

SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)



Syllabus of

PRE- Ph. D. COURSE IN MICROBIOLOGY

**Effective from Academic Session
2017-2018**

SYLLABUS

PRE- Ph. D. COURSE IN MICROBIOLOGY

CORE COURSE

- PMBC 101. Microbial Ecology (4 Credits)
- PMBC 102. Research Methodology and Scientific presentation (3 Credits)

OPTIONAL COURSE

- PMBE 103. Biogeochemistry and Extremophiles (9 Credits)
- PMBE 104. Plant Pathology and Pathogen Interaction
- PMBE 105. Medical Microbiology
- PMBE 106. Basic and Applied Statistics
- PMBE 107. Biochemistry and Metabolic Regulation
- PMBE 108. Biocatalyst and Enzyme Mechanisms
- PMBE 109. Genetic Engineering
- PMBE 110. Biosystematics and Ecobiology of Mushrooms

PMBC 101. MICROBIAL ECOLOGY

Unit I

Ecological principles: Distribution, Abundance, Frequency, Ecological Niche and guild. Substrate groups and nutritional strategies. Resource partitioning and successions. Biomonitoring. Ecological indicators and Biomarkers. Biomagnification. Pollution and its indicators.

Unit II

Introduction to microbial diversity. Conventional and molecular methods of studying microbial diversity.

Measures of diversity. Species richness versus Diversity Index. Unculturable and culturable bacteria.

Unit III

Aditi
21/08/17
(Dr. Aditi Grover
Bhambrni)

Keerti
21/08/17
(Dr. Keerti Singh)

mg
21/8/17
(Dr. Manoj Kohli)

Arshad
21/8/17
(Dr. Kunal Kish)

Abiotic-abiotic and abiotic-biotic interactions. Symbiosis of bacteria- protozoa, algae-invertebrates, Bacteria-plants, insect endosymbionts. Rumen microbiology. Theory of Endosymbiogenesis. Parasitism, mutualism, competition.

Unit IV

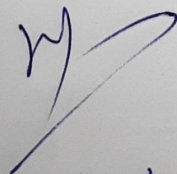
Stress and strain. Constant and fluctuating stress. Strategies to survive stress. Density dependent and density independent stresses. Life strategies: r- and K- selection. Stresses in arid soils and rocks.

Unit V

Microbial communication (e.g. quorum sensing, fruiting body formation). Biofilm formation, how biofilms work. Spatial patterning- spatial scale, biogeography. Temporal patterns, microbial community dynamics. Microbial response to disturbance, Microbial response to land use (investigating legacy effects) and Microbial response to biological invasions

Suggested Readings:

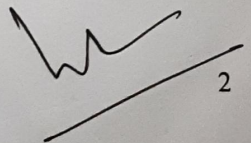
1. Odum E.P. Basic Ecology.
2. Cowld D. 1999. Microbial diversity.
3. Atlas & Bartha. Microbial Ecology.



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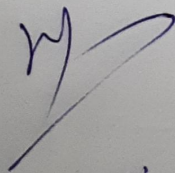
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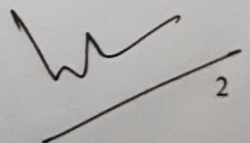
1. Odum E.P. Basic Ecology.
2. Cowld D. 1999. Microbial diversity.
3. Atlas & Bartha. Microbial Ecology.



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PMBC 102. RESEARCH METHODOLOGY AND SCIENTIFIC PRESENTATION

Unit I

Research Aptitude:

- Research: Meaning, characteristics and types;
- Steps of research;
- Research Ethics;
- Paper, article, workshop, seminar, conference and symposium; · Thesis writing: its characteristics and format.

Unit II

Data Interpretation

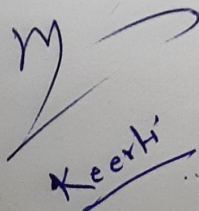
- Sources, acquisition and interpretation of data;
- Quantitative and qualitative data;
- Graphical representation and mapping of data.

