ANNAMALAI UNIVERSITY
ANNAMALAINAGAR

HAND BOOK

DEGREE OF MASTER OF SCIENCE
MARINE BIOTECHNOLOGY
(CHOICE BASED CREDIT SYSTEM)

2015 - 2016

ANNAMALAI UNIVERSITY
ANNAMALAI NAGAR

DEGREE OF MASTER OF SCIENCE

MARINE BIOTECHNOLOGY
(CHOICE BASED CREDIT SYSTEM)

2015 – 2016

FACULTY OF MARINE SCIENCES

REGULATIONS

MASTER'S PROGRAMME

A Master's Programme consists of a number of courses. Master's Programme consists of a set of Core Courses and elective Courses.

Core courses are basic courses required for each programme. The number and distribution of credits for core courses will be decided by the faculty.

Elective courses will be suggested by the respective departments, and they may be distributed in III and IV semesters.

A course is divided into five units to enable the students to achieve modular and progressive learning.

SEMESTERS

An academic year is divided into two semesters, Odd Semester and Even Semester. The normal semester periods are:

Odd Semester: July to November (90 Working days)

Even Semester: December to April (90 Working days)

CREDITS

The term credit is used to describe the quantum of syllabus for various programmes and hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design.

The minimum credit requirement for a two year Master's Programme shall be 94.

The core courses shall carry 88 credits and the elective courses shall carry 6 credits.

ELIGIBILITY

A graduate Degree in Biotechnology, Biochemistry, Microbiology, Industrial Microbiology, Industrial Fish and Fisheries, Agricultural Microbiology, Plant Science & Biotechnology and Animal Science & Biotechnology Plant Biology & Plant Biotechnology, Plant Science, Zoology, Animal Science, Biotechnology & Bioinformatics, Bioinformatics, Chemistry and Animal Biotechnology with a minimum of 50% marks in part – III.

COURSES

Each course may consist of lectures / laboratory work / seminar / project work / practical training / report / viva voce etc.

COURSE WEIGHT

Core and elective courses may carry different weightage. For example, a course carrying one credit for lectures, will have instruction of one period per week during the semester, if three hours of lecture is necessary in each week for that course then 3 credits will be the weightage. Thus normally, in each of the courses, credits will be assigned on the basis of the lectures / laboratory work and other form of learning in a 15 week schedule:

(i) One credit for each lecture period per week.

(ii) One credit for every three periods of laboratory or practical work per week.

(iii) One credit for 3 contact hours of project work in a week.

(iv) One credit for every two periods of seminar.

GRADING SYSTEM

The term Grading System indicates a 10-point scale of evaluation of the performance of students in terms of marks, grade points, letter grade and class.

DURATION

The duration for completion of a two year Master's programme is four semesters.

STRUCTURE OF THE PROGRAMME

The Master's Programme will consist of:

(i) Core courses which are compulsory for all students.
(ii) Elective courses which students can choose from amongst the courses offered the faculty as well as by Departments of other faculties (Arts, Science, Education and Indian Language).
(iii) The Elective subjects will be allotted by counseling by a committee of the respective Heads of the Departments under the Chairmanship of the Dean of the Faculty.
(iv) Dissertation / Project work / Practical training / Field work can be done in an organization (Government, Industry, Firm, Public Enterprise etc.) approved by the concerned department.

ATTENDANCE

Every teaching faculty handling a course shall be responsible for the maintenance of attendance register for candidates who have registered for the course.

The teacher of the course must intimate the Head of the Department at least Seven Calendar days before the last instruction day in the semester about the attendance particulars of students.

Each student should earn 80% attendance in the courses of the particular semester failing which he or she will not be permitted for the end – semester examination.

However, it is open to the authorities to grant exemption to a candidate who failed to obtain the prescribed 80% attendance based on valid reasons on payment of a Condonation fee and such exemptions should not under any circumstance be granted for attendance below 70%.

EXAMINATIONS

The internal assessment for each course carries 25% marks and is based on two sessional tests. The pattern of question paper will be decided by the faculty. The tests are compulsory.

