MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

Common Course Structure including project oriented elective papers for M. Phil Microbiology (Affiliated colleges)

(With effect from the academic year 2018-2019 onwards

Sl.No	Semester	Subject	Credits	Hours/ week
1	I	**Core – 1** Research and Teaching Methodology	4	4
2	I	**Core – II** Microbial Technology	4	4
3	I	**Project oriented Elective Course:** Microbial Probiotics and Prebiotics (or) Synthetic Biology and its Applications (or) Nanobiotechnology and Application (or) Microbes and Clean Environment (or) Microbiome, Metagenomics and Molecular Techniques (or) Microbial Product Development and Patenting	4	4
4	II	Project and Viva - voce	12*	-
		Total	**24***	**-**

*as per the direction / UGC guidelines.

Core Papers for M. Phil. Microbiology

Paper – I : Research and Teaching Methodology

Objectives: To understand the principles and applications of basic and advanced instruments and their techniques in Microbiological research. Also technically know how the teaching methods in Microbiology.

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Unit 1: Principles and applications of Microscopy: Light microscope, Phase contrast microscope, Florescent microscope, Scanning and Transmission Electron microscope, Cytophotometry and Flow Cytometry, Fixation and Staining techniques. (10h)

Unit 2: Principles and applications of chromatography: Gel filtration, ion exchange and affinity chromatography, TLC and Gas chromatography, HPLC, Electrophoresis and electro focusing, NMR studies – Proton NMR & Carbon NMR (10h)

Unit 3: Recombinant DNA Technology – Principles and Techniques of nucleic acid hybridization and Cot-curves – Proteins and nucleic acid sequencing- Blotting techniques (Southern, northern and south western blotting)- PCR and qRTPCR techniques, Methods of measuring nucleic acids and protein interactions.

Immunological techniques: Antigen and antibody reactions, Serological tests, Blood analysis and Blood grouping studies. (12h)

Unit 4: Principles and practice of Statistical Methods in Biology: Samples and population studies, Collection of data, Diagrammatic representation of data, Statistics of central tendency and Dispersion, Co - efficient of Variation, Standard Error, Probability distributions, Test of statistical significance, Correlation and Repression analysis and ANOVA. (16h)

Unit 5: Teaching – Objectives of teaching, phase of teaching – Teaching methods: Lecture method, Discussion method, Discovery learning, Inquiry, problem solving method, Project method, seminar – Integrating ICT in Teaching: Individualised instruction, ways for effective presentation with power point – Documentation – Evaluation : Formative, summative & Continuous and comprehensive evaluation – Later adolescent Psychology: Meaning, physical, cognitive, emotional, social and moral development – Teaching later adolescents. (12h)

References: **Total (60h)**

1. Practical Biochemistry – principles and Techniques by Keith Wilson and John Walter, 2000. Cambridge University press.
2. Cell and molecular Biology – Concepts and Experiments by Gerald Karp.
3. Cell Biology (Vol. I – IV) by Julio E. Celies.
4. Cell and Molecular Biology by De Robertis.
5. Molecular cell Biology by Bruce Alberts
6. Genes V by Benjamin Lewin
7. Biotechnology – Theory and Techniques by Jack. G. Chirikjain.

8. Bio statistical analysis by Zar J.H.
9. Sampath, K., Pannerselva,A. & Santhanam,S.(1984). Introduction to educational technology. (2nd revised edition). New Delhi: Sterling Publishers.
10. Sharma,S.R.(2003).Effective classroom teaching modern methods, tools & Techniques. Jaipur: MangalDeep.
11. Vedanayagam,E.G.(1989).Teaching technology for college teachers. Newyork: Sterling Publishers.

Paper II – Microbial Technology

Objectives: To provide indepth knowledge about gene organization in microbes and the development of antibiotics, Vitamins, Probiotics, Vaccines and the industrial products from microbes.

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Unit 1: Gene organization in prokaryotes: Bacteria, Virus – Gene transfer mechanisms – Plasmids and their types – Electrophoration – Micro injection – short gun method (Partial bombardment) (12h)

Unit 2: Antibodies and other products : Classification and production of antibodies – penicillin, streptomycin, Tetracycilin Classification and production of vitamins like cyanocobalamin, riboflavin, ascorbic acid, Probiotics – definition of probiotics, advantages of probiotics, possible mode of action, important characters, beneficial microbes, probiotics in aquaculture.

(14h)

Unit 3: Vaccines : Types and production, disease resistance, competitive exclusion principle, Physico - chemical control of fish pathogens. Industrial microbes and their products.