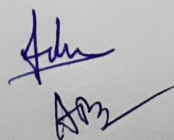
Unit III

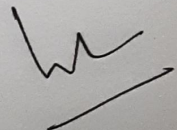
Information and Communication Technology (ICT)

- ICT: meaning, advantages, disadvantages and uses;
- General abbreviations and terminology; · Basics of internet and emailing.

Literature survey of the previous works and search for articles in the library, Review of an article in the relevant field and preparation of a short report. Scientific presentation: Use of internet in research works, Use of internet networks in research activities in searching material, paper downloading, submission of papers in arXiv, use of SPIRES database, relevant websites for journals and arXives. Introduction to Patent laws etc. Patent laws, process of patenting a research finding, Copy right, Cyber laws.


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Unit IV

One seminar paper preparation in power point (which includes text, graphs, picture, tables, reference etc., Oral in Powerpoint/Poster); development of communication skills in presentation of scientific seminar eye to eye contact, facing to audience, question & answer sessions etc. Art of scientific writing: Steps to better writing, flow method, organization of material and style, drawing figures, graphs, tables, footnotes, references etc. in a research paper.

Unit V

Theoretical Foundation for Experiments and Instrumentation Principles governing:

Microscopy, Compound Microscope, Bright and dark field microscopy, Phase contrast and fluorescent microscopy, Electron microscopy- Transmission and Scanning electron microscopy.

Colorimetry- Beer Lamberts Law and its limitations, Spectrophotometry, Mass spectrophotometry, Absorption spectra.

Autoradiography, Tracer techniques.

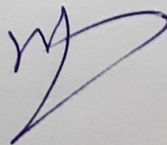
Chromatography- Absorption column chromatography, thin layer and gas liquid chromatography; Centrifugation density gradient and differential centrifugation.

Electrophoresis and electrofocussing.

PCR, its types and applications.

Suggested Readings:

Concerned literature will be given by individual faculty member.



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PMBE 103. BIOGEOCHEMISTRY AND EXTREMOPHILES

Unit I

Nutrition of microorganisms: Classification of microorganisms and nutrients, elemental composition of biomass, requirement and physiological functions of principle elements (H, O, N, P, S, major cations and trace elements). Concept of the limiting nutrient, design and analysis of defined minimal growth media, experimental verification.

Unit II

Oxidation-reduction reactions in biological system, introduction to biogeochemical cycles, major forms of C, N, S and iron, their importance in biogeochemical cycling. Carbon Cycle: Photo and chemoautotrophy in prokaryotic world, ecology and microbiology. Methanogens: diversity and phylogeny, habitats, physiology and biochemistry. Methylotrophs: Significance, aerobic and anaerobic methylotrophs, methylotrophic yeast. Iron metabolism: Iron uptake, intracellular "free" and stored iron, iron in primary fueling reactions, iron and pathogenicity.

Unit III

Nitrogen cycle: Dinitrogen fixation, biochemistry and microbiology, ecology of nitrogen fixation. Assimilation and ammonification. Nitrification: biochemistry and microbiology of NH_4^+ oxidation, NO_2^- oxidation, ecology of nitrification, heterotrophic nitrification. Denitrification: biochemistry and microbiology, ecology of denitrification, primary controlling factors of denitrification. Sulfur cycle: Microbial sulfate reduction, microbial sulfur oxidation, transformation of sulfur compounds, sulfur cycling within ecosystem, its environmental consequences.

Unit IV

Extremophiles: definition, ecology and biotechnology of extremophiles. Hyperthermophiles: temperature classes, habitat and microorganisms, biochemistry and physiological adaptations.

Habitats, biochemistry and physiological adaptations of psychrophiles and extreme acidophiles.

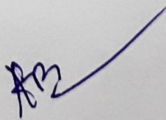
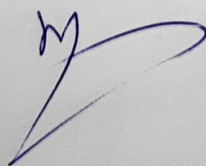
Unit V

Habitats, biochemistry and physiological adaptations of Barophiles, Halophiles, Alkaliphiles, Oligotrophs and Radiation resistant microorganisms.

