

**M.Sc. Marine Biotechnology Syllabus Scheme (97 Credits available)****CORE COURSES**

<b>Course Code</b>	<b>Name of the Course</b>	<b>No. of Credits</b>	<b>Course Level</b>
MBT 103	PRINCIPLES OF GENETICS & MOLECULAR BIOLOGY	3	100
MBT 104	PRINCIPLES OF OCEANOGRAPHY	2	100
MBL 103	LAB IN MOLECULAR GENETICS	2	100
MBT 111	THE MARINE ECOSYSTEM	2	100
MBT 112	INTRODUCTORY IMMUNOLOGY	3	100
MBT 211	CELL & DEVELOPMENTAL BIOLOGY	3	200
MBT 212	PLANT TISSUE CULTURE TECHNOLOGY	2	200
MBL 111	LAB IN MARINE BIOLOGY & CHEMISTRY	2	100
MBL 112	LAB IN IMMUNOLOGY	2	100
MBL114	LAB IN PLANT TISSUE CULTURE	1	100
MBT 221	BIOPROCESS & INDUSTRIAL BIOTECHNOLOGY	3	200
MBT 222	RECOMBINANT DNA TECHNOLOGY	3	200
MBT 223	ANIMAL CELL CULTURE	2	200
MBL 221	LAB IN FERMENTATION TECHNOLOGY	2	200
MBL 222	LAB IN RECOMBINANT DNA TECHNOLOGY	2	200
MBT 331	POTENTIAL APPLICATIONS OF MARINE ORGANISMS	3	300
MBT 231	AQUACULTURE TECHNOLOGY & MARINE PHARMACOLOGY	3	200
		<b>40</b>	

## OPTIONAL COURSES

Course Code	Name of the Course	No. of Credits	Course Level
MBT 101	FUNDAMENTALS OF GENERAL AND MARINE MICROBIOLOGY	3	100
MBT 102	CONCEPTS IN BIOCHEMISTRY	3	100
MBT 105	BIOSTATISTICS	2	100
MBT 113	BIOINFORMATICS	2	100
MBL 101	LAB IN MARINE MICROBIOLOGY	2	100
MBL 102	LAB IN BIOCHEMISTRY	2	100
MBL 113	LAB IN BIOINFORMATICS	2	100
MBT 106	COMMUNICATION SKILLS & SCIENTIFIC WRITING	2	100
MBT 224	ENZYMOLGY	3	200
MBT 225	MOLECULAR IMMUNOLOGY	3	200
MBL 121	LAB IN ANIMAL CELL CULTURE	2	100
MBL 223	LAB IN ENZYME CHARACTERIZATION	2	200
MBT 332	APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY	3	300
MBT 232	BIOSAFETY & IPR	3	200
MBT 131	CELLULAR BIOPHYSICS	3	100
MBT 333	GENOMICS AND PROTEOMICS	3	300
MBM 131	SCUBA DIVING	2	100
		<b>42</b>	
*MBM 111	SEMINAR PRESENTATIONS	1	100
*MBM 221	SUMMER TRAINING PRESENTATION & REPORT	1	200
*MBM 231	SEMINAR PRESENTATIONS	1	200

*MBM 222	DISSERTATION (MARINE BIOTECHNOLOGY) (Stage I)	4	200
*MBM 331	DISSERTATION (MARINE BIOTECHNOLOGY) (Stage II)	8	300

\*To

be compulsorily opted for

# **M.Sc MARINE BIOTECHNOLOGY SYLABUS**

## **SEMESTER I**

### **MBT 101: FUNDAMENTALS OF GENERAL AND MARINE MICROBIOLOGY**

#### **MODULE I**

- A brief history of microbiology: discovery of the microbial world, controversy over spontaneous generation, role of microorganism in causation of disease, development of pure enrichment culture methods.
- Modern /contemporary microbiology in 21<sup>st</sup> century
- An overview of the organization and cell structure of prokaryotes and archaea:
  - i) cell wall
  - ii) outer membrane
  - iii) cytoplasmic membrane
  - iv) flagella & specialized movements in microbes
  - v) cell inclusions
- Differences among the groups
- Characteristics of marine microorganisms.

#### **MODULE II**

- Microbial nutrition:
  - i) autotrophic & heterotrophic modes,
  - ii) defining culture media to support growth,
  - iii) selective and differential culture media.
- Bacterial growth kinetics:
  - i) growth curve, the mathematical expression of growth & measurement of growth
  - ii) synchronous growth
  - iii) factors affecting growth
  - iv) chemostat & turbidostat.
- Microbial taxonomy:
  - i) nomenclature
  - ii) polyphasic identification, traditional & molecular,
  - iii) Bergey's manual & scheme for identification of marine bacteria.

#### **MODULE III**

- i) Structure & classification.
  - Algae
  - Fungi.
  - Cyanobacteria
  - Bacteria
  - Viruses:

- Viroids & prions
- ii) Specialized microorganisms
  - extremophiles,
  - barophiles,
  - thermophiles,
  - psychrophiles
  - halophiles.
  - anaerobes

## REFERENCES:

1. Brock's Biology of microorganisms. (2007). Madigan, M., Martinko & Parker, J. Pearson Prentice Hall
2. Microbiology: Fundamentals and Applications. (1989). Atlas, R.M.
3. Microbiology (1996). M J Pelezar, Chan E C S and Krige
4. Industrial Microbiology. (1987). G Reed, Prescott & Dunn, CBS Publishers.
5. General Microbiology. (1987). Stanier, R.Y., Ingraham, Wheelis and Painter
6. Aquatic Microbiology: An ecological approach. (1993). Ford T E. Blackwell Scientific Publication. Aquatic Microbiology
7. Aquatic Microbiology (1980) Rheinheimer, G, John Wiley and sons. New York.
8. Microbial ecology of the ocean (2000) Wiley, New York.
9. Marine and Estuarine Microbiology Laboratory Manual. (1975). Colwell, R. et al.
10. Microbiology Methods. (1975). Collins, C.H. and Lyne, P.M.
11. Source book of Experiment for the teaching of Microbiology. (1982). Primrose, S.B. and Wardlaw, A.C.
12. Laboratory Methods in Microbiology. (1973). Harrigan, W.F. & McCance, M.E.

## MBT 102: CONCEPTS IN BIOCHEMISTRY

### MODULE I

Biochemistry: the molecular logic of life.  
 Biochemical evolution: principles and mechanisms.  
 Buffering in biological systems.  
 Enzymes: catalytic power and specificity  
 Amino acids; structure and functional group properties.

Peptides and covalent structure of proteins

Levels of structural organization, sequencing, 3-D structure and functional diversity of proteins, the concept of the proteome.

- Elucidation of primary and higher order structures
- Structure-function relationships in model proteins

## MODULE II

Carbohydrates - structure and biological role.

Basic concepts and design of metabolism - glycolysis, gluconeogenesis, the pentose phosphate pathway; the TCA cycle.

Structure and diversity of biological membranes; mechanisms of membrane transport.

Bioenergetics – basic principles. Thermodynamic quantities and laws, equilibria and concept of free energy, ATP as the main carrier of free energy in biochemical systems.

