MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

Ph.D. course work study papers in Microbiology

Ph.D.Microbiology

(With effect from the academic year 2017-2018 onwards)

Semester	Sub. No.	Subject Status	Subject Title	Hrs/ week	L Hrs/ week	T Hrs/ week	P Hrs/ week	C Credits
I	1		Advanced Research Methodology	4	4	-	-	4
	2		Advanced Bioinstrumentation	4	4	-	-	4
	3		Microbial Probiotics and Prebiotics	4	4	-	-	4
	4		Synthetic Biology and its Applications	4	4	-	-	4
	5		Nanobiotechnology and Application	4	4	-	-	4
	6		Microbial Drug Discovery and Management of Drug Resistance	4	4	-	-	4
	7		Microbes and Clean Environment	4	4	-	-	4
	8		Microbiome, Metagenomics and Molecular Techniques	4	4	-	-	4
	9		Advanced Marine Microbiology and Extremophiles	4	4	-	-	4
	10		Emerging and Re-emerging Microbial Infectious Diseases in India	4	4	-		4
	11		Microbial Product Development and Patenting	4	4	-		4
	12		Bioentrepreneurship and STARTUPS	4	4	-		4

Ph.D. course works Study papers in Microbiology

1. Advanced Research Methodology

Objectives

To inculcate knowledge on research methodology and to familiarize the usage of various instruments, techniques and analysis applied in Microbiology research.

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Unit 1: Research Methodology – Introduction - Meaning - Objectives – Motivation. Types of Research - Research Approaches, Criteria of Good Research.Research and Scientific Method. Research Problem – identification- Selection – Techniques and necessity of defining the Problem. Research ethics- Importance of doing genuine Research.

(10 h)

Unit 2: Survey of Literature: Meaning- Mode of literature survey using scientific documents – research paper, review paper, book reviews, theses, conference and project reports. Research Design: Meaning – Need - Basic Principles – Types- Important concepts relating to research design, Developing a research plan. Sampling: Steps in sampling design, characteristics of a good sample design, Different types of sample designs. Research methods versus methodology, Problems encountered by researchers in India.

(10 h)

Unit 3: Biostatistics and Computer Application: Introduction, significance of statistical methods. Normal distribution.Probability.Degrees of freedom.Measures of variation - standard deviation, Non linear regression, iteration methods.Analysis of variance.Standard error. Test for statistical two ways ANOVA and multiple comparison procedures. Significance - students Test, chi - square test. Fisher's exact test. Wilcoxon rank test. Two - tailed student's t - test.Mann - Whitney test.Dunnet's two - tailed test, Kruskell - Wallis non-parametric test.Computer applications in Biology - Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts / graph and other features, Tools – Microsoft Word, Excel, Power Point and WWW, Use of search engines, Biological data bases.

(14 h)

Unit 4: Scientific Writing: Definition and kinds of scientific documents – research paper, review paper, book reviews, thesis, conference and project reports (for the scientific community and for funding agencies). Thesis writing – follow the format prescribed by the ManonmaniamSundaranar University - Components of a research paper – the IMRAD system, submission of manuscript, ordering reprints. Oral and poster presentation of research papers in conferences/symposia. Preparation and submission of research project proposals to funding agencies.

(12 h)

Unit 5: Biomolecular separation Techniques: Identification and characterization of biomolecules – optimization of AGE – Blotting techniques, RAPD, RFLP, DGGE, TGGE, PCR, ELISA. Enzyme assay, enzyme activity and specific activity determination.Cell disintegration and extraction techniques, separation of proteins (ammonium sulphate, organic solvents). Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, column chromatography, thin layer chromatography, ultra filtration, Ultracentrifugation. Gel electrophoresis - PAGE – Gel Documentation – immunoelectrophoresis, advanced Microscopy, HPLC, HPTLC, GC-MS, FTIR, NMR, AAS.

(14 h)

Total (60 h)

References:

1.Kothari, C.R. (2004). Research Methodology: Methods and Techniques, New Age International Publishers, New Delhi.

2. Arya., P.P. and Pal, Y. (2001), Research Methodology in Management: Theory and Case Studies, Deep and Deep Publishers Pvt. Ltd., New Delhi

3. Robert A. Day (1998), How To Write & Publish a Scientific Paper. Oryx Press; 5th edition.

4. Frank D. Bell (1995), Basic Biostatistics: Concepts for the Health Sciences. William C.Brown

5.Suresh C. Sinha and Anil K. Dhiman, (2002), Research Methodology (2 Vols– Set)Vedams Books (P) Ltd.