There will be one End Semester Examination (75% marks) of 3 hours duration for each course. The pattern of question paper is decided by the faculty.

The Internal assessment for each practical course carries 40% of marks while the end semester practical examination carries 60% of marks.

EVALUATION

The performance of a student in each course is evaluated in terms of Percentage of Marks (PM) with a provision for conversion to Grade Point (GP). The total performance in each semester will be rated by Grade Point Average (GPA) while the continuous performance from the 2nd Semester onwards will be marked by Overall Grade Point Average (OGPA).

MARKS AND GRADING

A student cannot repeat the assessment of Sessional Test I and Sessional Test II. However, if for any compulsive reason, the student could not attend the test, the prerogative of arranging a special test lies with the teacher in consultation with the Head of the Department.

A student has to secure 50% minimum in the End Semester Examination.

The student who has not secured a minimum of 50% of marks (sessional plus end semester examination) in a course shall be deemed to have failed in that course.

A candidate who has secured a minimum of 50% marks in all the papers prescribed in the programme and earned a minimum of 90 credits will be considered to have passed the Master's Programme.

GRADING

A ten point rating scale is used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme.

Marks	Grade	Letter grade	Class
90	10	S	Exemplary
85 – 89	9.0	D	Distinction
80 – 84	8.5	D	Distinction
75 – 79	8.0	D	Distinction
70 – 74	7.5	A	First Class
65 – 69	7.0	A	First Class
60 – 64	6.5	A	First Class
55 – 59	6.0	B	Second Class
50 – 54	5.5	C	Second Class
49 or Less	-	F	Fail

The successful candidates are classified as follows:

I Class – 60% Marks and above in overall percentage of Marks (OPM).

II Class – 50-59% Marks in overall percentage of marks.

Candidates who obtain 75% and above but below 90% of marks (OPM) shall be deemed to have passed the examination in FIRST CLASS (Distinction) provided he / she passes all the papers prescribed for the programme at the first appearance.

For the Internal Assessment Evaluation, the details are as follows:

Test - 25 Marks.

COURSE – WISE LETTER GRADES

The percentage of marks obtained by a candidate in a course is indicated by a letter grade.

A student is considered to have completed a course successfully and earned the credits if he / she secures an overall letter grade other than F. A letter grade F in any course implies a failure in that course. A course successfully completed cannot be repeated for the purpose of improving the Grade point.

The F grade once awarded in the grade card of the student, is not deleted even when he / she completes the course successfully later. The grade acquired later by the student will be indicated in the grade sheet of the odd / even semester in which the candidate has appeared for clearance of the arrears.

A student who secures F grade in any course which is listed as a core course has to repeat it compulsorily when the examination is held next. If it is an Elective course, the student has the option to repeat it when it is offered next or to choose a new elective if he / she so desires in order to get a successful grade. When new elective is chosen in the place of failed elective, the failed elective will be indicated as dropped in the subsequent grade card.

If a student secures F grade in the Project Work / Field Work / Practical Work / Dissertation, he / she shall improve it and resubmit it if it involves only rewriting incorporating the clarifications of the evaluators or he / she can re-register and carry out the same in the subsequent semesters for evaluation.

ANNAMALAI UNIVERSITY
CAS IN MARINE BIOLOGY
M. Sc. MARINE BIOTECHNOLOGY
CHIOCE BASED CREDIT SYSTEM (2015 – 2016)

I SEMESTER

MBTC 101	Biochemistry
MBTC 102	Analytical Techniques and GLP
MBTC 103	Cell and Developmental Biology
MBTC 104	Molecular Biology
MBTC 105	Marine Bioresources, Biodiversity and Oceanography
MBTC 106	Introductory Mathematics
MBTC 107	Communication Skills
MBTP 108	Practical I (Covering courses 101 &102)
MBTP 109	Practical II (Covering courses 104 &105)
MBTP 110	Seminar / Journal Club / Assignment

