A.J. Principles of plant pathology
19. Vander Plank Plant disease resistance
20. Vidyasekaran Molecular plant pathology.

List of Practical based on the theory paper (Sem-III)
GMMB LAB-301

1. Isolation of amylase producing bacteria from soil
2. Preparation of standard curve of reducing sugars by DNS method
3. Quantitative estimation of amylolytic potential of isolated bacterial culture
4. Isolation of yeasts from natural environment
5. To perform an experiment to show the Ethanol fermentation by yeast.
6. Quantitative estimation of ethanol by distillation method
7. Demonstration of surface fermentation
8. To isolate plasmid DNA from a given culture
9. To prepare agrose gel and to run the plasmid DNA samples
10. Isolation of chromosomal DNA
11. Searching Data from NCBI Database.
12. Working on EMBL.
13. Searching structural data from PDB.
14. Genome Map viewer from NCBI.
15. Database search using BLAST.
16. Sequence alignments.
17. Sequence and structure visualization

List of Practical based on the theory paper (Sem-III)
GMMB LAB-302

1. Plant DNA extraction by Phenol: Chlorophorm method
2. Demonstration of submerged fermentation
3. Demonstration of solid state fermentation
4. Whole cell immobilization of bacterial cell using calcium alginate
5. Detection of susceptibility to dental caries
6. Bacteriological examination of skin and throat.
7. Bacteriological examination of urine sample.
8. Dnase agar tests and coagulation test for identification of Staphylococcus.
9. Optochin sensitivity test and bile solubility test for Streptococcus.
10. Isolation of enteric pathogens from stool by direct plating method.

11. Antibody purification from the serum collected from immunized mice: affinity purification/chromatography.
12. Immunoelectrophoresis.
13. Demonstration of Western blotting
14. Protein estimation by Lowry's method /Bradford's method