6. Bajpai, S. 2014. Revised Edition, Biological Instrumentation and Methodology:(Tools and Techniques of Biology), Chand & Company Ltd., New Delhi.

7. Gurumani, N. 2016. First Edition, Research Methodology for Biological Sciences, MJPPublishers, A unit of Tamilnadu Book House, Chennai.

8.Lederberg, J. 2000. Second Edition, Encyclopedia of Microbiology, Volume 4, AcademicPress.

4. Palanivelu, P. 2009. Fourth Edition,

9. Analytical biochemistryand separation techniques – A Laboratory Manual, Twenty first Century Publications, Madurai, Tamilnadu.

10.Pelczar, M.J., Schan, E.C. and Kreig, N.R. 2010. Microbiology – An application based approach, Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi.

2. Advanced Bioinstrumentation

Objectives

- To understand the principle, applications and limitations of basic and advanced instruments used in biological research.
- Preparing the researchers for interdisciplinary research.
- To improve the quality and reliability of the research.

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Unit 1: Buffers, standard, percentage, molars and normal solutions, pH meter, pH electrodes – calomel and glass electrodes. Colorimeter –UV-Spectrophotometer.Calibration of Laminar air flow-Different meters available for the measurement of biological research and their applications and calibration.

(14 h)

Unit 2: Centrifugation: Principle – types of centrifuges – low speed, high speed, ultra centrifuge, and Differential centrifugation – density gradient centrifugation. Applications of centrifuge.

(12 h)

Unit 3: Electrophoresis – SDS – PAGE and Agarose gel electrophoresis. Southern blotting – Northern blotting – Western blotting – DOT blotting.

(10 h)

Unit 4: Chromatography – paper, thin layer, column, ion exchange, gas chromatography and GC – GCMS -HPLC-MS - FACS - Biosensors.

(10h)

Unit 5: Biological Techniques - ELISA - Principles and types. Immunodiffusion techniques - ODD, RIA.Agglutination and its applications - IFT, CFT. Principle and Applications of XRD - FTIR - ICPOES- ICP-MS- TGDTA –Proton NMR – C13 NMR – Polarimeter – Mass Spectrum –TEM AND SEM

(14 h)

Total (60 h)

References:

1. Bajpai PK (2010). Biological Instrumentation and Methodology.Revised edition, S.Chand& Co. Ltd., New Delhi.
2. Palanivelu P (2004). Analytical Biochemistry and Separation techniques**.**Third edition, MKU Co-op, Press Ltd., Palkalai Nagar, Madurai.
3. Gurumani N (2006). Research Methodology for Biological Sciences.First edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai.
4. Subramanian MA (2005). Biophysics – Principles and Techniques. First edition, MJP Publishers, A Unit of Tamil Nadu Book House, Chennai.
5. John G Webster (2004). Bioinstrumentation.Student edition.John Wiley and Sons, Ltd.
6. Ravishankar S (2001). A Text Book of Pharmaceutical Analysis.Third edition.Rx Publications, Tirunelveli.
7. Upadhyay&Upadhyay. Biophysical Chemistry**,** (2010). Himalaya Publishing house

3. 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 EinarRingo, 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 *Penaeusmondon*, 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.

4. Synthetic Biology and itsApplications

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

5. 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. DebasisBagchi, ManashiBagchi, Hiroyoshi Moriyama, FereidoonShahidi, "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. BalajiSitharaman "Nanobiomaterials Handbook", Taylor & Francis Group, 2011.
7. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005.

6. Microbial Drug Discovery and Management of Drug Resistance

Objectives:

To provide an in-depth knowledge about the development of new antimicrobial agents using standard guidelines of NCCLS and CLSI.
To make a clear understanding of Pharmacogenomics.
To give a brief knowledge about the databases and tools used for drug designing.
To furnish the ideas regarding clinical trials and guidelines of FDA.
To provide knowledge on the discovery of drugs from microbial resources and management of the drug resistant microorganisms.

