MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI

Ph.D. course work study papers in Marine Biotechnology

Ph.D. Marine Biotechnology

(With effect from the academic year 2018-19 onwards)

Details for Course Work Papers

Sl. No.	Subject Title
1	Nanoscience and Nanobiotechnology
2	Marine Biofouling
3	Marine Natural Products
4	Bioethics and Biosafety
5	Extremophiles
6	Animal Cell Culture Technology
7	Marine Pharmacology
8	Research Methodology
9	Marine Toxicology
10	Marine Genomics & Proteomics
11	Marine Planktology
12	Mini Project

NANOSCIENCE AND NANOBIOTECHNOLOGY

L T P C
4 0 0 4

Objectives:

The objective of this course is to be familiar with the synthesis and preparation of nano-structured materials and to understand the chemical background involved in the chemical reactions, their characterization.

Unit I: Classification of Nanomaterials and Synthesis: Nanomaterials as nano particles and 1D, 2D, 3D nanomaterials. Concept of bulk versus nanomaterials and dependence of properties on size. Introduction to 'Top down' vs. 'Bottom up' approach of synthesis. Nano synthesis techniques based on liquid and vapour phase as the starting material. The study of wet chemical method like sol-gel method, micro emulsion technique, reduction of metal salts, decomposition of organometallic precursors, organic block copolymers, cryochemical synthesis. Study of rapid solidification route, electro and electroless deposition etc. **(12 h)**

Unit II: **Protein and DNA Based Nanostructures:** Introduction to nanolithography and self-assembly routes. Preparation of quantum dots, nano wires and films, preparation of single-walled and multi-walled nanotubes; Nanocircuitry – S-layer proteins: structure, chemistry and assembly – lipid chips – S – layers as templates – engineered nanopores – DNA - Protein nanostructures DNA-based metallic nanowires and networks, DNA - Gold - Nanoparticle conjugates. **(12 h)**

Unit III: Nanostructured Materials Characterization Techniques: Techniques on characterization of size of nano powders/ particles using BET method and laser diffraction. X-ray diffraction (XRD), SEM, EDAX, TEM, Elemental mapping, FTIR, UV-Visible spectrophotometer, Laser Raman Spectroscopy, Nanomechanical Characterization using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), Electrochemcial Characterization measurements. **(12 h)**

Unit IV: Nanobiomaterials and Biocompatibility: Surface and bulk properties of biomaterials – Nanobiomaterials –Nanoceramics – Nanopolymers – Nano silica – Hydroxy apatite – Carbon based nanomaterials surface modification – Textured and porous materials – Surface immobilized biomolecules – Cell-biomaterial interactions – immune response – *In vitro* and *in vivo* assessment of tissue compatibility. **(12 h)**

Unit V: **Nanotechnology in Agriculture and Food Technology:** Nanotechnology in agriculture - Precision farming, Smart delivery system – Nanofertilizers: Nanourea and mixed fertilizers, Nanofertigation - Nanopesticides, Nanoseed science. Nanotechnology in Food industry – Nanopackaging for enhanced shelf life - Smart/Intelligent packaging - Food processing and food safety and bio-security – Electrochemical sensors for food analysis and contaminant detection. **(12 h)**

Total 60 h

References

1. Nanomaterials Chemistry by C.N. Rao, A. Muller, A.K. Cheetham, Wiley VCH, 2007.
2. Nanoscale Materials in Chemistry by Kenneth J. Klabunde, Wiley Interscience Publications, 2001.
3. Nanochemistry by G.B. Sergeev, Elseiver Publication, 2006.
4. Nanomaterials – Handbook by Yury Gogotsi, CRC Press, Taylor & Francis group, 2006.
5. Biomaterials: A Nano Approach, Seeram Ramakrishna, Murugan Ramalingam, T.S. Sampath Kumar, Winston O. Soboyejo, CRC Press, 2010.
6. Bionanotechnology: Lessons from Nature, David S. Goodsell, by John Wiley & Sons, Inc., 2004.
7. Nanobiotechnology: Concepts, Applications and Perspectives, Eds. Christof M. Niemeyer and Chand A. Mirkin, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2004.