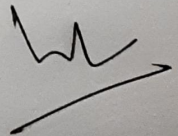
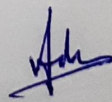
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Suggested Readings

1. Stanier, R.Y., J.L. Graham, M.L. Wheelis & P.R. Painter. General Microbiology. 1986. McMillan.
2. Caldwell, DR. Microbial Physiology & Metabolism. 1995. Brown Publishers.
3. Moselio Schaechter. The desk encyclopedia of microbiology. Elsevier.



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PMBE 104. PLANT PATHOLOGY AND PATHOGEN INTERACTION

Unit I

Types of plant pathogens, mode of infection, pathogenesis strategies -fungus, bacteria, nematodes, nonhost pathogens, viruses, subviral agents viroids, satellite viruses, satellite RNAs.

Initial establishment, multiplication and spread of pathogens, symptoms host ranges **Unit**

Unit II

Nature, causes and classification of plant pathogen, Dissemination and methods of preservation and control of plant diseases, Host-parasite relationship, plant defense mechanism.

Unit III

Fungal disease of plant crops- rice, wheat, maize, sugarcane, cotton and groundnut; fruit crops- apple, peach, mango, citrus and grapes; vegetable crops- crucifers, tomato, potato and brinjal; other crops- tobacco, turmeric and coriander.

Unit IV

Bacterial diseases of field crops, vegetable, fruits and other economically important plants. Viral diseases of field crops, vegetable, fruits and other economically important plants. Nematode disease of plants: a knowledge of some important nematode disease of economically important crops.

Unit V

Application of biofertilizers in production of healthy and vigorous transplants in nursery. Role of mycorrhiza in growth of plants.

Suggested Reading:

1. Mehrotra, RS. 1980. Plant Pathology. Tat McGrawHill.
2. Singh, RS. 1998. Plant Disease. Oxford & IBH Publ.
3. Bilgrami, KS. & Dubey, H.C. 1976. Vikas Publ. House, New Delhi.

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PMBE 105. MEDICAL MICROBIOLOGY

Unit I

History of medical microbiology. Normal microbial flora of human body and its role. Sources, vehicles and reservoirs of infection. Exogenous and endogenous infection.

Mechanism of bacterial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urogenital tracts. Establishment of infection, spreading, tissue damage and anti-phagocytic factors.

Unit II

Role of aggressins (Hyaluronidase), coagulase, fibrinolysins or kinase, depolymerizing enzymes (Mucinase, lipases, proteases, nucleases, collagenases, neuraminidase), organotropisms, variation and virulence. Mode of spread of infection.

Unit III

Respiratory, skin, wound and burn infection, venereal infections, alimentary tract infection, arthropod-borne blood infections and laboratory infections. Pathogenesis: Microbial pathogenicity, transmissibility, infectivity and virulence. Opportunistic pathogens, Toxigenicity.

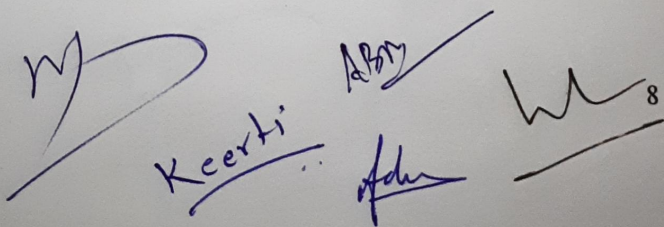
Invasiveness. Immune response to bacterial infection in man.

Unit IV

Classification of medically important microorganisms. Causal organisms, diagnosis, symptoms, toxic components, etiology and disease development in man by bacteria, fungi and viruses. Causal organisms, symptoms and diagnosis of New Castle (Ranikhet), bird flue, and salmonellosis in poult, rinderpest, anthrax, foot and mouth disease, mastitis and tympany in cattle. Hog cholera.