SEMESTER II

MBTC 201	Immunology
MBTC 202	Marine Microbiology
MBTC 203	Genetic Engineering
MBTC 204	Genetics, Genomics and Proteomics
MBTC 205	Aquaculture Technology and Pharmaceutical Chemistry
MBTP 206	Practical III (Covering course 201)
MBTP 207	Practical IV (Covering courses 202 &205)
MBTP 208	Practical V (Covering course 203)
MBTP 209	Seminar / Journal Club / Assignment

SEMESTER III

MBTC 301	Bioprocess Technology
MBTC 302	Marine Environmental Biotechnology
MBTC 303	Endocrinology and Reproduction of Marine Animals
MBTC 304	IPR and Biosafety
MBTC 305	Elective – I
MBTP 306	Practical VI (Covering courses 301 &302)
MBTP 307	Practical VII (Covering course 303)
MBTP 308	Project Proposal Presentation

SEMESTER IV

MBTC 401	Elective - II
MBTC 402	Project Work

CREDITS, INTERNAL ASSESSMENT MARKS AND END SEMESTER EXAMINATION MARKS

Course Code Theory/Practical	Credit Points	Int. Ass.	End Sem. Exam Marks	Total Marks
I SEMESTER				
MBTC 101 Biochemistry	3	25	75	100
MBTC 102 Analytical Techniques and GLP	3	25	75	100
MBTC 103 Cell and Developmental Biology	3	25	75	100
MBTC 104 Molecular Biology	3	25	75	100
MBTC 105 Marine Bioresources, Biodiversity and Oceanography	3	25	75	100
MBTC 106 Introductory Mathematics		25	75	100
MBTC 107 Communication Skills		25	75	100
MBTP 108 Practical – I (Covering courses 101 & 102)	4	40	60	100
MBTP 109 Practical – II (Covering courses 104 & 105)	4	40	60	100
MBTP 110 Seminar / Journal Club / Assignment	1	40	60	100
Total	**24**			
II SEMESTER				
MBTC 201 Immunology	3	25	75	100
MBTC 202 Marine Microbiology	3	25	75	100
MBTC 203 Genetic Engineering	3	25	75	100
MBTC 204 Genetics, Genomics and Proteomics	3	25	75	100
MBTC 205 Aquaculture Technology and Pharmaceutical Chemistry	3	25	75	100
MBTP 206 Practical – III (Covering course 201)	3	40	60	100
MBTP 207 Practical – IV (Covering courses 202 & 205)	3	40	60	100
MBTP 208 Practical – V (Covering course 203)	2	40	60	100
MBTP 209 Seminar / Journal Club / Assignment	1	40	60	100
Total	**24**			
III SEMESTER				
MBTC 301 Bioprocess Technology	3	25	75	100
MBTC 302 Marine Environmental Biotechnology	3	25	75	100
MBTC 303 Endocrinology & Reproduction of Marine Animals	3	25	75	100
MBTC 304 IPR and Biosafety	3	25	75	100
MBTC 305 Elective – I	3	25	75	100
MBTP 306 Practical – VI (Covering courses 301 & 302)	3	40	60	100
MBTP 307 Practical – VII (Covering course 303)	3	40	60	100
MBTP 308 Project Proposal Presentation	2			100
Total	**23**			

IV SEMESTER				
MBTC 401 Elective – II	3	25	75	100
MBTC 402 Project Work	20	40	60	100
Total	**23**			

Students have to choose courses for 6 credits (2 courses) out of the elective courses offered in other departments / faculties of the University. The elective papers are for students of other departments / faculties of the University.

Credit

Core	**Optional**	**Total Credit**
88	6	94

SUGGESTED ELECTIVES

1. Computational Biology
2. Bioentrepreneurship
3. Nanobiotechnology
4. Marine Food Technology
5. Ornamental Fish Culture & Aquarium Keeping
6. Genomics & Proteomics
7. Vaccines
8. Bacteriology
9. Plant and Animal Cell Culture Technology

SEMESTER – I

MBTC 101 - BIOCHEMISTRY

Unit I

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Bio-molecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships

Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, haemoglobin, chymotrypsin etc.