MARINE BIOFOULING

L T P C
4 0 0 4

Objectives:

This course will introduce the concept of marine pollution, biofouling patterns and their control technology.

Unit 1: Fouling and Corrosion: Biofouling, biofilm formation; Marine fouling and boring organisms - their biology, adaptation; Factors influencing the settlement of macrofoulers; Antifouling and Anti boring treatments; Corrosion process and control of marine structures. **(12 h)**

Unit 2: Marine Pollution and Biodeterioration: Marine pollution-major pollutants and Biological indicators (e.g., Marine microbes, algae and crustaceans) and accumulators, Oil pollution: Sources, composition and its fate in marine habitats. Treatment options available, case studies, Thermal and radioactive pollution: sources, effects and remedial measures. Solid dumping, mining and dredging operations: their effects on marine ecosystem, Biofouling and biodeterioration: Agents and protection methods. **(14 h)**

Unit 3: Biofouling Patterns: Biofouling patterns with depth, Natural control of fouling, Freshwater biofilms, Biofilms in medicine, Fouling on artificial substrata, Paint and coatings technology for the control of marine fouling, Fouling on shipping: Data-Mining the World's largest Antifouling archive. **(12 h)**

Unit 4: Biofouling and Control Technology: Biofouling organisms - Problems due to biofouling - Antifouling paints and its environmental pollution - Biotechnological approach to control of biofoulers. **(12 h)**

Unit 5: Biofouling, Biocorrosion and Biomaterials: Microorganisms in biofouling and biocorrosion. Biofilms and general mechanisms in biocorrosion. Biocorrosion and biofouling – Mechanisms, failure analysis and control. Biomaterials and human implants. **(10 h)**

Total 60 h

References

1. Fouling Organisms of the Indian Ocean, Biology and Control Technology, Nagabushanam, R and Thompson, M.F. (Eds), Oxford and IBH Publishing Co. Pvt. Ltd, 1997.
2. Absorption of Microorganisms to Surfaces, Bilton, G. and Marshall. C. (Eds), John Wiley and sons, New York, 1980.
3. Marine Biodeterioration: an Interdisciplinary Study, Costlow, J.D. and Tipper, R.C. (Eds), Naval institute press, Annapolis, 1984.
4. Environmental Biotechnology, Principles and Applications, Bruce E. Rittmann and Perry L. McCarthy, McGraw Hill, 2001.

MARINE NATURAL PRODUCTS

L T P C
4 0 0 4

Objectives:

This course work will provide an understanding on the marine environment and its metabolites, as it became a focus of natural products drug discovery research because of its relatively unexplored biodiversity compared to terrestrial environments.

Unit 1: Introduction to Marine Natural Products: Survey, resource assessment, sampling and identification of organisms containing bioactive compounds. Theories of drug action and factors affecting drug action. **(10 h)**

Unit 2: Significance of Marine Natural Products: Isolation techniques- liquid-liquid extraction, membrane separation methods, chromatography (Paper, TLC, HPLC) techniques. Characterization techniques- IR, UV, NMR and Mass Spectral analysis. **(12 h)**

Unit 3: Types of important products: Antibiotic, anti-tumour, tumour-promotor, anti-inflammatory, analgesic, cytotoxic, anti-viral and anti-fouling compounds of marine origin. Marine toxins- saxitoxin, brevitoxin and ciguatoxin. Marine peptides and alkaloids- pyridoacridine, pyrrolocridine indole, pyrrole, isoquinoline alkaloids. Marine prostaglandins and marine cosmetic products. **(14 h)**

Unit 4: Important Products isolated from Marine Organisms and Their Uses: Marine colloids and hydrocolloids, agarose, agar, alginate, carageenans, chitin, chitosan and glucosamines – their extraction process, methods of purification, their importance and uses. **(12 h)**