(10h)

Unit 4: Bio remediation : definition – Pollutants and their metabolites in marine, fresh water and brackish water environments; Bio mediation process – Genetically engineered microbes in bioremediation and the metabolism.

(12h)

U**nit 5:** Extremophiles: Archaebacteria – Extremozymes – Role of halobacteria in salt production. Halophilic microalgae – Products from halophilic bacteria. Bioactive compounds – extraction, purification and sensitivity assay. (12h)

References: **Total (60h)**

1. Applied Biochemistry and Biotechnology by C.E. Wyman and B.H. Davidson.
2. Product Recovery in Bioprocess Technology by Butterworth and Heincemann.
3. Industrial Microbiology and Biotechnology by A.L. Demain and J.E. Davies.
4. Introduction to Aquaculture by Mathew Landau.
5. Applied Therapeutics – The clinical use of drugs by M.A.K. Kimple and L.Y. Young.

Elective Courses

MICROBIAL PROBIOTICS AND PREBIOTICS

Objectives:

- To study the use of live bacterial supplements on disease resistance and growth promotion in aquatic organisms.
- To understand the history, growth and development of probiotics.
- To study the prebiotic effect on gut bacterial community.
- To explore knowledge on isolation, screening, characterization and production of probiotic microbes.

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Unit 1:Probiotic History : Definition, History and development of probiotics, Indian and Global Scenario of Probiotics, General features of probiotics, Mechanism of action of probiotics. (12 h)

Unit 2: Probiotic characterization: Isolation of probiotic bacterial strains from various sources, Screening of probiotic bacteria: antimicrobial potentials, enzyme producing ability, colonization potentials, Identification of probionts using molecular tools – Mass cultivation of probiotic bacterial strains. (12 h)

Unit 3: Probiotics in Food: Dairy and Non dairy based probiotic products. Interactions between probiotics and components of fermented foods - Probiotic food Product Specifications, Quality Assurance and Regulatory Issues - (12 h)

Unit 4: Application of Probiotics – Humans: Bowel diseases, Oral and Dental health, Diabetes and obesity, Cancer prevention. Plants: Role of plant probiotics in production of highly functional fruits and disease resistance. Animals: Probiotics in poultry, pig and ruminant nutrition. Aquatic organisms- Probiotics for finfish and shellfish. (14 h)

Unit 5:Prebiotics and Synbiotics: Definition – Types of prebiotics - Characteristics of probiotics – Synbiotics – List of synbiotics and their applications (10 h)

Total (60 h)

Reference

1.Daniel Merrifield and Einar Ringo, 2014, Aquaculture nutrition: Gut Health, Probiotics and Prebiotics, Wiley Blackwell.

2.Soundarapandian, P. and Ramanan, V. 2010. Role of probiotics on the farming of shrimp *Penaeus mondon*, India, VDM Verlag Publishers.

3. Ganguly, S. And Mukhopadhayay, S.K. 2011. Immunostimulants, Probiotics and Prebiotics, LAP Lambert Academic Publishing, Germany

4.Anthony von Fraunhofer, J. 2012. Prebiotics and Probiotics, CreateSpace Independent Publishing Platform, USA.

5.Watson, R.R. and V.R. Preedy, 2016. Probiotics, Prebiotics and Synbiotics: Bioactive foods in health promotion, Academic Press, USA.

SYNTHETIC BIOLOGY AND ITS APPLICATIONS

Objectives

- To understand the gene regulation in naturally occurring organisms and to learn the mode of alteration of gens and their products. Also to explore the possibility of alteration of properties of cells / organisms.
- To apply a scientific approach to the planning, execution, reporting and interpretation of advanced projects with the aim at creating replicating systems with new properties that can be regulated, and to critically analyse the results and generate testable hypotheses from these experiments
- To critically analyse, present and defend scientific literature in synthetic biology, including practical applications such as biofuel and metabolic engineering and to develop ethical perspectives in synthetic biology

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Unit 1: Introduction to Synthetic Biology: Basic concepts in biology – Definition – History - Perspectives- Engineering - Re-writing - Enabling technologies-Standardized parts - Synthesis - Sequencing - Microfluidics - Modular protein assembly - Modeling – Chemical Synthetic biology

(12h)

Unit 2: Concepts and Components in Synthetic genomics: Metabolic engineering - Biological computers -Biosensors - Cell transformation (10 h)