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Unit 1 : Screening and development strategies for new antimicrobial agents acting on bacterial cell wall, cell membrane, nucleic acid and protein metabolism, Bioassay of antibacterial agents in liquid media and in agar media using standard guidelines (e.g. National Committee for Clinical Laboratory Standards (NCCLS)/Clinical and Laboratory Standards Institute (CLSI)).
(12 h)

Unit 2: Drug discovery-Historical perspectives, Current approaches to drug discovery-Rational Drug design, receptor/target concept in drug designing, Introduction to pharmacogenomics, Phases of drug discovery: Bioprospecting, Principles of extraction, purification and characterization of bioactive molecules from natural resources. (12 h)

Unit 3: Search of database/data mining for Drug designing, Preclinical and Clinical trials, Estimation of toxicity-LD50, Acute, subacuteand chronic toxicity, Rational drug design-principle (Structure activity relationship- SAR) and Tools (applications of High through Put Screening, Combinatorial synthesis). (12 h)

Unit 4: Regulatory authorities for introduction of medicines in market-Role of Food and Drug Administration, FDA guidelines for drugs/biologicals, Validation (GMP,GLP, GCP, etc.), Clinical studies: Phase I, phase II, phase III and phase IV of clinical trials-Objectives, Conduct of trials, Outcome of trials, Drug distribution in body, bio-availability and pharmacokinetic studies.

(12 h)

Unit 4: Mechanisms of bacterial resistance to host cellular (phagocytosis) and humoraldefences, Antibiotic/Drug resistance-origin, cause and clinical implication with special references of multidrug resistant tuberculosis and MRSA.

(12 h)
Total (60 h)

References

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges.Essential Microbiology for Pharmacy and Pharmaceutical Science.(2013).Wiley Blackwell.
4. S. P. Vyas& V. K. Dixit.Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
6. Gregory Gregoriadis. Drug Carriers in Biology & Medicine. (2001). Academic Press New York.
5. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.

7. MicrobesandClean 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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Unit1: 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)

Unit2: 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)

Unit3: Food Industry Waste: Food processing industrial waste-solids and liquids-ultimate goal of green productivity- Zerodischarge-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, biodegradableproducts-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 textpdf
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.

8. Microbiome,Metagenomicsand MolecularTechniques

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 metagenomiclibraries; Sequence-based metagenomics Analysis; Functionbasedmetagenomicsanalysis; Phylogenetic analysis and comparative genomicssoftwares& 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 ;Metagenomicanalysis of Bacteriophage; metagenomics and its applications to the study of the human microbiome; Archaealmetagenomics: 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 deoxynucleotidyltransferase, 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

9. Advanced MarineMicrobiology and Extremophiles

Objectives

- Marine microbes are fundamental players of marine food webs. They mediate in all fluxes of matter and energy in the oceans. Many important microbes are recorded from extreme environments from marine habitat.
- The aim of this course is to provide the students with a basic theoretical and practical understanding of the interactions between microorganisms and ocean processes and discuss their future role in a rapidly changing planet.
- This advance course will also build up a strong scientific base from the oceanographic properties and processes affecting microbial life through extensive review of microbial ecology, role of these microorganisms in global biogeochemical cycles and physiological adaptations to extreme ecological conditions.

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Unit 1: **Marine Microbial Ecology:** Vertical structure and physico-chemical gradients in the ocean - The physical nature of the ocean (stratification / mixing, light gradients) - Chemical and biological vertical partitioning -overview on structure and function of microbial communities in the oceans including discussions on novel methods, results and hypotheses - Current understanding of microbial diversity - Microbial diversity and evolution - physiology and interactions with the environment – Microbes in marine sediments - Role of microbes in biogeochemical cycles. Invasive microbial species - ship ballast water -introduction of alien species in new ecological areas and their effects.

(12h)

Unit 2: **Microbial growth and marine food webs:**Marine microbes – bacteria, fungi, phytoplankton, zooplankton, viruses: Modes of microbial growth: viable but non-culturable (VBNC) microorganisms, Marine Biofilm, microbial mats, epibiosis. - physiology and contribution to ocean processes - Marine bacteria and the carbon cycle- UV radiation effects on microbes and microbial processes- uptake and regeneration of inorganic nutrients by marine heterotrophic bacteria. Bacterivory: interactions between bacteria and their grazers- Mixotrophy among pelagic microorganisms.