Unit 5: Other By-Products from Marine Organisms: Fish meal, silage products, FPC, fish hydrolydate, fish flakes, fish glue, pearl essence, fish peptones – their production process and importance. **(12 h)**

Total 60 h

References

1. Fish Resources of the ocean – J.A. Gulland, Fishing News (Books) Ltd., England, 1971.
2. Pharmaceuticals and the Sea - C.W. Jefford, Kenneth L. Rinehart, Lois S. Shield, Taylor & Francis, 1988.
3. *Marine Natural Products* – Editors: Paul J. Scheuer, 1st Edition, Academic Press, 1998.
4. *Bioactive Marine Natural Products* - **Bhakuni**, S. Dewan, D.S. **Rawat**, Springer, 2005.
5. Fish and fish products – A.L. Winton, B.K.B. Winton, Allied Scientific Publishers, 1998
6. Fishery by products (CIFT Manual) – CIFT Publications, Cochin, India, 2002.

BIOETHICS AND BIOSAFETY

L T P C
4 0 0 4

Objectives:

Aims to study the typically controversial ethical issues emerging from new situations and possibilities brought about by advances in biology and medicine. It is also moral discernment as it relates to medical policy, practice, and research and the prevention of large-scale loss of biological integrity, focusing both on ecology and human health.

Unit 1: Biosafety-Regulatory Framework for GMOs in India: Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), State Biosafety Coordination Committee (SBCC), District Level Committee (DLC). Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification (1989). **(14 h)**

Unit 2: Biosafety-Regulatory Framework for GMOs at International Level: Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.

(12 h)

Unit3: Bioethics: Distinction among various forms of IPR, Prior art for a patent, Patenting live microorganism, Human genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals. Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal. **(12 h)**

Unit 4: Intellectual Property Rights: Concept of property, rights, duties and Jurisprudential definition, Introduction to patent, copy right, trademarks, Design, geographical indication. History and evolution of IPR, Economic importance of IPR, Indian patent act 1970 (amendment 2000), Distinction among various forms of IPR, invention step, biopiracy and bioprospecting-Appropriate case studies. Infringement/violation of patent, remedies against infringement (civil, criminal, administrative) **(12 h)**

Unit 5: Patents and Patent Laws: Plant and Animal growers rights patents trade secrets, and plant genetic recourses GATT and TRIPS, Dunkels Draft Patenting of biological materials, Current Issues of Patents for higher animal and higher plants, patenting of transgenic organisms, isolated genes and DNA sequences. **(10 h)**

Total 60 h

References

1. Biotechnology and Patent Protection – An International Review - F.K. Beier, R.S. Crespi, and J. Straus, Oxford and IBH Publishing Co. New Delhi, 1985.
2. Intellectual Property Rights and Biotechnology (Biosafety and Bioethics) - Anupam Singh and Ashwani Singh, Narendra Publishing House, New Delhi, 2012.
3. Biotechnologies and Development, A. Sasson, UNESCO Publications, 1988.
4. Intellectual Property Rights on Biotechnology – K. Singh, BCIL, New Delhi, 2010.
5. IPR, Biosafety and Bioethics – Deepa Goel, Shomini Parashar, Pearson, New Delhi, 2013.
6. Regulatory Framework for GMOs in India - Ministry of Environment and Forest, Government of India, New Delhi, 2006.
7. Cartagena Protocol in Biosafety - Ministry of Environment and Forest, Government of India, New Delhi, 2006.

EXTREMOPHILES

L T P C
4 0 0 4

Objectives:

This course will provide an understanding about the extreme microorganisms and their applications.