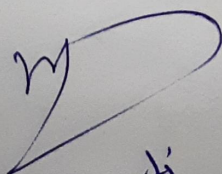
Unit V

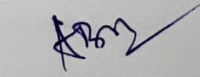
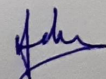
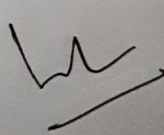
Antimicrobial therapy. Antibiotics and their classification, mode of action. Drug resistance. Methods of drug susceptibility testing. Antibiotic assay in body fluids. Brief account on available vaccines and schedules. Passive prophylactic measures. Nosocomial infections. Common types of hospital infections, their diagnosis and control. Principles of disinfection. Disinfectants and their mode of action.

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Suggested Readings:

1. Ananthnarayanan R and Jayaram C.K. 1997. Textbook of Microbiology. Orient Longman.
2. Mackie and McCartney. 1996. Medical Microbiology. Vol.1. Microbial Infection, Vol. 2. Practical Medical Microbiology. Churhill Livingstone.
3. Shanson DC. Wright PSG 1982. Microbiology in Clinical Practice.
4. Baron EJ, Peterson LR and Finegold SM. 1990. Bailey and Scott's Diagnostic Microbiology. Mosby.
5. Mims CA. 1987. The Pathogenesis of Infectious disease. Academic Press.
7. Murrey, P.R., Rosenthal, K.S., Kobayashi, G.S. & Pfaller, M.A. Medical Microbiology. Mosbay.

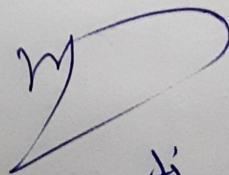

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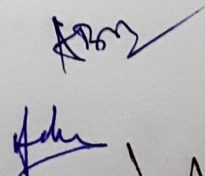
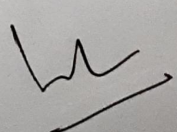




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1. Ananthnarayanan R and Jayaram C.K. 1997. Textbook of Microbiology. Orient Longman.
2. Mackie and McCartney. 1996. Medical Microbiology. Vol.1. Microbial Infection, Vol. 2. Practical Medical Microbiology. Churhill Livingstone.
3. Shanson DC. Wright PSG 1982. Microbiology in Clinical Practice.
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5. Mims CA. 1987. The Pathogenesis of Infectious disease. Academic Press.
7. Murrey, P.R., Rosenthal, K.S., Kobayashi, G.S. & Pfaller, M.A. Medical Microbiology. Mosbay.


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PMBE 106. BASIC AND APPLIED STATISTICS

Unit I

Introduction, Data Tabulation, Diagrammatic and Graphical Representation: Definition, Aims, Limitation, Classification, Tabulation, Types of Tabulation, Types of Diagrams, Graphical Representations, Utility and Limitations. Measures of Central Tendency and Dispersion:

Characteristics of Satisfactory Average, Arithmetic, Geometric, Harmonic, Weighted Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Coefficient of variation, Standard Error.

Unit II

Test of Significance and Goodness of Fit: Statistical Hypotheses, Parametric and Non-Parametric Hypothesis, Null Hypothesis, Statistical Significance, Levels of Significance, Degrees of Freedom, Student's t test, Goodness of Fit, χ^2 -Test, Conditions for the Application of χ^2 - Test.

Regression and Correlation: Bivariate universe or population, Arrays and Correlation, Measurement of Correlation, Intra-class, Rank, Partial and Multiple Correlations, Lines of Regression, Regression Coefficients, Limits and Range of γ - Correlation Coefficient expressed in terms of Regression Coefficients.

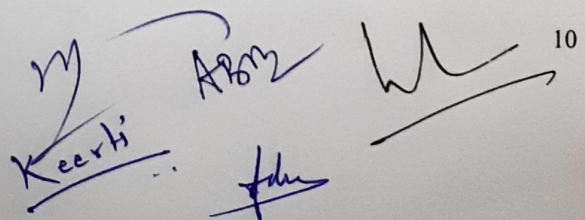
Unit III

Probability : Introduction, Definitions, Mathematical and Experimental Approach, Simple and Compound Events, Independent and Dependent Events, Laws of Composition of Events, Certainty and Impossibility, Limiting values and Range of Probability, Permutation and Combinations. Principles of Experimental Design and Analysis of Variance and Covariance:

Validity, Soil Heterogeneity and Uniformity Trial, Precision and Accuracy, Basic Principles of Field Experimentation, Experimental Technique.