Unit II

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes

Unit III

Glycobiology - sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signalling- informational molecules, lectins, selectins; Glycosylation of other biomolecules - glycoproteins and glycolipids

Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins. Nucleosides, nucleotides, nucleic acids, brief overview of central dogma. Biosynthesis of cellular constituents (brief) -proteins carbohydrates, lipids and nucleic acids.

Unit IV

Bio-membrane organization – membrane dynamics. Biosignaling – Signal transduction, Pathways of intracellularsignals and second messengers, sensory transduction in vision, olfaction and gustation. Regulation mechanism (brief) - steroid hormones, protein kinases.

Unit V

Bioenergetics-basic principles; Equilibrium and concept of free energy; Coupled processes; Glycolytic pathway; Krebs cycle; Oxidative phosphorylation; Anaerobic condition of pyruvate, fermentation. Photosynthesis, Electron flow, ATP synthesis.

Reference Books

1. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

2. D.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.

3. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
4. Robert K. Murray, Darryl K. Granner, Peter A. Mayes, Harper's Illustrated Biochemistry (LANGE Basic Science), McGraw-Hill, 693, 2003.
5. Donald Voet, Judith G. Voet Biochemistry, Biomolecules, John Wiley & Sons, 1200pp, 2003

MBTC 102 - ANALYTICAL TECHNIQUES AND GLP

Unit I

Microscopy and Centrifugation

Light Microscope; Phase contrast and electron microscope; Photomicrography; Centrifugation- Centrifugal force and principal of sedimentation; Sedimentation coefficient; Types of centrifugation; Molecular weight determination

Unit II

Spectroscopic techniques

Absorption and Emission principles – principle and application of colorimeters; UV-visible; Spectrophotometer; Spectroflourometer; Flame photometer; Atomic absorption spectrophotometer; Inductively Coupled plasma Spectrophotometer (ICP) – Brief account of NMR, ESR and Mass spectrophotometry in Biology.

Unit III

Immunochemical and Chromatography techniques

Electrophoresis: General principles; Factors affecting mobility of charged molecules – principles and uses of paper electrophoresis; Agarose gel electrophoresis; Pulsed Field Gel Electrophoresis; Iso electric focusing; Polyacrylamide gel electrophoresis; SDS-PAGE; Chromatography – General principle, Types: Paper, Thin layer, Gas chromatography, HPLC, Ion-exchange chromatography – Principles and uses of each type.

Unit IV

Radioisotope techniques

Nature and units of radioactivity; Detection and measurement of radioactivity- Geiger and scintillation counters; Autoradiography; Applications of radioisotopes in biology; Radiation hazardous.

Unit V

GLP (Good laboratory practice)

Principles; Commodities; Apparatus; Reagents and materials; Pest control; Cryogenic safety - General Precautions; Storage; Test Systems; Standard protocols; Quality assurance; Laboratory signage- Biosafety level; Treatment and disposal –sharps, cultures, stock & labware; Biotoxin and pathological waste – fixed tissues & bedding; Storage and retention of records.

Reference Books

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.

2. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.

3. D. Holme & H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.

4 Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.

5. Sambrook, J. and D.W. Russell, Molecular cloning: A laboratory manual, 3rd Edition, (app. 900pp), 2001.

6. Selected readings from Methods in Enzymology, Academic Press.

MBTC 103 - Cell and Developmental Biology

Unit I

Cell Theory & Methods of Study

Origin and evolution of cells, types of cells and tissues. Tools of cell Biology – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc.

Membrane Structure and Function

Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.

Unit II

Organelles

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; nuclear pore complex, Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure-function relationship; Mitochondrial DNA and male sterility and its significance; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis.

Unit III

Endo-membrane System and Cellular Motility

Structure and function of microbodies – peroxisome; glyoxysome; Endoplasmic Reticulum, Golgi apparatus, and Lysosome; role in protein sorting and transport. Cell shape and motility; Actin-binding proteins and their significance; Actin, myosin and cell movement - Muscle organization and function; Molecular motors; Intermediate filaments.