## MODULE III

Lipids – Structure and biological role

Fatty acid synthesis,  $\beta$ -oxidation.

Overview of amino acid biosynthesis.

General principles of intermediary metabolism and regulation of pathways.

*De novo* synthesis and salvage pathways in nucleotide metabolism.

Electron transport

Oxidative phosphorylation.

Photosynthesis.

Vitamins and hormones: chemistry and physiological role.

## REFERENCES:

1. Principles of Biochemistry (2008). Lehninger A.L. (ed.)
2. Biochemistry. (2002). Stryer, L.
3. Principles of Biochemistry. (1995). Zubay, G.L., Parson, W.W. & Vance, D.E.
4. Harper's Biochemistry.(1990). Murray, R.K. et al
5. Biochemistry. (2004). Voet, D. & Voet J.G.
6. Biochemistry and Molecular Biology.(2005). Elliott, W.H. & Elliott, D.C.
7. Fundamentals of Biochemistry. (1999). Voet, D., Voet, J.G & Pratt,C.W.
8. Introduction to Protein Structure (1999). Branden C. & Tooze J.

## **MBT 103: PRINCIPLES OF GENETICS & MOLECULAR BIOLOGY**

### MODULE I

- DNA structure & topology; organelle genomes.
- DNA reassociation kinetics, DNA repetitive sequence
- DNA packaging in viruses, bacteria & eukaryotes.

- Epigenetics
- Mutation: spontaneous & induced mutation; types of mutagens
- DNA repair in prokaryotes & eukaryotes
- Transposon, retroposons

## **MODULE II**

Transcription

Prokaryotic & eukaryotic promoters, mRNA, rRNA, tRNA, RNA polymerases

Transcription initiation & termination, transcription factors, RNA processing

Ribosomes

Initiation, elongation & termination

Translation factors

Genetic code: genetic code is triplet, codon – anticodon

Wobble hypothesis

Characteristics of genetic code

Operon: lac, Trp

Genetic diseases

## **MODULE III**

Gene transfer in bacteria: transformation, conjugation, transduction

Population genetics: Hardy Weinberg law

Biology of  $\lambda$ -bacteriophage

Recombination

DNA replication in prokaryotes & eukaryotes: DNA polymerases (prokaryotes & eukaryotes), replicon (prokaryotes & eukaryotes), model for DNA replication (prokaryotes & eukaryotes), termination, D-loop & rolling circle model for DNA replication

## **REFERENCES:**

- 1) Genes X (2010). Lewin, B.

- 2) Essential Genes (2006) Lewin.
- 3) Essential Genetics: A genome perspective. Hartl and Jones. (4th Edition)
- 4) Principle of Genetics. Gardner, E.J., Simmons, M.J. & Snustad, D.P. (8th Edition)
- 5) Genetics (2002). Strickberger, M.
- 6) Molecular Biology of the Cell (2002) Alberts. *et al.*
- 7) Molecular Biology of the Gene (2008) Watson *et al.*
- 8) Cell and Molecular Genetics (1987) Schlesf, R.
- 9) Microbial Genetics (2006). S.Maloy, J.Cronan Jr and Friefelder, D
- 10) Concept of Genetics (2002). Klug, W.S. & Michael, R & Cummins, M.R.
- 11) Igenetics: A molecular approach (2005). Russel, P.J.

## **MBT 104 : PRINCIPLES OF OCEANOGRAPHY**

### **MODULE I**

Discovering the oceans

Scope of Oceanographic research and Premier world Institutes

Temperature, salinity and density – horizontal, vertical and temporal variations.

Introduction to tides and waves. Currents and water masses.

Wind patterns and general oceanic circulation. ENSO (El Nino Southern Oscillation).

Upwelling

The Ocean Floor: Landforms, sediments and global plate tectonics

### **MODULE II**

Major and minor elements in the sea water.

Importance of micronutrient elements and dissolved oxygen in the ocean.

Biological productivity processes: primary, secondary & tertiary; marine food web dynamics.

Properties of light: light penetration & distribution, euphotic zone, compensation depth & bioluminescence

Remote Sensing: principles & techniques; applications of oceanremote sensing.

Marine natural disasters.

### **REFERENCES:**

1. Biological Oceanography.(1999). Lalli, C.M.
2. An introduction to Marine Sciences.(1988). Meadiws, P.S. & Campbell J.J.
3. General Oceanography – An introduction.(1980). Dietrich, G., Kalle, K, Krauss, W. & Siedler, G.
4. Marine Biology.(1984). Thurman, H.V. & Webber,H.H.
5. Introduction to Dynamic Oceanography.(1983). Pond,S. & Pickard,G.H.
6. Chemical Oceanography.(1992). Millero & Saha. M.L.
7. Descriptive Physical Oceanography – An introduction.(1989). Pickard, G.B. & Emery, W.J.

## **MBT 105 : BIOSTATISTICS**

### **MODULE I**

1. Scope of Biostatistics
2. Brief description and tabulation of data and its graphical representation, frequency distributions
3. Measures of Central Tendency and dispersion: mean, median, mode, range, standard deviation, variance, coefficient of variation, skewness, kurtosis
4. Displaying data: Histograms, stem and leaf plots, box plots
5. Probability analysis: axiomatic definition, axioms of probability : addition theorem, multiplication rule, conditional probability and applications in biology.

### **MODULE II**

6. Counting and probability, Bernoulli trials, Binomial distribution and its applications, Poisson distribution  
Normal distribution, z, t and chi square tests, levels of significance
7. Testing of hypotheses: null and alternative hypothesis, Type I and Type II errors
8. Simple linear regression and correlation
9. Analysis of variance
- 10.

### **REFERENCES:**

1. Introduction to Biostatistics (1973). Sokal,R. et al.
2. Statistical methods: George, W.S. & Harward,W.G.
3. Statistical method in Biology. University Press Ltd.
4. Biostatistics. (1984). Zar, J.

## **MBL 101: LAB IN MARINE MICROBIOLOGY**

- Sterilization and disinfection.
- Preparation of solid & liquid media:
- Differential and Selective media
- Enumeration: serial dilution methods, plating.
- Isolation and maintenance of organisms:
- Streaking, slants and stabs cultures, storage of microorganisms.
- Isolation of bacteria from marine samples
- Study of morphology and cultural characteristics
- Gram staining.
- Motility
- Cell inclusion studies: metachromatic granules
- Spore staining



- Biochemical characterization and identification of marine bacteria
- Cultivation of fungi: Slide, chunk and coverslip techniques
- Culture of anaerobes.

## **REFERENCES:**

1. Brock's Biology of microorganisms. (2006). Madigan, M., Martinko & Parker, J.
2. General Microbiology. (1987). Stanier, R.Y., Ingraham, Wheelis and Painter
3. Marine and Estuarine Microbiology Laboratory Manual. (1975). Colwell, R. et al.
4. Microbiology Methods. (1975). Collins, C.H. and Lyne, P.M.
5. Laboratory Methods in Microbiology. (1973). Harrigan, W.F. & McCance, M.E.
6. Source book of Experiment for the teaching of Microbiology. (1982). Primrose, S.B. and Wardlaw, A.C.