Unit IV

Sampling: Aims of Sampling, Types of Population, Choice of Sampling Methods, Multi-stage and Multi-phase Sampling. Completely Randomized, Randomized Block and Latin Square Design: Description, Treatments, Randomization, Statistical Analysis, Merits and Demerits.



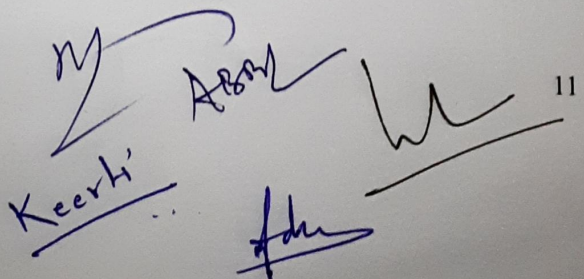
Split-plot Design: Description, Relation to the Confounded Factorial Designs, Structure of Analysis of Variance, Standard Error in Split -plot Experiments, Testing the Significance of the Differences among the treatment means, Statistical Analysis, Advantage and Disadvantage.

Unit V

Statistics and Computer: Calculation in Statistics, Software in Aid to Statistics, Working with Useful Software to Agricultural Researches.

Suggested Readings:

1. Wardlaw, A.C. 1985. Practical Statistics for Experimental Biologists. John Wiley.
2. Holmes D., Moody, P. Dine D. 2006. Research Methods for the Biosciences. Oxford University Press.


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PMBE 107. BIOCHEMISTRY AND METABOLIC REGULATION

Unit I

Carbohydrates- Glycolysis, aerobic and anaerobic fate of pyruvate, Oxidative phosphorylation, Gluconogenesis, pentose phosphate pathway, glycogen metabolism. **Nucleic acids-** Purine synthesis and catabolism. Pyrimidine synthesis and catabolism. **Proteins-** Transamination, Deamination, Oxidative deamination, Urea cycle. **Aminoacids-** Biosynthesis of non-essential aminoacids, catabolism of aminoacids. Lipids- Fatty acid synthesis, β -oxidation of fatty acids

Unit II

Light reaction and Dark reaction. The photosynthetic eubacteria: common properties, organization of photochemical apparatus and differences among the major groups.

Chemoautotrophic eubacteria.

Unit III

Structure of plasma membranes. Transportation of molecules across plasma membrane. Modes of cell signaling, Types of receptors used for cell signaling, pathway of intracellular signal transduction using secondary messengers, Apoptosis

Unit IV

Protein synthesis, Co-translation and post translation of proteins. Protein targeting

Unit V

Nomenclature and classification of enzymes. Factors affecting enzymes. Enzyme specificity. Enzymes assay. Enzyme inhibition. Applications

Suggested Readings:

1. Biochemistry and Molecular Biology, Third Edition by William H. Elliott and Daphne C. Elliott, Oxford University press.
2. Biochemistry L. Stryer Third Edition
3. Biochemistry. White, Handler and R.B.Smith 7th Ed. 1983
4. Principles of Biochemistry A. Lehninger 1987.
5. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand.

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PMBE 108. BIOCATALYSIS AND ENZYME MECHANISMS

Unit I

Biocatalysts: Current Status, Advantages & disadvantages, Comparison with other Catalysts, Biocatalysts as a technology, Green Chemistry.

Unit II

Enzyme Kinetics, Basis of Enzyme Action, Theories of Enzyme Catalysis, Efficiency, Stability, Selectivity of Enzymes, Screening of New Enzyme Activity.