(12 h)

Unit 3: **Marine Symbiotic Microbes and their importance:**Symbiosis in marine organisms with special reference to microbes: Symbiotic marine bacteria with other marine organisms - Endosymbionts (Ex: Sponge-microbial interaction; sea weedsmicrobes interaction) - Molecular methods and conventional methods for studying symbiotic bacteria – Marine endophytic fungi and their significance - Global Ocean Survey of Marine Metagenomics. Methods to study marine microbial diversity: flow cytometry; molecular approaches such as metagenomics, community fingerprinting and Fluorescence *in situ* hybridization (FISH).

(12 h)

Unit 4: **Physiology of marine microbes**: Metabolic diversity and energy-yielding processes in marine microbes: microbial loop - marine snow; phototrophy and primary productivity, fermentation, aerobic respiration, anaerobic respiration (denitrification, sulphate reduction, methanogenesis); nitrification, annamox, sulphur oxidation, methanotrophy; carbon dioxide fixation in autotrophs; the role of microorganisms in biogeochemical cycling: carbon- nitrogen - phosphorous- sulphur- iron- manganese.

(12 h)

Unit 5: **Extremophils :** Concept of extremophiles versus conventional microbial forms and archaea – Genetic basics of adaptation - Anaerobes (Ex: *Anaerobrancahorikoshi, Methanobacteriumthermoautotrophicus*) - Microbial communities in Deep sea (piezophilic/ barophilic microorganisms in the deep sea), Aphotic Zone and Hydrothermal vents - Microbial diversity and factors influencing microorganisms in polar environments: Archaea – Thaumarchaeota; Bacteria - *Glaciecolapsychrophila, Pseudoalteromonashaloplanktis, Marinomonaspolaris;* cyanobacteria – Oscillatoria; fungi and yeast - *Glaciozyma Antarctica* - Cellular, structural and physiological characteristics, community interactions and food webs - Biotechnological importance of extremophilic microorganisms: psychroenzymes, anti-freeze proteins, novel antibiotics and other bioactive compounds.
(12h)

Total (60)

Reference

1.A practical handbook of seawater analysis. Strickland, J.D.H and Parsons, T.R. Fisheries Research Board of Canada, Ottawa. (1972).

2.Extremophiles in Deep Sea Enbironments. K. Horikoshi, K. Tsujii. Springer Science & Business Media.316 pages (1999).

3.Marine Microbiology: Ecology and Applications (C. Munn, Garland Science, 2011)

4.Marine viruses and global climate change. FEMS Microbiology Reviews, 35: 993–1034. (Danovaro, R., Corinaldesi, C., Dell'Anno, A., Fuhrman, J.A., Middelburg, J.J., Noble, R.T., Suttle, C.A. 2011) .

5.Microbial Ecology of the Oceans. (Third Edition).J.M. Gasol and D.L. Kirchman (Editors). 528 pages (2018).

6.Methods of Seawater Analysis (Third Edition). K. Grasshoff; K. Kremling and M. Ehrhardt Print ISBN:9783527295890 (2007)

7.Polar Microbiology: The ecology, biodiversity and bioremediation potential of microorganisms in extremely cold environments, Bej, A. K., Aislabie, J. and Atlas, R. M., CRC Press (2009).

8.Extremophiles: Microbial Life in Extreme Environments. Horikoshi, K and Grant, W.D (Eds). 322pp. (1998).

10. Emerging and Re-emerging Microbial Infectious Diseases in India

Objectives:

i. To create an awareness about the re-emerging infectious diseases.
ii. To inculcate the significance of microbiology in the diagnosis and treatment of infectious diseases.
iii. To learn the molecular diagnostic procedures.

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Unit 1: Emerging and re-emerging infectious diseases - Epidemiological triad of disease - Factors contributing to emergence: Agent. Antimicrobial drug resistance, Host and Environmental factors.Role of Microbiology in diagnosis - Role of public health professionals- Strategies to reduce threats.

(12 h)

Unit 2: Emerging bacterial diseases - Zoonotic diseases: Leptospirosis, Brucellosis, Anthrax, Rickettsial diseases - Food and water borne diseases: Enterohaemorrhagic*Escherichia coli, Vibrio cholerae, Listeria monocytogens, Campylobacter spp*; Drug resistant bacteria - Drug resistant Mycobacterium tuberculosis, Drug resistant *Staphylococcus aureus* (MRSA, VISA,VRSA, VRE), AMR N*eisseria gonnorhoeae*; Mellidiosis - Chronic neoplastic diseases : *Helicobacter pylori, Chlamydiae, Pneumoniae*.