### **MBL 102: LAB IN BIOCHEMISTRY**

- Principles of colorimetry
- Spectral characteristics of coloured solutions.
- Estimation of proteins by the Biuret method
- Estimation of proteins by the Lowry's method
- UV absorption of proteins
- Estimation of sugars.
- Titration curves of amino acids
- Paper chromatography.

## **REFERENCES:**

1. Modern experimental Biochemistry (2003). Boyer, R.
2. Principles and Techniques of Biochemistry and Molecular Biology (2005). Wilson, K. & Walker, J.
3. An Introduction to Practical Biochemistry. (2005). Plummer, D.T.
4. Laboratory Manual of Biochemistry. (1998). Jayaraman, J.

### **MBL 103: LAB IN MOLECULAR GENETICS**

- DNA isolation a) bacterial cell , b) bacteriophage.
- RNA isolation from bacterial cell.
- UV survival curve for *E.coli*.
- Chemical mutagenesis & isolation of auxotrophs by replica plating.
- Transformation.
- Conjugation & gene mapping by Transduction.
- Transposon mutagenesis.
- Transduction.

## **REFERENCES:**

Experiments in molecular Genetics (1972) Miller J.H.

Laboratory manual in Molecular Genetics (1979). Jayaraman, K & Jayaraman, R.

## **MBT 106: COMMUNICATION SKILLS & SCIENTIFIC WRITING**

### **MODULE I**

#### **Process of communication**

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non verbal communication- Interpreting non verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences

#### **Presentation skills**

Formal presentation skills; Preparing and presenting, using Overhead Projector, Power Point; Defending Interrogation; Scientific communication skills, poster preparation & presentation; Participating in group discussions

### **MODULE II**

#### **Technical Writing Skills**

Types of reports; Layout of a formal report; Scientific writing skills:

Importance of communicating Science; Problems while writing a

scientific document; Plagiarism; Scientific Publication Writing:

Elements of a Scientific paper including Abstract, Introduction,

Materials & Methods, Results, Discussion, References; Drafting

titles and framing abstracts

### **Computing Skills for Scientific Research**

Web browsing for information search; search engines and their

mechanism of searching; Hidden Web and its importance in

Scientific research; Internet as a medium of interaction between

scientists; Effective email strategy using the right tone and

conciseness

### **Texts/References:**

1. Mohan Krishna and N.P. Singh, Speaking English effectively, Macmillan, 2003

## **SEMESTER II**

### **MBT 111: THE MARINE ECOSYSTEM**

#### **MODULE I**

- The marine ecosystem and its functioning: intertidal, estuarine, salt marsh, mangrove, coral reef, coastal & deep sea ecosystems. Hydrothermal vents.
- Classification of marine organisms; living resources of the Indian sea;
- Marine Biodiversity: defining, measurement and conservation strategies.

#### **MODULE II**

- Nutrients cycling: carbon, nitrogen, sulphur & phosphorus.
- Global climate changes: impact on species diversity & productivity, oceans as a carbon sink, effects on corals bleaching.

- Biological rhythms.

## **REFERENCES:**

1. Biodiversity (2004) Borua, P.K
2. Ecology of Coastal water (1988). Mann,K.H.
3. Elements of Ecology (1982). Tait, R.V.
4. Text book of Marine Ecology (1989). Nair N.B. & Thampy, D.M.

## **MBT 112: INTRODUCTORY IMMUNOLOGY**

### **MODULE I**

- Introduction – History and scope of immunology
- Phylogeny of immune system
- Innate and acquired immunity:- factors, features, processes
- Clonal nature of immune response
  
- Organization and structure of lymphoid organs
- Cells of the immune system: Hematopoiesis and differentiation, lymphocyte trafficking, B lymphocytes, T lymphocytes, macrophages, dendritic cells, natural killer and lymphokine active killer cells, eosinophils and mast cells, lymphocyte subpopulations and CD markers.
- Nature and biology of antigens and superantigens: haptens, adjuvants, carriers, epitopes, T dependant and T independent antigens.

### **MODULE II**

- Theories of antibody formation.
- Humoral immunity: cells, antibody formation, primary and secondary response.
- Immunoglobulins – structure, distribution and function.
- Antigen – Antibody interactions: forces, affinity, avidity, valency and kinetics.
- Immuno-diagnostics

### **MODULE III**

- Major histocompatibility complex.
- Complement system: mode of activation, classical and alternate pathway.
- Cell mediated immune responses: cell activation, cell-cell interaction and cytokines.
- Cell-mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, antibody-dependant cell-mediated cytotoxicity, and macrophage-mediated cytotoxicity.

- Hypersensitivity: An introduction to the different types.
- Hybridoma technology and monoclonal antibodies.
- Introduction to autoimmune diseases.

## **REFERENCES:**

1. Essential Immunology (2005) Roitt I.M. and Delves P.J.
2. Immunology – Roitt I, Bostoff J. & Male D.
3. Immunology (2006) Luttmann M, Bratke K, Kupper M & Myrtek D.
4. Immunology (2007) Goldsby R.A., Kindt T.J., Osbrne B.A. and Kuby J.

## **MBL 111 : LAB IN MARINE BIOLOGY & CHEMISTRY**

Samplers : water samplers, dredges, grabs, snappers.

Sampling (Field trips) and identification:

- phytoplankton,
- zooplankton,
- nekton
- benthos.

Estimations:

- Nutrients
- nitrate,
- phosphate
- silicate
- Dissolved oxygen
- pH & alkalinity
- Salinity
- Chlorophyll
- Primary productivity

## **REFERENCES:**

1. Methods of Sea Water Analysis. (1995). Grasshoff, K., Ehrhardt, M. & Kremling, K.
2. Quantitative Ecology Ecology & Marine Biology. (1990). Bakus, G.J.
3. Methods of study of Marine Benthos. (1984). Holme, N.A. & McIntyre, A.D.
4. Methods in Marine Zooplankton Ecology. (1984). Omori, W & Ikeda, T.