Unit III

Basic of stereochemistry; Enantiomerically pure amino acids, Hydroxy esters with carbonyl reductase, Alcohols with ADH, Penicillin G, Ephedrine, Chiral drugs, Anticholesterol drugs, Anti-infectives, Anti-AIDS drugs, Cardiovascular drugs, Applications of Lipases and Esterases in the Pharma industry, Steroids.

Unit IV

Enzymes in organic solvents, Advantages of Biocatalysis in organic media, Role of water in Enzyme reactions in Organic solvents, Substrate as solvent, Ionic liquids and Supercritical Solvents for enzymatic reactions.

Unit V

Enzymes in the food industry, Cell-wall degrading enzymes, Lipases, Proteases, Amylases, Xylanases, Enzymes in brewing, Fat splitting, Enzymes in the paper and pulp industry, Enzymes in the textile industry, Enzymes for preservation, The future of enzyme applications.

Suggested Readings:

1. Biocatalysis: Fundamentals & Applications by Andreas Sebastian Bommarius , Bettina R. Riebel, VCH (02 April, 2004)
2. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin 5th Edn, 2004
3. Enzymes by palmer,
4. Enzymes in Industry by Wolfgang Aehle, Wiley-VCH, 2004.

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PMBE 109. GENETIC ENGINEERING

Unit I

Scope of Genetic Engineering Milestones in Genetic Engineering - Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines.

Unit II

Molecular Tools in genetic engineering: Restriction enzymes, ligases, S1 nuclease, terminal deoxynucleotides, transferases, Poly A polymerases, Reverse Transcriptase, Alkaline phosphatase etc., modification enzymes, DNA, and RNA markers.

Unit III

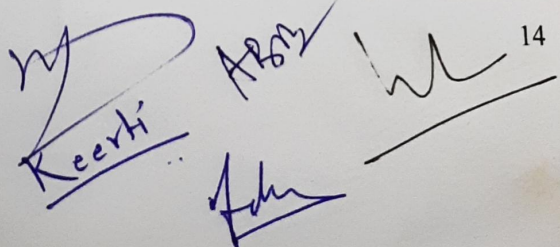
Nucleic Acid Purification, Yield Analysis. Nucleic Acid Amplification and Its Applications. Restriction Mapping of DNA Fragments and Map Construction. Nucleic Acid Sequencing. Gene Cloning Vectors: Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes. cDNA Synthesis and cDNA library preparations. Cloning mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors and their chemical synthesis, Library construction and screening. Genomic libraries (complete sequencing projects). Alternative Strategies of Gene Cloning, Cloning interacting genes- Two-and three hybrid systems, cloning differentially expressed genes. Site-directed Mutagenesis and Protein Engineering

Unit IV

How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, RNase protection assay, Reporter assays. Nucleic acid microarrays. Expression Strategies for Heterologous Genes Vector engineering and codon optimization, host engineering, In vitro transcription and translation, expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants. Processing of Recombinant Proteins Purification and refolding, characterization of recombinant proteins, stabilization of proteins. Metagenomics.

Unit V

Phage Display T-DNA and Transposon Tagging Role of gene tagging in gene analysis, T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon.



Transgenic and Gene Knockout Technologies Targeted gene replacement, Chromosome engineering. Gene Therapy Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Suggested Readings:

1. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J; Cseke, CRC Press, Florida, 1995.
2. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
3. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990.
4. DNA Science. A First Course in Recombinant Technology, D.A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New York, 1990.
5. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
6. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
7. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.
8. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
9. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

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PMBE 110. BIOSYSTEMATICS AND ECOBIOLOGY OF MUSHROOMS

Unit I

Biodiversity of mushroom flora in India: belowground diversity of mushrooms (Truffles): forest fire in relation to diversity of fungi in micro level. Distribution pattern of mushrooms flora in the world. Ethnomycological approach of mushroom specially in Uttarakhand Himalaya.