Unit 1: Microbes in Extreme Environments: Thermophilic, alkalophilic, asmophilic, barophilic, psychrophilic microorganisms – Hyperthermophilic and halophilic organisms and their importance in biotechnology. **(12 h)**

Unit 2: Classification and Characteristics of Archaebacteria: Halophiles – Dead Sea – halotolerence – Applications of halophiles and their extremozymes. Barophiles – high pressure habitats, life under pressure, barophily, death under pressure. **(12 h)**

Unit 3: Biotechnological Applications of Extremophiles in Bioprocessing: diagnostics, molecular biology, food industry, genetic engineering, geo-microbiology sectors. **(10 h)**

Unit 4: Thermophiles: History and discovery of hyper thermophiles, Carbohydrate-active enzymes from hyper thermophiles. Lignocellulose converting enzymes from thermophiles. Enzymes involved in DNA amplification (e.g., polymerases) from thermophiles, evolution of PCR enzymes. Metalloproteins from hyperthermophiles. **(14 h)**

Unit 5: Psychrophiles: Ecology of Psychrophiles-Subglacial and permafrost environments. Taxonomy, adaptative mechanisms of psychro tolerant bacterial pathogens. Psychrophilic enzymes, Acidophiles: Physiological features, adaptative strategies, growth kinetics and enzymes of various extremophilic acidophiles. **(12 h)**

Total 60 h

References

1. Microbiology, Prescott, Harley and Klein, W.C. Brown publishers, 2006.
2. Bacterial Systematics, N.A. Logan, Blackeell Scientific publishers, 1994.
3. Biology of Microorganisms, T.D. Brock and M. T.Madigan, Prentice Hall publishers, 1991.
4. Microbiology, M.J. Pelczar and Reid, 5th Edn., Tata Mc Graw Hill Co., New Delhi, 1986.
5. Introduction of Microbiology, Robert G. Arnegar, Mac Millan, New York, 1973.

ANIMAL CELL CULTURE TECHNOLOGY

L T P C
4 0 0 4

Objectives:

Animal cell culture is an important course for any biotechnology-related training program because it is a technique that must be performed by investigators before they perform many molecular procedures and vertebrate cell culture is becoming increasingly important for biomanufacturing of therapeutic proteins.

Unit 1: Introduction and Biology of Cultured Cells: Introduction - historical background-technological innovations in development of cell and tissue culture-types of tissue culture-culture environment- cell adhesion, cell proliferation, differentiation, cell signalling, energy metabolism- selection –cell line development. **(12 h)**

Unit 2: Laboratory Design: Requirements, ventilation - design and layout, Equipments - sterile working area, incubation and culture, preparation and sterilization, storage, supplementary and specialized equipments; aseptic techniques - sterile handling, standard procedure; safety protocols - biohazards, bioethics and quality assurance. **(12 h)**

Unit 3: Culture Vessels and Media Development: Culture vessel-substrate, substrate coating, choice of culture vessel, specialized systems; Media development - physicochemical parameters, balanced salt solutions, complete media, serum, selection of media, supplements. Serum-free medium development and sterilization. **(12 h)**

Unit 4: Primary Culture, Secondary Culture, Cloning and Selection: Isolation of tissue, types of primary culture, subculture and cell lines, cloning and selection- monolayer clones and suspension clones, Contamination, cryopreservation and cytotoxicity. **(12 h)**

Unit 5: Organo-typic Culture and Specialized Cell Culture Techniques: Cell separation, characterization, differentiation & transformation; organ culture- histotypic culture -organotypic culture; Culture of specialised cells - epithelial, mesenchymal, neuroectodermal, hematopoietic and tumour cell culture; stem cell culture. **(12 h)**

Total 60 h

References

1. Culture of Animal Cells, 6th Edition- R Ian Freshney – John Wiley & Sons, Inc., 2016.
2. Cell Culture Technology: Recent Advances and Future Prospects (Euroscicon Meeting Reports Book 1) - Oystein Bruserud, Astrid Englezou – Honnao Publishers, 2012.
3. Vertebrate Cell Culture II and Enzyme Technology: Volume 39 (Advances in Biochemical Engineering/ Biotechnology) - A.F. Bückmann et al., Springer, 2013.
4. Animal Cell Culture and Technology (The Basics) (Garland Science)) - Michael Butler, CRC Press, 2003.
5. The Immortal Life of Henrietta Lacks - Rebecca Skloot, Crown, 2010.