## **MBL 112: LAB IN IMMUNOLOGY**

- Blood grouping
- Single and double immunodiffusion
- Assessment of antigen similarity using Ouchterlony double diffusion test.
- Determination of antibody titre using double diffusion
- Estimation of Ag/Ab using radial immunodiffusion
- Quantitative precipitin assay
- DOT ELISA test
- Immunoelectrophoresis
- Antibody – HRP conjugation
- Latex Agglutination test
- Counter current immunoelectrophoresis
- Immunoblotting
- Rocket immunoelectrophoresis

## REFERENCES:

1. Practical Immunology (2003) 4<sup>th</sup> edition Frank, C. Hay & O.M.R. Westwood

## MBT 113 : BIOINFORMATICS

### MODULE I

- Databases - Definition, data mining methods and analysis tools
- Biological Database- Primary, secondary and composite
- Various types of databases
  - Nucleic acid sequence database
  - Protein sequence database.
  - Protein structure database
  - Taxonomic database.
  - Genomic database.
  - Protein families, domains and functional sites
  - Enzyme/metabolic pathway database (EMP and Brenda),
  - Regulatory pathway (KEGG)
- Tools for similarity searches and sequence alignments.
- Alignment of pair sequences- methods and scoring alignments (Global Alignments
- Needleman Wunsch Algorithm and Local Alignments - Smith Waterman Algorithm)
- Scoring matrices: PAM and BLOSSUM

- Alignment of multiple sequence alignment and phylogenetic analysis- method of evaluation of multiple alignment. Phylogenetic analysis and tree evaluation methods.
- Profiles and Hidden Markow model. Artificial neural networks, support vector machines (supervised machine learning)

## MODULE II

- Gene identification and prediction: pattern recognition and gene prediction methods
- Protein structure prediction- primary and secondary structure analysis and prediction, motifs, profiles, patterns and fingerprint search, *comparative protein model* for protein prediction, methods of 2-D structure prediction, protein function prediction from a DNA sequence.
- Pharmacogenetics- high throughput screening for drug discovery- identification of drug targets; Drug development.
- Functional Genomics-global gene expression analysis; Micro-array; comparative transcriptomics; Differential gene expression
- Proteomics: definition; identification and analysis of protein by 2D analysis; techniques for studying proteome.

## REFERENCES :

2. Bioinformatics-sequence,structure and databanks. (2000) D.Higgins and W. Taylor A practical approach.
3. Bioinformatics computing (2003). B. Bergeman.
4. Bioinformatics databases and algorithms (2007) N. Gautham.

## MBT 212: PLANT TISSUE CULTURE TECHNOLOGY

### MODULE I

- Laboratory requirement and general techniques.
- Tissue culture media.
- Cellular totipotency, somaclonal variation, micropropagation techniques
- Somatic embryogenesis.
- Haploid production.

- Protoplast isolation and culture.
- Production of pathogen-free plants.

## **MODULE II**

- Axenic culture of seaweed and tissue culture.
- Germplasm storage.
- Embryo culture
- Ovule and seed culture.

## **REFERENCES:**

1. Plant Tissue culture: Basic and applied (2006) T. Jha and B. Ghosh.
2. Plant Biotechnology: Methods in tissue culture and gene transfer (2006). R. Keshavachandra and K.V. Peter.
3. Plant, cell, tissue and organ culture (2005) Gamborg and Phillips.
4. Plant cell and Tissue culture.(2005). I Vasil and T. Thorpe.
5. Plant tissue culture: Theory and practice- revised editions. Bhojwani and M. Rajdan
6. Plant cell & tissue culture. (1994). Vasil, I.K. & Thorpe, T.A.
7. Plant tissue culture: Applications and limits. (1990). Bhojwani, S.S.
8. Plant propagation by tissue culture (1984) George, E.F. & Sherrington, P.D.

## **MBT 224 : ENZYMOLOGY**

### **MODULE I**

Classification and nomenclature of enzymes.

Effect of pH, temperature, ions, etc. on enzyme activity.

Enzyme extraction and assay.

Enzyme purification: principles and techniques of salting in and out, molecular sieving, ion exchange and affinity chromatography, gel electrophoresis, isoelectric focusing, 2-D electrophoresis.

### **MODULE II**



Isozymes ; *in situ* localization of enzymes in gels.

Catalytic mechanisms: mechanism of action of lysozyme, chymotrypsin etc.

Cofactors and Coenzymes.

Allosteric enzymes.

Reaction kinetics, order and molecularity; steady state kinetics; analysis of kinetic data; enzyme inhibition.

Multisubstrate reactions.

Enzyme activation.

Biological regulation of enzyme activity.

### **MODULE III**

Enzyme modification.

Clinical and industrial applications of enzymes; enzyme immobilization.

Ribozymes, catalytic antibodies and their applications.

Enzyme fusion.

Biosensors.

### **REFERENCES:**

1. Enzymes. (1979). Dixon M. & Webb E.C.
2. Methods in Enzymology (relevant volumes of the series)
3. Fundamentals of Biochemistry. (1999). Voet, D., Voet, J.G & Pratt,C.W.
4. Genes VII. (2000). Lewin, B.
5. Biological Chemistry. (1986). Mahler, H.R. and Cordes E.
6. Bioseparations: Principles & Techniques (2005). Sivasankar B.
7. Enzymes- a practical introduction to structure mechanism and data analysis (2000). Copeland, R.A.
8. Enzymes: Biochemistry, Biotechnology & clinical chemistry (2004). Palmer, T.

### **MBL 113: LAB IN BIOINFORMATICS**

- Search engines for bibliographic search
- Construction of plasmid map.
- Database search engines (Entrez/SRS) and submission of DNA/protein sequence.

- Exploring protein structure using RASMOL/Discovery studio/view
- Designing PCR primers and probes.
- Fundamentals in C-programming and construction of small programs in Bioinformatics .
- Reconstruction of phylogenetic tree using molecular data (Distance-based method or Neighbor-joining).
- Tools for Genomic Data Mining
  - Basic of Genome Annotation
  - Special tools for searching genomic data
  - Prediction of ORFs and Genes
  - Prediction of Signal sequences (Promoters, splice sites, UTRs etc. sequence analysis tools (Bioedit/MEGA)
- Browsing & viewing genome data
  - Ensembl@EBI
  - MapViewer@NCBI
- Drug designing.
- Immunoinformatics
  - Prediction of B and T cell epitopes for vaccine drug design
- Comparative and structural genomics.
- Proteomics (Expasy) and Interprotein Scan- pattern/motiof detection in proteins
- Protein-Protein interaction

## REFERENCES :

- 1) Practical Bioinformatics (2006) J. Bajnieci (Ed).
- 2) Bioinformatics (1995). A Practical guide to analysis of genes and protein.

## MBL 114: LAB IN PLANT TISSUE CULTURE

- Sterilization of explants and callus induction.
- Regeneration of plantlet from callus.
- Single cell suspension and protoplast isolation.
- Axenic culture & tissue culture of seaweeds.
- Somatic embryogenesis.
- *Agrobacterium* mediated gene transfer.

## REFERENCES:

1. Plant Biotechnology: methods in tissue culture and gene transfer (2006). R. Keshavachandra and K.V. Peter.
2. Plant tissue culture: theory and practice- revised editions. Bhojwani and M. Rajdan

## **MBL 223 : LAB IN ENZYME CHARACTERIZATION**

1. Enzyme isolation – preparation of cell-free lysates
2. Ammonium sulphate precipitation
3. Dialysis
4. Gel filtration
5. Ion exchange chromatography
6. Affinity chromatography
7. Enzyme kinetic parameters
8. Assessing protein purity by native polyacrylamide gel electrophoresis
9. Molecular weight determination by SDS-PAGE

### **REFERENCES:**

1. Modern Experimental Biochemistry (2003). Boyer, R
2. Fundamentals of Biochemistry. (1999). Voet, D., Voet, J.G & Pratt, C.W.
3. Bioseparations: Principles & Techniques (2005). Sivasankar B.

## **SEMESTER III**

### **MBT 211 : CELL AND DEVELOPMENTAL BIOLOGY**

#### **MODULE I**

Biochemical organization of the cell; diversity of cell size and shape; cell theory, the emergence of modern Cell Biology.