Unit 3: Synthetic genomics – Synthetic Genomes – basic concepts of genomics - Elements of genetic circuits. Natural and synthetic promoters; attenuation and termination. Codon usage, Operons, RBSs and their relevance to biotechnology sRNA and ribolocks - Hybrid systems - RNA Replicon-cell factories-algae befouls (14 h)

Unit 4: Applications of Synthetic Biology: - Designed proteins - Industrial enzymes - Information storage - Materials production - Reduced amino-acid libraries - Space exploration - Synthetic genetic pathways - Synthetic life - Synthetic amino acids - Synthetic nucleotides. Therapeutics: Gene circuits- Delivery platform- Engineered bacteria-based platform- Cell-based platform- Cancer detection/diagnostic (14 h)

Unit 5: Bioethics and Security: European initiatives – US initiatives – opposition – ethical concern – status of research in Synthetic biology in India. (10 h)

References:

https://en.wikipedia.org/wiki/Synthetic_biology
www.synbioproject.org/topics/synbio101/definition/
https://www.syntheticgenomics.com/cell-factories
https://www.syntheticgenomics.com/exxonmobil-and-synthetic-genomics-algae-biofu

NANOBIOTECHNOLOGY AND APPLICATION

Objectives

- To familiarize students with new concepts and understand the fundamentals of Nanotechnology.
- To give basic knowledge on classes of nanomaterials and various synthesis and characterisation techniques involved in Nanotechnology.
- To employ bio-nanomaterials for analysis and sensing techniques.
- To explain the bio-medical applications of Nanobiotechnology.

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Unit 1:Basics of Nanotechnology: Time and Length scale in structures - Definition of nanosystem -Properties of nanoscale (optical, mechanical electronic and magnetic) - Classes of Nanomaterials: Classification based on dimensionality - Quantum dots - Wells and wires - Carbon based nanomaterials (nanogold, nanosilver and metal oxides) - Nanocomposites, Synthesis of nanomaterials: Physical methods - Electrodeposition, Ball Milling, Magnetron Sputtering, Molecular Beam Epitaxy (MBE) - Chemical Methods - Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Sonochemical routes, Chemical vapour Deposition.

(12 h)

Unit 2: Bio-Analytics of Nanoparticles: Nanofabrication: Photolithography - Electron-beam lithography (EBL) - Nanoimprint - Soft Lithography patterning, Characterisation: Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM) - Analysis of Biomolecular Structure by Atomic Force Microscopy and Molecular Pulling - X-ray photoelectron spectroscopy (XPS) - Rutherford Backscattering Spectroscopy (RBS) - Surface Enhanced Raman Spectroscopy (SERS) - Force Spectroscopy - Biofunctionalized Nanoparticles for Surface - Enhanced Raman Scattering and Surface Plasmon Resonance - Luminescent Quantum Dots for Biological Labeling - Nanoparticle Molecular Labels -Bioconjugated Silica Nanoparticles for Bioanalytical Applications.

(13h)

Unit 3: Principles of Nanobiotechnology: Structural and Functional Principles: Lipid Bilayers - Liposomes - Neosomes - Polysacharides - Peptides -Nucleic acids - DNA scaffolds - Enzymes - Biomolecular motors: Linear, Rotary mortors - Immunotoxins - Membrane transporters and pumps - Antibodies - Monoclonal Antibodies - Immunoconjugates - Limitations of natural biomolecules.

(10 h)

Unit 4: Nanobiomaterials: Surface and Bulk Properties of Biomaterials –Nano ceramics - Nanopolymers - Nano Silica - Hydroxy apatite - Surface modification - Textured and Porous Materials - Surface immobilized biomolecules - Cell-biomaterial interactions - Immune response - *in vitro* and *in vivo* assessment of tissue compatibility, Protein and DNA Based Nanostructures: Nanocircuitry - S-layer proteins: structure, chemistry and assembly - lipid chips – S-Layers as Templates - Engineered nanopores - DNA–Protein Nanostructures - DNA-templated Electronics - DNA-based Metallic Nanowires and Networks - DNA-Gold-Nanoparticle Conjugates - DNA - templated Electronics - DNA Nanostructures for Mechanics and Computing.