MARINE PHARMACOLOGY

L T P C
4 0 0 4

Objectives:

This course enables the students to know the efficacy and specificity of the different classes of drugs available from marine resource.

Unit 1: Terms and Definitions: Pharmacokinetics – ADMET properties- drug metabolism; Bioavailability; Pharmacodynamics – Dose response relationship, drug receptors- interactions-quantification. **(12 h)**

Unit 2: Biologically Active Compounds from marine flora, fauna and microbes – Anti-bacterial anti-fungal, anti-viral, anti-parasitic, anti-inflammatory and cytotoxic compounds, anti-coagulants and marine toxins. Fish pharmacological and pharmacodynamical agents: - vaccines, immunostimulants, breeding induction agents, osmoregulators, disinfectants. **(12 h)**

Unit 3: Bioprospecting of Marine Natural Products: Isolation, structural elucidation and mode of action. Biological evaluation of novel compounds-Primary screens-broad spectrum evaluation; secondary screens- binding assays, functional activity, reporter gene assay, phamacodynamic assays; animal models- preclinical proof of concept. Strategy and tactics in drug discovery-target identification and validation, lead identification, optimization-candidate selection. **(14 h)**

Unit 4: Computational Chemistry: Introduction- basic toolkit-protein modelling programs-structural information-X-ray crystallography, NMR, databases- Docking and virtual screening-prediction of binding energies- homology modelling- QSAR. **(12 h)**

Unit 5: Drug Safety: Methods of drug administration, antibiotic hazards and biotransformation; Toxicology in drug discovery process- toxicity assessment-in vivo, in vitro, in silico systems; - genetic toxicity- target organ toxicity; Novel technologies in safety assessment-toxicogenomics, proteomics, NMR; ethical issues; IPR and patents. **(12 h)**

Total 60 h

References

1. Pharmacolgy – Rapid Review – T. Pazdernik, L. Kerecsen, Elseiver Health Sciences, 2010.
2. Essentials of Medical Pharmacology, 8th Edition - K.D. Tripathi, Jaypee Brothers Medical Publishers, 2018.
3. Marine Natural Products – D.S. Bhakuni, S. Devan and D.S. Rawat, Springer, 2005.
4. Applied Fish Pharmacology, 2nd Edition – John F. Burka, Kluwer Acudemic Publishers, 2000.
5. Medicinal Chemistry- Principles and Practice, 2nd Edition, Frank. D. King (Ed.), Glaxosmithklime, UK, 2002.

RESEARCH METHODOLOGY

L T P C
4 0 0 4

Objectives:

This course will introduce the concept and methods of research, to impart knowledge on scientific procedures on preparing research reports and papers and making presentations and to provide information on preparing research projects, research ethics and impact factors of publications.

Unit 1: **Foundations of Research**: Meaning, objectives, motivation, utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific methods – Understanding the language of research – Concept, construct, definition, variable, research process. Problem identification and formulation – Research question – Investigation question – Measurement issues. **(12 h)**

Unit 2: Research Design: Concept and importance in research – Features of a good research design – Exploratory research design – concept, types and uses, Descriptive research designs – concept, types and uses. Experimental design: Concept of independent and dependent variables. Qualitative and quantitative research: Qualitative research – Quantitative research – Concept of measurement, merging the two approaches. **(12 h)**

Unit 3: Sampling: Concepts of statistical population, sample, sampling frame, sampling error, sample size, non response. Characteristics of a good sample. Probability sample – Simple random sample, systematic sample, stratified random sample and Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. **(12 h)**

Unit 4: Data Analysis: Data preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations numerical and graphical presentation of data; Measures of central tendency; Measures of dispersion; Testing of significance of hypothesis by student's t-test, paired t-test and Fisher's t test; Determination of correlation coefficient between two variables; Regression analysis; Analysis of variance; Chi-square test including testing hypothesis of association Post-hoc test; Basic statistical modelling. **(12 h)**