Principles underlying microscopic techniques for study of cells : Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy.

Cellular junctions and adhesions; structure and functional significance of plasmodesmata.

Membrane assembly

Structure and function of cellular organelles; subcellular fractionation; organization of cytoskeleton and nucleus; the plant cell wall.

## MODULE II

The eukaryotic cell cycle and its regulation.

Molecular aspects of cell division.

Cell signaling

Cell fusion.

Apoptosis.

Protein localization – synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes, receptor-mediated endocytosis.

- Chaperones.
- Proteosomes.

## MODULE III

- Germ cells and fertilization; embryogenesis.
- Laying of body axis planes; cellular polarity: differentiation of germ layers.
- Morphogens, gradients, concept of compartmentalization and fate mapping with particular reference to development in *Drosophila*, *Caenorhabditis* and mammalian systems.

Stem cells and cell differentiation.

Nuclear–cytoplasmic interactions.

Differentiation of cancerous cells and role of proto-oncogenes.

Oncogenes and theories regarding tumour formation.

Ageing.

## REFERENCES:

1. The Molecular Biology of the cell. (2002). Albert et al.
2. Molecular Cell Biology. (1986). Darnell, J. et al.
3. Genes X (2010). Lewin, B.
4. Molecular Biology of the Gene. (2003). Watson, J.D., Hopkins, N.H. et al.
5. Developmental Biology. (1997). Gilbert, S.F.
6. Handbook of the Biology of Aging. (1990). Schneider, E.L. & Rowe, J.W. (Eds.)
7. Introduction to Protein Structure (1999). Branden C. & Tooze J.
8. Molecular Cell Biology (2008) Lodish H., *et al.*
9. Cell Biology (1996). Smith, C.A. & Wood, E.J.  
Basic Bioinformatics (2005) S. Ignacimuthus.
5. Bioinformatics: concepts skills and applications (2004). S.C. Rastogi, N. Mendiratta and P. Rastogi.
6. Bioinformatics: A modern approach . (2005) V.R. Srinivas.
7. Essential Bioinformatics (2006). J. Xiong.
8. Statistical methods in Bioinformatics: An introduction. (2005). W. Even and G. Grant.

## **MBT 221 : BIOPROCESS & INDUSTRIAL BIOTECHNOLOGY**

### **MODULE I**

Basic Principles of Biochemical Engineering and Fermentation Processes:

- Isolation, screening, and preservation of industrially important microbes
- Bioreactor designs
- Types of fermenters
- Concepts of basic modes of fermentation: batch, fed-batch and continuous
- Scale up fermentation processes
- Media formulation
- Air and media sterilization.
- Aeration & agitation in bioprocess.
- Measurement and control of bioprocess parameters.

### **MODULE II**

Industrial production of chemicals :

- Strain improvement for increased yield & other desirable characteristics
- alcohol (beer)
- organic acids (citric acid)
- antibiotics (Penicillin)
- amino acids (lysine)
- Application of microbes in food processing: manufacture of cheese and monosodium glutamate

### **Module III**

## Downstream Processing:

- introduction, removal of microbial cells & solids
- bioseparation, filtration, centrifugation sedimentation.
- flocculation, cell disruption, liquid-liquid extraction,
- Purification by chromatographic techniques
- Drying, crystallization.
- Storage & Packaging
- Effluent treatment & disposal.
- Immobilization of microbial cells & their applications
- Bioprocess for the production of biomass: yeast and mushrooms
- Single cell proteins

## REFERENCES

1. Encyclopedia of bioprocess technology. Vol 1-5. (1999). Flickinger, M.C. & Drew, S.W.(Ed).
2. Fermentation technology. (1994). Cassida.
3. Bioprocess engineering: Down stream processing & recovery of bioproducts, safety in biotechnology and regulations. (1990). Behrens, D. & Kramer, P.(Ed).
4. Fundamentals of biotechnology. (1987). Prave, P., Fanst, V., Sitting, W. & Sukatesh, D.A. (Ed.)
5. Comprehensive biotechnology. Vol 2-4. (1985). &Young, M. (Ed)
6. Chemical engineering. (1984). Coulson, J.M. & Richardson, J.F.
7. Principles of fermentation technology. (1984). Stanbury, F. & Whitaker,A.
8. Immobilized enzymes: An introduction & application in biotechnology. (1980). Trevan, M.D.

## **MBT 222 : RECOMBINANT DNA TECHNOLOGY**

### MODULE I

DNA modifying enzymes and their uses in Molecular Biology a)Restriction enzymes b) DNA Polymerases I) Klenow ii) DNA polymerase I iii) T4/T7 DNA polymerase c) Reverse Transcriptase d) Terminal Transferases e) T4 Polynucleotide Kinases & Alkaline phosphatases f) DNA dependent RNA polymerases. g) DNA ligases h) Nucleases:- Bal 31, S1 nucleases, DNase I, mungbean nucleases, Ribonucleases, Exo III. Thermostable DNA polymerases used in PCR.

## **MODULE II**

Cloning vectors and their applications a) Plasmids of Gram +ve & Gram –ve bacteria b) Phages – Lambda and M13 vectors c) Cosmids d) Phagemids 3. Specialized vectors & their uses a) Expression vectors for prokaryotes & Eukaryotes b) Gene fusion vectors c) Yeast vector. d) Drosophila genetic element based vectors. DNA cloning a) Sticky ends b) Blunt ends c) Homopolymeric tailing d) Use of adapters & linkers. Construction of genomic libraries (shotgun cloning) Construction of cDNA libraries. Preparation of radiolabelled/non radiolabelled DNA & RNA probes.

## **MODULE III**

Screening of genomic libraries with oligoprobe & antibodies. Technique of DNA and plasmid isolation with special reference to commercial kits, Equilibrium density gradient centrifugation, DNA finger printing, Foot printing, Northern/Southern/Western blot, dot/zoo blot Chromosome jumping, Chromosome walking, DNA sequencing. Site directed mutagenesis.

## **REFERENCES**

1. Biotechnology. (1998). Singh, B.D.
2. Genetic engineering: principles & practice (1996). Mitra, S.
3. Principles of gene manipulations (1996) Old,R.W. & Primrose,S.B.
4. The basic principles of gene cloning (1996). Brown, T.A.
5. An introduction to Genetic engineering.(1994). Nicholl,D.S.T.
6. Recombinant DNA. (1992). Watson et al.
7. Genetic engineering fundamentals: An introduction to principles & applications. (1989). Kammermeyer,K. & Virginica,C.
8. From Genes to Clones: Introduction to Gene Technology. (1987). Winnacker, E.L.
9. Genetic engineering Vol I-VI Setlow and Halander.
10. Genetic engineering Vol I-IV (1981). Williamson, R.(Editor).