(13 h)

Unit 5: Applications of Nanotechnology in Health Science: Nano particle based drug delivery systems - Ultra sound triggered Nano/Microbubbles - Regenerative Medicine – Nanoimmuno conjugates- Biosensors - Optical Biosensors Based on Nanoplasmonics - Nanobiosesors - Nanobiosensors for Mimicking Gustatory and Olfactory Senses -Cyclodextrin in Nanomedicinal Foods and Cosmetics - Bioavailability and delivery of nutraceuticals and functional foods using Nanotechnology - Polymer based nanocomposites for food packaging - Nanocomposites for food packaging - Toxicity and environmental risks of nanomaterials - Challenges of nanotoxicology.

(12 h)

(Total 60 h)

References

1. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Niemeyer C. M., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006.
3. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.
4. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi, "Bio-Nanotechnology: A Revolution in Food, Biomedical and Health Sciences" Wiley-Blackwell, 2013.
5. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine",Academic Press, 2012.
6. Balaji Sitharaman "Nanobiomaterials Handbook", Taylor & Francis Group, 2011.
7. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005.

MICROBES AND CLEAN ENVIRONMENT

Objectives:

Strengthening the knowledge of students in the area of microbiological and its allied subjects research by exposing them to basic and advanced concepts and applications of clean Environment and make them fit for their effective operations.

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Unit 1: A tribute to clean environment: The contamination clean up strategy- bioremediation-bioaugmentation-Aerobic biodegradation pathway-Anaerobic biodegradation pathway-physicochemical mechanism-Molecular mechanism- Biotechnological invention-Bioremediation Research studies using designed and developed laboratory bioreactors-Nanobioremediation.

(14 h)

Unit 2: Biological control agents for sustainable agriculture, safe water and soil health: Brief history of biopesticides- Biopesticides in India- Bio agents- Bioremediation of pesticides in surface soil treatment unit using microbial consortia- scale up process- Designed and developed partitioning bioreactor- Mycorhizosphere ecological remediation- Industrial effluent treatment-GMO'S. (14 h)

Unit 3: Food Industry Waste: Food processing industrial waste-solids and liquids-ultimate goal of green productivity- Zero discharge- Zero emission- Zero pollution-cost effective production and application of clean production technology. Fruit and vegetable food processing sector. Beverage and fermentation sector-Diary industry-Food packaging waste.

(12 h)

Unit 4: Carbon Foot Printing, Ecological Foot Printing, Global Dimming (GD) and Global warming (GW): Green gases- suspended pollutants-causes of global dimming-burning fossil fuels- Global warming-comparison of GD and GW- common factors-carbon positive, carbon negative and neutral-future challenges.

(10 h)

Unit 5: Environmental toxicological studies: Global scenario- Indian scenario-Vehicles-Road dust-Hotels and Restaurants-Hospitals-Shopping mall-municipal and corporation solid waste burning-Aiming for eco-friendly, biodegradable products-Bioplastics.

(10 h)

Total (60 h)

References:

1. http://www.enviroliteracy.org/625php
2. http;//www.Epa.gov/superfund/site
3. http://www.yale.edu/epi/files/2008EPI text pdf
4. http://www.yale.edu/esi/ESI 2005 Main Report.pdf
5. http://www.bact.wise.edu/Microtextbook/index.php.
6. http://www.teachingtools.com/crude energy/Oil environment.htm.
7. http://www.Sfgate.com/cgi-bim/article.

MICROBIOME, METAGENOMICS AND MOLECULAR TECHNIQUES

Objectives

To make students familiar with and can use and apply modern technologies used in microbiome research.

To use metagenomic data to describe the taxonomic make-up, functional potential and ecological processes of microbial communities from a range of environments.

To make students familiar with new techniques in genetic engineering.

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UNIT 1: Microbiome : Introduction- History of the study of the microbiome; Describing the organisms present in the microbiome: 16S rRNA sequencing; Analysis and interpretation of 16S rRNA sequencing; Extracting Whole genomes from the microbiome – genome sequencing through PacBio; Culturing organisms of interest from the microbiome: bacteria, fungal and archaea. Learning the metabolic potential of the microbiome :Metagenomics. Microbiome- transcriptomics; RNA influencing gene expression: sRNA sequencing. Functions available in the microbiome- Metaproteomics

(14 h)

Unit 2: Metagenomics: Introduction; Pure culture and in consortium ; Cultivable and Non-cultivable microbial analysis; Recombination DNA technology and DNA cloning; Types of vectors, applications of recombination DNA technology; Molecular fingerprinting techniques (RFLP, T-RFLP, ARISA, DGGE, rDNA library, and FISH); Stable isotope probing (SIP); Suppressive subtractive hybridization (SSH); Differential expression analysis (DEA); Microarrays & Metagenome sequencing; Next-generation sequencing approaches to metagenomics

(12 h)

Unit 3: Cataloging microbes: phylogenetic tree and construction - Construction of a metagenomic library; Analysis of metagenomic libraries; Sequence-based metagenomics Analysis; Function based metagenomics analysis; Phylogenetic analysis and comparative genomics softwares & Tools

(10 h)

Unit 4: Metagenomic analysis of soil microbial communities; Metagenomic analysis of marine microbial communities; Metagenome of the Microbial Community in acid mine drainage ; Metagenomic analysis of Bacteriophage; metagenomics and its applications to the study of the human microbiome; Archaeal metagenomics: Bioprospecting novel genes and exploring new concepts.