Unit 5: Interpretation of Data and Paper Writing: Layout of a research paper, Journals in life science, Impact factor of journals, When and where to publish?, Ethical issues related to publishing, Plagiarism and self-plagiarism. Use of tools/techniques for research: Methods to search required information effectively. Reference management software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of plagiarism.
(12 h)

Total 60 h

References:

1. Introducing Research Methodology – A Beginners Guide to do Research Project – Uwe Flick, 2nd Edition, SAGE Publishing, 2015.
2. Quality Inquiry and Research Design: Choosing among five approaches – John W. Creswell, Cheryl N. Poth, 4th Edition, SAGE Publications Inc, 2017.
3. Research Methodology – Methods and Techniques, C.R. Kothari and Gaurav Garg, New Age International Publishers, 2019.
4. Biostatistics – P.N. Arora, P.K. Malhan, Himalayan Publishing House, 2010.
5. Statistical Methods – S.P. Gupta, S. Chand & Sons, New Delhi, 2017.
6. Biostatistical Analysis – Jerrold H. Zar, 5th Edition, Northern Illionois University, Pearson, 2010.

MARINE TOXICOLOGY

L T P C
4 0 0 4

Objectives:

This course will provide an understanding on different marine habitats: salt marshes, mangroves, corals, barrier beaches, rocky coastlines and openocean. This course will give opportunity to take a close look at coastal ecosystems, and learn about the scientific sampling techniques in the field and also the sample handling and analyses techniques in the lab.

Unit 1: Coastal and Marine Ecosystems: Estuarine and mangrove ecology – Soft sediment ecology - Salt marsh ecology - Coral reef ecology - Rocky intertidal ecology - Hydrothermal vents ecology - Polar ecology - Human impacts on the marine environment and biofouling.**(10 h)**

Unit 2: Marine Ecotoxicology and Toxicants: General introduction and principles on marine toxicology – General chemistry of different types of pesticides and toxicants like organochlorine, organophosphate, PCBs, POPs, PAH, Dioxins, heavy metals – Effect of Toxicants on animal physiology – Global transport of POPs – Mercury and Lead cycling in the environment. **(12 h)**

Unit 3: Metal Sources in Marine Environment and Their Impacts: Natural, anthropogenic, metal retention in sediments, role of grain size, organic matter, Fe-Mn oxides, sulphides. Bioaccumulation of metals: definition, metal accumulation in benthic biota, Arsenic bioaccumulation in biota of the Sundarban mangrove wetland – a case study. Bioaccumulation factor (BAF): concept of Bioconcentration, Bioconcentration factor (BCA), harmful effects of bioaccumulation of metals on biota, Biomagnification in trophic levels – risk to human health. Metal accumulation in mangroves, Remediation of metal contamination: phytoremediation, techniques of phytoremediation, phytostabilization, phytodegradation and advantages & disadvantages of phytoremediation. **(16 h)**

Unit 4: Toxicology: Principles of toxicology, dose-response relationships, chronic and acute toxicity; effective concentration, LD_{50}, Median tolerance limit and Margin of safety; Toxicity testing (holistic and numeric approach). Uptake, bioaccumulation, bio-transformation and excretion of xenobiotics. **(10 h)**

Unit 5: Risk Assessmesnt: Aquatic toxicology testing methods – Chemical uptake, transformation, elimination and accumulation – Marine and estuarine invertebrate toxicity tests - Bioassays and biomarkers – Multi-species test systems – Biodegradation – Factors influencing bioaccumulation and trophic transfer – Sub-lethal effects – Acute and chronic lethal effects – Risk assessment of contaminants on communities and ecosystems. **(12 h)**

Total 60 h

References

1. Toxicology- The Basic Science of Poisons - Klaassen, D. Curtis, 7th Edition, McGraw-Hill, 2008.
2. Essentials of Toxicology - Curtis D. Klaassen, John B. Watkins III, 3rd edition, LANGE, 2015.
3. Environmental Toxicology – D.A. Wright, P. Welbourne, Cambridge University Press, 2002.
4. Principles and Practices of Toxicology in Public Health - Ira. S. Richards, Barlett Publications, 2008.
5. Trace Elements in Terrestrial Environments – D.C. Adriano, Springer Science, 2001.
6. Bioaccumulation in Marine Organisms – J.M. Neff, Elsevier Ltd, 2002.