## **MBT 223: ANIMAL CELL CULTURE**

### **MODULE I**

#### **1. INTRODUCTION**

Introduction to tissue culture

History and concepts of Animal cell culture

Applications and limitations

#### **2. DESIGNING AND EQUIPPING THE TISSUE CULTURE LAB : Laboratory design**

Equipment needed and used

Glassware and plasticware - tissue culture vessels

### 3. ASEPTIC TECHNIQUES

### 4. TYPES OF TISSUE CULTURE

Primary Cultures : explant culture

Cell cultures: sources, types-adherent/suspension, kinetics of cell growth, rodent and human cell cultures, techniques for isolation , methods for cell separation

Organ cultures – techniques for organ culture, histotypic, organotypic, organoids and 3D cultures.

Stem cell cultures

Embryo cultures and IVF.

## MODULE II

### 1. CULTURE OF CELL LINES

evolution of cell lines, maintenance of cell lines, phases of cell cycle, growth curve of cells, protocols for subculturing of cells: monolayer and suspension cultures, setting up replicate cultures, established cell lines. Large scale culturing of animal cells.

#### CULTURE ENVIRONMENT

Atmosphere, media- types, components, natural and artificial substrate material

#### PRESERVATION AND CHARACTERISATION OF THE ANIMAL CELL

Maintenance, cryopreservation and storage of cell cultures, culture banks, sources for seed cultures.

#### BIOLOGY OF THE CULTURED CELL AND CELL COUNTING

Transformation, differentiation, deadaptation and dedifferentiation

Cell Counting: hemocytometer, coulter counter, Flow cytometry and

Basic t



## Cytofluorometry

### APPLICATIONS OF ANIMAL CELL CULTURES

#### REFERENCES:

1. In Vitro Cultivation of Animal Cells (1995) Butterworth – Heinemann
2. Animal Cell Culture (2000) – A Practical Approach John R.W. Masters
3. Culture of Animal Cells – A manual of Basic technique (2005) R.I. Freshney

### MBT 225 : MOLECULAR IMMUNOLOGY

#### MODULE I

##### Recognition of antigens

##### 1. The major histocompatibility complex:

- i) Discovery and its role in immune response
- ii) Structure of MHC molecules
- iii) Binding of peptides to MHC molecules
- iv) Genomic organization of the MHC

##### 2. Recognition of antigens by T Lymphocytes

- i) Antigen processing and presentation to CD4<sup>+</sup> and CD8<sup>+</sup> T Lymphocytes.
- ii) Antigen receptors and accessory molecules of T Lymphocytes
- iii) Effector molecules of T lymphocytes

##### Maturation, activation and regulation of Lymphocytes

##### 1. Maturation of Lymphocytes

- i) General features of Lymphocyte maturation
- ii) Formation of functional antigen receptor genes in B & T lymphocytes.
- iii) Maturation of B lymphocytes.
- iv) Maturation of T lymphocytes.

#### MODULE II

##### 2. Activation of T lymphocytes

- i) Signal transduction by the T lymphocyte receptor complex – Ras and Rac,

Calcineurin and Protein Kinase C signaling.

ii) Activation of transcription factors in T cells

### 3. Activation of B cells

i) Signal transduction by the B cell antigen receptor complex

ii) CD40 and its role in T-B cooperation

iii) Bidirectional molecular interactions between T-B cells

### 4. Immunologic tolerance

i) General features & mechanisms of immunologic tolerance

ii) T Lymphocyte tolerance

iii) B Lymphocyte tolerance

iv) Homeostasis in the immune system: termination of normal immune response

### **Effector mechanisms of immune responses**

i) Cytokines – regulating innate and adaptive immunity and stimulate hematopoiesis

ii) Cell mediated immunity

iii) Humoral immunity

## **MODULE III**

### **Immunity in defense and disease**

#### 1. Immunity to Microbes –

Immunity to extracellular and intracellular bacteria: Innate and adaptive response,  
evasion of mechanisms by bacteria

Immunity to fungi, viruses and parasites

Strategies for vaccine development

#### 2. Immunity to tumors

i) Tumor antigens

ii) Immune responses to tumors

iii) Evasion of immune responses by tumors

iv) Immunotherapy for tumours

#### 3. Diseases caused by immune responses: hypersensitivity and autoimmunity

- i) Mechanisms of autoimmunity
- ii) Types of hypersensitivity diseases
- iii) Therapeutic approaches for immunologic diseases
- iv) Immunosuppression
- v) Bone marrow transplantation immunology

#### **REFERENCES:**

1. Cellular and Molecular Immunology (2000) Abbas A.K., Lichtman A.H. & Pober, J.S.
2. Practical Immunology (2003) Frank C. Hay & O.M.R. Westwood
3. Immunology (2007) Goldsby R.A., Kindt T.J., Osbrne B.A. and Kuby J.
4. Essential Immunology (2005) Roitt I.M. and Delves P.J.
5. Immunology – Roitt I, Bostoff J. Male D.
6. Immunology (2006) Luttmann M, Bratke K, Kupper M & Myrtek D.
7. Manual of Molecular and Clinical Laboratory Immunology (2006)  
Detrick B, Hamilton R.G. & Folds J.D.

#### **MBL 221: LAB IN FERMENTATION TECHNOLOGY**

1. Microbial production of ethanol using yeast sp.
2. Estimating ethanol concentration by Ceric Ammonium nitrate method.
3. Microbial production and estimation of organic acids: Citric acid using *Aspergillus* sp.
4. Microbial production of antibiotics.
5. Immobilization of microbial cells: use of alginate.
6. Use of fermenter with special reference to scale-up operations.
7. Batch and continuous culture.
8. Manufacture of ginger ale.
9. Mushroom cultivation.

#### **References**

- 1) Practical Fermentation Technology (2008) Brian Mcneil and Linda Harvey. Wiley

## **MBL 222: LAB IN RECOMBINANT DNA TECHNOLOGY**

Plasmid isolation by alkaline lysis and boiling method. Ethidium bromide/CsCl density gradient centrifugation. Transformation of plasmid using competent bacterial cells. Restriction mapping. Cloning  
a) Restriction of plasmid and alkaline phosphatase treatment. b) Ligation of insert. c) Selection/screening for recombinant. Transfection and preparation of ssDNA. PCR. RT-PCR. Western blotting. Southern blotting. DNA sequencing.

### **REFERENCES**

1. Molecular cloning (1989) Maniatis, T. *et al*
2. Recombinant DNA methodology. (1985). Dillon, R.G., Nasim, A. & Nestmann. E.R.

## **MBL 121: LAB IN ANIMAL CELL CULTURE**

1. Sterilization and preparation of glassware, preparation of tissue culture medium and membrane filtration.
2. Preparation of single cell suspension from spleen or thymus
3. Cell counting and cell viability
4. Setting up of macrophage monolayer and use of inverted microscope
5. Preparation of goat serum
6. Setting up monolayer of tilapia hepatocytes
7. Staining and preparation of permanent slides

### **REFERENCES :**

1. Animal cell culture (2000) – A Practical Approach John R.W. Masters
2. Culture of animal cells – A manual of Basic techniques (2005) R.I. Freshney

## **MBT 332 : APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY**

## **MODULE I**

PCR, types and their applications in clinical diagnosis, mutagenesis, monitoring of GEMS phylogenetic analysis, genetic markers assisted screening, pathogen detection and biodiversity. Metagenomic studies, Studying large genomes: Plasmid/marker rescue techniques & Tn-tagging for isolation of genes., Physical maps by PFGE., Ordering cosmids., Binary finger printing using oligo probes., Linking cosmids with cosmid contigs., Ordering cosmids & YACS along chromosome using *in situ* hybridization.