Unit II

Introduction to mushroom groups, taxonomic study of order Agaricales, dark spored group-systematics of dark spored families: Cortinariaceae, Coprinaceae, Bolbitiaceae, Gompidiaceae, Boletaceae, Bondarzewiaceae. Systematics of light spored families: Tricholomataceae, Amanitaceae, Hygrophoraceae, Pluteaceae, Agaricaceae.

Order Aphyllorales: Introduction and systematics; Cantharelloid forms; Thelephoroid forms, cupuloid forms, Clavarioid forms, Hydroid forms and Poroid forms.

Gasteromycetes: Introduction and systematic; order Podaxales, Hymenogastrales, Sclerodermatales, Lycoperdales, Phallales, Nidulariales.

Unit III

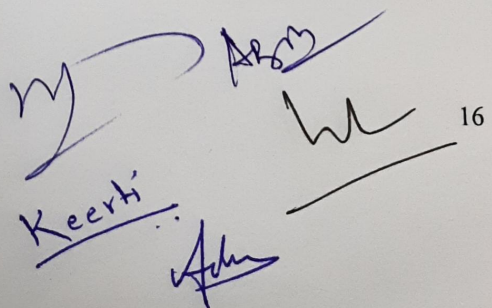
DNA isolation, amplification and ITS; RAPD analysis, DNA primers and markers; PCR machines and working knowledge, Gel electrophoresis; use of Gel-Doc, sequence and phylogenetic data analysis.

Unit IV

Ecology of mushrooms, role of mushrooms in forest ecosystems, Mycorrhiza: VAM fungi, ectomycorrhiza and forest ecosystem. Tissue culture of wild mushrooms; media preparation, solid and liquid culture media preparation: pure culture techniques, techniques used in maintenance of mushroom cultures.

Unit V

Preparation of herbarium: methods of collection, identification and preserving wild mushrooms. Cultivation of edible and medicinal mushrooms: *Volvariella*, *Agaricus*, *Pleurotus*, *Lentinus*, *Ganoderma*.



Suggested Readings:

1. Singer, R. 1986. The agaricales in modern taxonomy (4th ed.) Bishen Singh Mahendra Pal Singh, Dehradun.
2. Bakshi, B.K. 1974. Mycorrhiza and its role in forestry. Forest Research Institute, Dehradun.
3. Largent, D.L. 1977. How to identify mushrooms to genus I: Microscopic features. Mad River Press Inc. Eureka.
4. Largent, D.L., Johnson, D. and Walting, R. 1977. How to identify mushrooms to genus III: Microscopic features. Mad River Press Inc. Eureka.

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PMBE 104. PLANT PATHOLOGY AND PATHOGEN INTERACTION

Unit I

Types of plant pathogens, mode of infection, pathogenesis strategies –fungus, bacteria, nematodes, nonhost pathogens, viruses, subviral agents viroids, satellite viruses, satellite RNAs.

Initial establishment, multiplication and spread of pathogens, symptoms host ranges **Unit**

Unit II

Nature, causes and classification of plant pathogen; Dissemination and methods of preservation and control of plant diseases, Host-parasite relationship, plant defense mechanism.

Unit III

Fungal disease of plant crops- rice, wheat, maize, sugarcane, cotton and groundnut; fruit crops- apple, peach, mango, citrus and grapes; vegetable crops- crucifers, tomato, potato and brinjal; other crops- tobacco, turmeric and coriander.

Unit IV

Bacterial diseases of field crops, vegetable, fruits and other economically important plants. Viral diseases of field crops, vegetable, fruits and other economically important plants. Nematode disease of plants: a knowledge of some important nematode disease of economically important crops.

Unit V

Application of biofertilizers in production of healthy and vigorous transplants in nursery. Role of mycorrhiza in growth of plants.

Suggested Reading:

1. Mehrotra, RS. 1980. Plant Pathology. Tat McGrawHill.
2. Singh, RS. 1998. Plant Disease. Oxford & IBH Publ.
3. Bilgrami, KS. & Dubey, H.C. 1976. Vikas Publ. House, New Delhi.

Handwritten signatures and initials: Keerti, fdr, LU 7