MARINE GENOMICS AND PROTEOMICS

L T P C
4 0 0 4

Objectives:

The objective of this course is to get a thorough knowledge about the marine genomics and proteomics and the techniques involved in it.

Unit 1: Genomes and Genomics: Genomics as a discipline, Structure and organization of genomes- prokaryotic, eukarytoic, organellar genomes, transposable elements, Beyond the genome-Epigenome, Central dogma revisited, Genome function, chromatin modification and gene expression, transcription initiation, synthesis and processing of RNA, synthesis and processing of proteome, Regulons and regulation of gene expression, Genomes of marine organisms, Genomics and human health-Gene Therapy-Somatic and germ-line therapy, Suicide gene therapy; Gene replacement; Gene targeting, Personalized medicine; Pharmacogenomics, Ethical, Legal and Social Implications (ELSI) of genomics. **(12 h)**

Unit 2: Genomic Techniques for Marine Genomics: Genomic libraries of marine organisms, Genome mapping methods, Sequencing genomes- Classical and next generation sequencing methods; Assembly of DNA sequences- methods; Databases-; Primary Databases; Nucleotide Sequence Database - NCBI, EMBL, EBI, DDBJ, Genome databases; Comparative genomics, Functional genomics- Transcriptomics; Computational functional genomics-, ORF and promoter predictions. Intron and exon predictions. Experimental- cDNA libraries of marine organisms, Assigning gene function; Differential gene expression, digital gene expression, DNA and cDNA microarrays. **(12 h)**

Unit 3: Marine Genomics: Population genomics of marine organisms to understand environmental adaptations, Phylogenomics of marine animals, Genomics of marine model organisms; Genomic approaches- fisheries and aquaculture- breeding and reproduction, growth and nutrition, host-pathogen interactions, seafood product quality and safety. Marine metagenomics- Accessing the metagenome, Construction of metagenomic libraries, Metagenome analyses, Library independent metagenomic analyses. **(12 h)**

Unit 4: Structural Proteomics: X-ray crystallography and NMR spectroscopy; Protein engineering; Interaction proteomics- complex isolation of proteins, protein interactionsgenetic methods, affinity approaches, physical methods, Functional proteomics - protein arrays; methods of analysis of protein modifications. **(12 h)**

Unit 5: Marine Proteomics: Marine based drug discovery, Protein structure prediction methods; Homology modeling; Threading and *ab intio* methods; Protein function prediction; Protein structure visualization tools- Rasmol, Swiss PDB Viewer; Target identification and validation; Lead optimization and validation; Structure-based drug design and ligand-based drug design.

(12 h)
Total 60 h

References

1. Genomes, T.A. Brown, 3rd ed. Garland Science, 2007.
2. Introduction to Marine Genomics, Cock, JM, Tessmar-Raibe, K., Boyen, C., Viard F. (Eds)., Springer, 2010.
3. Metagenomics: Theory, Methods and Applications, Diana M. (Ed.), Caister Academic Press, 2010.
4. Introduction to Proteomics: Tools for the New Biology, Liebler D.C., Humana Press Inc., New Jersey, 2002.
5. Principles of Gene Manipulation and Genomics, 7th Edition, Primrose, S.B., Twyman. R.M., Blackwell Publishing, 2006.
6. Principles of Proteomics, Twyman R.M., Garland Science/BIOS Scientific Publishers, New York, 2004.
7. An Introduction to Molecular Biotechnology, Wink, W., Wiley VCH Verlag Gm BH and Co. KGaA, Germany, 2006.
8. Introduction to Bioinformatics: A theoretical and Practical Approach, Stephen A. Krawetz and David D. Womble, Humana Press, Totowa, NJ, 2003.
9. Molecular Approaches to the Study of the Ocean, Cooksey, K.E. (Ed.)., Springer Netherlands, 1998.
10. Discovering Genomics, Proteomics and Bioinformatics, Heyer L. and Campbell A. 2006, Cold Spring Harbor Lab. Press, USA, 2006. .