## **MODULE II**

DNA microarrays and applications. Gene therapy, viral and non-viral strategies and application. Transgenic plants: Terminator gene technology, RNAi, Metabolic Engineering – Modification of plant Nutritional content – Amino acids and lipids as Bioreactor- polymers and foreign proteins in seeds. Selectable Markers, reporter genes- Promoters used in Plant vectors genetic engineering for- heat, drought and saline tolerance (Osmogenes)- Virus resistance.- Pest resistance- Herbicide resistance- Herbicide tolerance- Delayed fruit ripening- Fungal and bacterial resistance- Secondary metabolite production., Production of therapeutic proteins- antibodies- vaccines edible Vaccines- hormones- Golden Rice- Biolistic in transgenic plants. Marker free transgenic plants. Co-transformation-Transgenic silencing & their applications, Transgenic animals and their applications. Genetic engineering & pharmaceutical proteins, Restriction enzymes, Bioplastic and other commercial products.

## **MODULE III**

Molecular markers: use of nucleic acid probes and antibodies, In clinical diagnosis and tissue typing - Mapping of human genome-RFLP and applications. Animal cloning. Biotechnology of silkworms, transgenic silk production -Baculo viruses vector and foreign gene expression. Microbes in oil recovery & mining. Management and Commercialization aspects of Biotechnology & Entrepreneurship in Biotechnology.

## **REFERENCES:**

1. Pharmaceutical biotechnology: concepts and applications Gary Walsh. John Wiley and Sons, 2007
2. Biotechnology: expanding horizons B. D. Singh Kalyani, 2008.
3. Molecular Biotechnology: Principles and applications of recombinant DNA. (2009) Glick, B.R., Pasternak, J.J, Patten C.L. ASM press.
4. Principles of gene manipulation and genomics. S. B. Primrose, Richard M. Twyman. Wiley-Blackwell, 2006.
5. From genes to genomes: concepts and applications of DNA technology Jeremy Dale, Malcolm von Schantz. Wiley-Interscience, 2007
6. Biotechnology: The science and business (1999). Moses, V. & D.G. Springham. Harwood Academic.
7. Biotechnology and Genetic Engineering reviews (1988). Russel, G.E.
8. Biotechnology: applying the genetic revolution David P. Clark, Nanette Jean Pazdernik Elsevier, 2008.

## **MBT 232 : BIOSAFETY AND IPR**

### **MODULE I**

#### ***Introduction to Intellectual Property***

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.);

### **MODULE II**

#### ***Basics of Patents***

Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

#### ***Patent filing and Infringement***

Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US

Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives

Patent infringement- meaning, scope, litigation, case studies and examples

### **MODULE III**

#### ***Biosafety***

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines – Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

### **REFERENCES**

1. Intellectual property rights in Biotechnology. A status report (1993). Singh, K.
2. Biotechnology and Patent laws: patenting living beings (2008) Sreenivasulu, N.S. and Raju C.B. Manupatra Publishers.
3. Patents for Chemicals, Pharmaceuticals and Biotechnology: Fundamentals of Global Law, Practice and Strategy (2010) Grubb P. W. Grubb, P. L. Thomsen, P. R. Oxford University Press.
4. Patent law in Biotechnology, chemicals & pharmaceuticals. (1994) Harold C. Wegner Stockton Press
5. A User's Guide to Patents (2007) Trevor M. Cook. Tottel Publishing.
6. Intellectual property law (2008) Lionel Bently, Brad Sherman. Oxford University Press.

7. Biosafety and bioethics (2006) Rajmohan Joshi. Gyan Publishing House.
8. Laboratory biosafety manual. (2004). World Health Organization. WHO press, 2004.
9. Biological safety: principles and practices (2000) Diane O. Fleming, Debra Long Hunt. ASM Press.
10. CRC handbook of laboratory safety. (2000)A. Keith Furr. CRC Press.

## **MBT 131: CELLULAR BIOPHYSICS**

### **MODULE I**

Ohm's law, diffusion, electric fields, potentials and charge

- 1) Overview of the Cellular organization of the nervous system:
  - Typical nerve cell
  - Types of cells: Neuronal, Glial cells, ependymal cells and Schwann cells.
  - Role of meninges and CSF.
  - Classification and types of neurons , cytons and axons
  - function of nerve cells
  
- 2) Ion Channels
  - Sodium channels
  - Potassium channels
  - Calcium channels
  - Chlorine channels
  - Ligand-gated channels
  - Ionic basis of resting membrane potential: Donann's equilibrium experiments, Nernst's potential ,Goldman's equation, Sodium –Potassium pump.
  
- 3) Biophysics of neurons
  - Electrical properties of the axon, ion fluxes, potentials of nerve cell membrane
  - Resting membrane potential
  - Chemical –to- electrical transduction
  - Signal summation
  - Action Potential and propagation (a) Hodgkin and Huxley's model, voltage clamp experiment and the derivation and propagation of Action Potential
  - Compound Action potential
  - Sodium and Potassium ionic currents
  
- 4) Electrical- to- chemical Transduction (a) Graded potential (b) Synaptic potential

and synaptic integration [Electrical and Chemical Synaptic Potential, Excitatory Post Synaptic Potential (EPSP) Inhibitory Post Synaptic Potential (IPSP), Neuro-muscular junctions

5) Transmission of nerve impulse

## MODULE II

1) Communication between neurons :

Types of synapses and synaptic transmission (electrical and chemical )

Synaptic transmission at central synapse (Type of receptors)

Synaptic transmission through second messenger (including mechanism of signal transduction, Neuromodulation and synaptic inhibition

Neurotransmitter –physiological role, pharmacological significance, (example of one agonist and one antagonist for a neurotransmitter) Acetylcholine (Nicotinic and muscarinic receptors)

2) Muscle- structure and electro-physiology of contraction.

3) Sensory system :

Introduction – sensory systems and mediation of 4 attributes of a stimulus

i. modality; ii. Location; iii. Intensity; iv. Timing.

Common plan of sensory system. General idea of a receptor and transduction of specific types of energy into electrical signals.

4) Visual system: Vertebrate eye and retina.

Morphology and arrangement of photoreceptors.

Electrical response to light.

Concept of receptive fields.

Colour vision.

Visual pathway, lateral geniculate nucleus and visual cortex.

Visual perception as a creative process.

Perception of motion, depth, form and colour.

Visual attention and conscious awareness.

## MODULE III

Organisation of the nervous system in Marine organisms:

Structure of nerve net, neural plexus, an ganglionated nervous system e.g. hydra, starfish, aplysia and Zebrafish

Development of behavioral paradigms :

Type study of behavior of Aplysia: elementary behavior, neuroendocrine reflexes,



complex behavior; higher grade and learned behavior.