(12 h)

Unit 3: Emergence of viral diseases: Indian scenario - Nipah virus, Hantavirus, Chikungunya virus, Human entero virus 7i (EV-7i). Influenza virus, Avian influenza (H5N1), Chandipura virus, Crimean Congo virus, Haemorrhagic fever, SARS, Coronavirus, Buffalopox, Dengue, Japanese encepahlitis, Rotaviruses, Noroviruses, Bocaviruses, Parvoviruses B-19.

(12 h)

Unit 4: Emergence of fungal infections - Non albicans candida, *Penicilliummarneffi, Apophysomyces spp., Fusarium, Trichosporon, Curvularia, Alternaria, Zygomyces, Aspergillus,* Pencillosis, Histoplasmosis.

(10h)

Unit 5: Diagnostics: Traditional Microbial typing - Biotyping, Antibiograms, Resistograms and Bacteriocin typing. Protein analysis, Phage analysis, Chromatographic analysis, Nucleic acid based typing systems - plasmid analysis, restriction enzyme pattern, Ribotyping, RAPD, Nucleic acid probes, Branched DNA signal amplification. PCR Methods - RT-PCR, nested PCR ,Mutiplex PCR, broad range PCR, Trancription based amplification system (TAS), Ligase chain

Reaction (LCR), Strand displacement amplification (SDA), qβ - replicase system. Current applications of molecular diagnostics in clinical microbiology, clinical epidemiology and infection control.

(14h)

Total (60h)

References:

1.Emerging and Re-emerging Infectious Diseases , Subhash Chandra Parija, JaminiKantaDutta, Tarun Kumar Dutta, Jaypee Brothers Medical Publishers, Karnataka.

2. Emerging Infectious Diseases and Society, Washer, Palgrave Scholarly, UK

3.Pandemics and Emerging Infectious Diseases, Staniland Hoffman Dingwall, Wiley-Blackwell Publishers, USA.

4. Emerging infections 6 6th Revised edition Edition, Barbara E. Murray,W. Michael Scheld,James M. Hughes, American Society For Microbiology, USA.

5.Human Emerging and Re-emerging Infections, 2 Volume Set 1st Edition, Sunit Kumar Singh, Wiley-Blackwell Publishers, USA

11. 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. Staneberryet 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. NdukaOkafor (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.

12. Bioentrepreneurship and STARTUPS

Objectives

This course gives the students an oversight as how an idea can lead to a business. The contents give knowledge into making a business plan, market growth, managingcompetitions, human resource planning and financing the company.

L T P C
4 0 0 4

Unit 1: From an idea to a company – developmental stages of a business, innovative business ideas, benefit to the customer, unique selling proposition (usp), market and competitors, profitability scenario, protecting your idea, formal presentation of the business idea (12 h)

Unit 2: The business plan-product idea-management team, building a strong team, the founders and their shares, introducing the team, market and competition, defining your market, choosing your target market, positioning vis-à-vis competitors, market growth and market life cycle, competitors analysis (12 h)

Unit 3: Barriers to market entry and patent strategy, designing a strategy to keep the competition out, patents – essential market entry barriers in the life sciences Marketing and distribution, use of marketing tools, business organization and processes (12 h)

Unit 4: Human resources planning-make or buy – outsourcing and cooperation agreements, legal forms, partnerships and joint ventures, location planning - implementation plan, fundamentals of planning, effective planning, potential consequences of poor planning, presenting your plans

(12 h)

Unit 5: Finance and financial planning- opportunities and risks, Financing options , financing planning, using ratios to assess a business Risks , risk assessment and sensitivity analysis, typical crisis situations of companies, presenting opportunities and risks (12 h)

Total (60 h)

References

1.Bob businessplan handbook 2017

2. www.bestofbiotech.at/content.node/media/bob_businessplan_handbook_2017.pdf

3. The entrepreneur's guide to a biotech startup, 4th edition - uclactsi**.**

4.Https://www.ctsi.ucla.edu/researcher-resources/files/view/docs/egbs4_kolchinsky.pdf

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