MARINE PLANKTOLOGY

L T P C
4 0 0 4

Objectives:

This course will give a detailed idea about the phytoplanktons and zooplanktons present in the marine environment, their preservation and commercial applications.

Unit 1: General Planktology: Definition for plankton, history of planktology, Plankton and environment, habit and habitat, nutrition, thallus, organisation and life cycle of commercially important phytoplankton, life cycle of commercially important zooplankton. **(10 h)**

Unit 2: Phytoplankton: Methods for isolation of phytoplankton from the natural stock, Strain improvement, Stock maintenance of isolated species, Culture – Culture media preparation, Continuous culture system, Batch-culture system, Photo bioreactors and its application. Phytoplankton used in aquaculture, Oil industry and algal carotenoid production, Green water Aquaculture and preparation of pure culture of phytoplankton. **(14 h)**

Unit 3: Zooplanktons: General characteristics of zooplankton, Feed and feeding of zooplanktons. Methods for isolation and identification of zooplankton, Stock maintenance, Indoor and outdoor culture of commercially important zooplankton, Improvement of nutritive quality in zooplankton. Preparation of pure culture of zooplankton. **(12 h)**

Unit 4: Plankton and Larval Rearing: Selection and preparation of plankton for larval feeding optimization of physiochemical and biological parameters for the better growth of plankton, Enrichment and storage of planktons. **(10 h)**

Unit 5: Preservation of Plankton: Short term storage – Indoor culture (Stock culture), Longer term storage – Cryopreservation – Introduction to algal cryopreservation, Internal and External cryoprotectants and their advantages and disadvantages, Freezing Techniques – Slow and Rapid Freezing and their advantages and disadvantages, Vitrification – Importance and their advantages and disadvantages. **(12 h)**

Total 60 h

References:

1. Algae Anatomy, Biochemistry and Biotechnology, Laura Barsanthi, Paolo Gualtieri, CRC Press Taylor & Francis Group, 2013.
2. Plankton- A Guide to their Ecology and Monitoring for Water Quality, Iain M. Suthers and David Rissik, CSIRO Publishing, 2009.
3. Introduction to Marine Plankton, Abhijit Mitra, Kakoli Banerjee and Avijit Gangopadhyay, Daya Publishing House, 2004.

4. Introduction to Marine Phytoplankton, Abhijit Mitra, Kakoli Banerjee and D.P. Bhattacharyya, Narendra Publishing House, 2006.
5. Basic and Applied Zooplankton Biology, Perumal, Santhanam, Begum, Ajima, Pachiyappan, Perumal, Springer, 2019.
6. Zooplankton and Phytoplankton: Types, Characteristics and Ecology, Giri Kattel, Nova Science Publishers Inc., 2012.
7. An Introduction to Phytoplanktons: Diversity and Ecology, Avik Kumar Choudhury and Ruma Pal, Springer, 2014.
8. Practical Manuel on Microalgal Technology, M. Michael Babu and T. Citarasu, Southern Book Star Publishers, Trivandrum, 2019.

Websites

1. Plankton - Science Publishing Group sciencepublishinggroup.com/book/download?chapterId=2171&stateId=8000...4
2. Zooplankton Methodology, Collection & Identification – - a field ... - NIO
3. www.nio.org/userfiles/file/biology/Zooplankton_Manual_new.pdf

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