Molecular basis of neuronal development and degeneration:

Type model: Zebrafish

## REFERENCES

1. Introductory Biophysics , V. Pattabhi & N. Gautham, Narosa Publications
2. Ionic Channels of Excitable Membranes, Third Edition. Bertil Hille. Sinauer Associates. Sunderland, MA. 2001.
3. Physical Biology of the Cell by Rob Phillips, Jane Kondev and Julie Theriot, Garland Science, Taylor & Francis Group, New York, 2009.
4. Handbook of Molecular Biophysics- Methods and applications by H.G. Bohr Wiley-VCH Verlag GmbH & Co, KGaA, Weinheim (2009)
5. The Physiology of Excitable Cells, Aidley, D. J. (1998). Cambridge University Press.
6. Principles of Neural Sciences Ed: E. Kandel, J. Schwartz and T. Jessel. 4<sup>th</sup> edition (2000) McGraw Hill
7. Textbook of Medical Physiology Ed: Guyton and Hall 9<sup>th</sup> edition (1998) W. B. Saunders Company
8. Molecular Neurobiology Ed: J.B.Martin (1998) Scientific American
9. Elements Of Molecular Neurobiology C.U.M. Smith, J Wiley and Sons Publishers, N.Y.
10. An Introduction to Molecular Neurobiology Z.W. Hall Sinauer Associates Inc. Publishers

## MBT 333: GENOMICS AND PROTEOMICS

### MODULE I

#### *Introduction*

Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

### MODULE II

#### *Genome sequencing projects*

Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

### ***Pharmacogenetics***

High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

## **MODULE III**

### ***Proteomics***

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Micro-scale solution isoelectric-focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

### ***Functional genomics and proteomics***

Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics

## **REFERENCES**

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Bioinformatics, genomics, and proteomics: getting the big picture. Ann Batiza. Infobase Publishing, 2005
6. Genomics and proteomics: functional and computational aspects Sándor Suhai Springer, 2000
7. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998

## **SEMESTER IV**

### **MBT 331 : POTENTIAL APPLICATIONS OF MARINE ORGANISMS**

#### **MODULE I**

#### **Microorganisms :**

Marine viruses

Bacteria and their significance : unculturable bacteria : occurrence, characteristics

and exploitation, chemosynthetic and giant bacteria, the Superbug

### **Macroorganisms :**

- Hydrothermal vents : biodiversity of organisms
- Barophilic organisms & their applications

### **MODULE II**

Important Marine Products:

- Bioactive compounds from marine organisms
- GFP, RFP characteristics and their applications
- Green mussel adhesive protein
- Chitosan and its applications

### **MODULE III**

Marine Processes and control:

- Biofouling ,biofilms, corrosion and antifouling treatment
- Ballast water : consequences & management
- Red tides : causative organisms and control
- Marine pollution & its control ; Seaweeds for removal of metal pollutants
  - Techniques for identification of bacterial & viral pathogens in aquaculture and
  - remedies
- Probiotic bacteria and their importance in aquaculture
  - Vaccines in aquaculture: Fish ,shrimps & prawns
  - Marine food analysis-spoilage, quality control
  - ISO standards taking export into consideration

### **REFERENCES:**

1. Drugs from sea. (2000). Fusetani, N.
2. Microbiology of deep sea hydrothermal vents. (1995). Karl, D.M.
3. The search from bioactive compounds from microorganisms. (1992). Omum, S.
4. Biotechnology and Biodegradation (1990). Kamely, D. Chakraborty, A. & Omenn, G.S.
5. Recent Advances in Marine Biotechnology. Vol.2 (1998) Fingerman, M., Nagabushanam, R., Thompson, M.

6. Biotechnology in the marine sciences: Proceedings of the first annual MIT sea grant lecture & seminar. (1984). Colwell, R.D.(Ed)Recent articles from various journals such as Journal of Marine Biotechnology, Nature and Science will be covered.
7. 1. Environmental Biotechnology: Theory and Application Gareth G. Evans, Judy Furlong John Wiley and Sons, 2011
8. Recent Advances in Marine Biotechnology Volume 3 – Milton fingerman et al., 1999.
9. Cynobacterial and Algal Metabolisms and Environment Biotechnology – Tasneem Fatma, 1999.
10. Environmental Biotechnology Theory and applications – Evans et al., 2000.
11. Environmental Biotechnology – Gareth M.Evams et al., 2003
12. Biotechnology, Recombinant DNA Technology, Environmental Biotechnology – S.Mahesh et al., 2003.

## **MBT 231 : AQUACULTURE TECHNOLOGY & MARINE PHARMACOLOGY**

### **MODULE I**

#### ***Culture systems and Hatchery techniques***

Importance of coastal aquaculture; Aqua farms; Design and construction; Criteria for selecting cultivable species; Culture systems and management practices – extensive, semi intensive and intensive culture practices

Seed production in controlled condition; Types; Design and management of hatchery –induced spawning; Mass production of seeds; Live feed culture technique and feed formulation; Artificial insemination - *in vitro* fertilization.

### **MODULE II**

#### ***Introduction to marine pharmacology***

Terms and definitions; Medicinal compounds from marine flora and fauna - marine toxins, antiviral and antimicrobial agents.

#### ***Manipulation Techniques***

Chromosome manipulation in aquaculture – hybridization; Ploidy induction; Gynogenesis, Androgenesis and sex reversal in commercially important fishes.

### **MODULE III**

#### ***Microbial techniques***

Application of microbial biotechnology in culture ponds; Bioaugmentation; Bioremediation for soil and water quality improvement - nutrient cycling; bio-fertilization;

#### ***Diseases diagnosis***

Tools for disease diagnosis in cultivable organisms; Enzyme immunoassays; Dot immune-binding assay; Western blotting; Latex agglutination test; Monoclonal antibodies; DNA based diagnosis; Cryopreservation.

### **References**

1. Mime, PH., Fish and shellfish farming in coastal waters, Fishing News Ltd., London, 1972.
2. Bradach, J.E., H.H. Ryther and W.D. MC Larney, Aquaculture, farming and husbandry and fresh and marine organisms, Wiley Interscience, New York. 1972.
3. Iverson, E.S., Farming the edge of the sea, Fishing News Ltd., London. 1976.

4. Fingerman M., Recent advances in Marine Biotechnology, Science Publishers, 2000.
5. Aquaculture, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
6. Kenneth, B.D., 2000. Environmental impacts of Aquaculture. CRC. pp. 214.
7. Stickney, R.R., 2000. Encyclopedia of Aquaculture. John Wiley Sons Inc. pp. 1063.
8. Rautenstraub, B. and T. Liehr, 2002. Fish technology, 494pp.

## **MBM 131: SCUBA DIVING**

### **Module I**

#### Dive Theory

- Introduction
- Diving equipment
- Physics
- Physiology
- Planning dives
- Executive dives
- The underwater world
- Scuba experience and beyond

### **Module II**

#### **Practicals**

- 2 sessions of pool training for skills
- 2 days of sea dives- repeating pool skills and pleasure
- Dives – total 4 dives.

### **REFERENCES:**

( To be distributed by Instructor at commencement of Course)