(10 h)

Unit 5: Genetic Engineering – Introduction, Mendelian and non mendelian inheritance, Basics of r-DNA technology: Enzymes used in r-DNA technology; DNA ligase, DNA polymerase,

Klenow fragment, reverse transcriptase, exonuclease, endonuclease, terminal deoxynucleotidyl transferase, alkaline phosphatase, polynucleotide kinase, and dephosphatases; restriction modification systems and their types; sticky and blunt end ligation, joining with linkers, adapters &homopolymer tailing. Recent trends in Molecular Biology Research Targeted Genome Editing: ZFNs, TALENs, CRISPRs -- Gene Targeting: Knock-ins & Knock-outs -- DNA Finger Printing

(14 h)

Total (60 h)

References

1. Diana Marco Universidad Nacional de Cordoba, Argentina, "Metagenomics: Theory, Methods and Applications", Caister Academic Press,2010.
2. Diana Marco Universidad Nacional de Cordoba,Argentina "Metagenomics: Current Innovations and Future Trends",Caister Academic Press,2011.
3. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "Molecular Ecology", McGraw Hill, 2nd Edition "2012.
4. Beebee T.J.C., D G. Rowe," An Introduction to Molecular Ecology", McGraw Hill, 2004.
5.BrownT. A. Gene Cloning and DNA Analysis: An Introduction - 6th Edition - - John Wiley & Sons
6. Desmond Nicholl S. T. An Introduction to Genetic Engineering - 3rd Edition - - Cambridge University Press

MICROBIAL PRODUCT DEVELOPMENT AND PATENTING

Objectives:

i. To teach the recent development of products using the microorganisms in industries.
ii. To provide a brief knowledge about the industrial production of organic solvents, organic acids, antibiotics, enzymes etc. and their applications in industries.
iii. To insist the awareness of patenting.

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Unit 1: History and development of microbial products, Isolation, preservation and screening of microbes used in industries, Strain improvement by mutation, selection and enrichment, Types of bioreactor-Air lift, acetator, fluid bed reactors. (12 h)

Unit 2: Production of beverages and industrial alcohols, wine and beer, Production of organic acids-lactic acid, acetone, butanol, citric acid and acetic acid, Production of microbial biomass-SCP. (12 h)

Unit 3: Industrial production of antibiotics-Penicillin, erythromycin and streptomycin, Bacterial production of enzymes-protease, cellulose, amylase, Immobilization of enzymes, Development of biosensors, Biopolymers and EPS, Bioplastics, Biosurfactants, Biopreservatives and its uses. (12 h)

Unit 4: Role of microorganisms in cheese production-cheddar cheese, blue cheese, camembert cheese, yogurt, sour cream, Leather processing and development. (10 h)

Unit 5: Basic requirement of patentability, process of patenting, patenting biological materials, National and International patent laws, Biosafety regulations and assessment of biotechnology products- drugs/vaccines and GMO, Biosafety protocols-Biological weapons, Principles of bioethics- ethical conflicts in biotechnology. (14 h)

Total (60 h)

References

1. Glick BR and Pasternak JJ. Molecular Biotechnology-Principles and applications of recombinant DNA, ASM Press, 2006.
2. Staneberry et al., Fermentation Technology, 1998.
3. Glazer AN, Nikaido H. (1994) Microbial Biotechnology-Fundamentals of Applied Microbiology WH Freeman and Company, New York.
4. Raledge C. and Kristiansen B Eds. (2001) Basic Biotechnology, 2nd edition, Cambridge University Press.
5. Nduka Okafor (2007). Modern Industrial Microbiology and Biotechnology. 1st Edition: Science Publishers.
6. Waites, M.J., Morgan, N.L., Rockey, J.S. and Higton, G. (2002). Industrial Microbiology: An Introduction. Blackwell Science Publishers.

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