Unit IV

Cellular Movements, Pattern Formation and Embryogenesis

Eukaryotic cell cycle and differentiation (brief) - regulators of cell cycle. Organization and role of microtubules and microfilaments; Laying of body axis planes; Separation of mitotic chromosomes, Cellular polarity, Cilia and flagella, Differentiation of germ layers ; Gastrulation , blastulation - Cellular polarity; Maternal gene effects; Zygotic gene effects; Homeotic gene effects with an example. Embryogenesis: Cell lineages and developmental control genes in Caenorhabditis.

Unit V

Singling and Differentiation of Specialized Cells

Tyrosine kinase, Ras, MAP kinase pathway. Programmed cell death – Caspases and Apoptosis. Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Differentiation of cancerous cells and role of proto-oncogenes.

Reference Books

1. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
2. Lodish *et al*., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
3. B. M. Turner, Chromatin & Gene regulation, 1st Edition, Wiley-Blackwell, 2002.
4. Watson *et al.,* Molecular Biology of the gene*,* 5th Edition, Pearson Prentice Hall. USA, 2003.
5. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.

MBTC 104 - Molecular Biology

Unit I

DNA Structure & organization

Structure of DNA - A-, B-, Z- and triplex DNA; Measurement of properties-Spectrophotometric, CD, AFM and Electron microscope analysis of DNA structure; Matrix binding proteins.

Replication, Repair & Recombination

Replication initiation, elongation and termination in prokaryotes and eukaryotes; Enzymes and accessory proteins; Fidelity; Replication of single stranded circular DNA; Gene stability and DNA repair- enzymes; Photo-reactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Recombination: Homologous and non-homologous; Site specific recombination; Chi sequences in prokaryotes; Gene targeting; Gene disruption; FLP/FRT and Cre/Lox recombination.

Unit II

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA

Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors; Transcriptional and post-transcriptional gene silencing

Unit III

Post Transcriptional Modifications

Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Unit IV

Translation & Transport

Translation machinery; Ribosome; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation

Unit V

Mutations, Oncogenes and Tumour suppressor genes

Nonsense, missense and point mutations; Intragenic and Intergenic suppression; Frame-shift mutations; Physical, chemical and biological mutagens; Transposition - Transposable genetic elements in prokaryotes and eukaryotes; Mechanisms of transposition; Role of transposons in mutation; Viral and cellular oncogenes; Tumour suppressor genes.

Reference Books

1. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland, 2002
2. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
3. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
4. Thomas E. Creighton, Encyclopedia of Molecular Biology, 4 Volume Set 2898 pp, Wiley-Interscience,1999.
5. Bruce Alberts , Alexander Johnson , Julian Lewis, Martin Raff , Keith Roberts and Peter Walter Molecular Biology of the Cell 1392pp, 2008

MBTC 105 Marine Bioresources, Biodiversity & Oceanography

Unit I

Introduction to Marine Biology

Introduction to marine environment; Marine Flora-Phytoplankton, seaweeds, sea grasses and mangroves their characteristics and identification.

Unit II

Important marine Organisms and their behaviour

Marine fauna–Zooplankton; Major marine invertebrates (crustaceans & molluscs); Vertebrates(Pisces) and marine mammals (dolphin and whales) - characteristics and identification; Biology - food & feeding - age & growth - reproduction - life history of crustaceans, molluscs and fishes.

Unit III

Marine resources assessment

Methods of surveying the living resources (Acoustic, Aerial and Remote sensing); Principal methods of exploitation (Indigenous and modern crafts & gears)

Unit IV

Population study and Marine environment protection

Population dynamics - Principles of population dynamics; Unit stocks; Age & size composition of the population; Abundance and density; Recruitment; Growth; Mortality(fishing & natural); Conservation and management-*in situ* and *ex situ*; IUCN categorization; Marine biosphere reserves; Marine parks - heritage sites.

Unit V

Oceanography

Physical: waves, tides and currents

Chemical-nutrient cycle, metals, minerals and trace elements Biological-primary and secondary productivity, finfish and shellfish resources.

Reference Books

1. Miller RI, Mapping the Diversity of Nature, Chapman & HaIl. pp. 218. 1994.
2. Heywood V.H., Global Biodiversity Assessment. UNEP, Cambridge University Press PP. 1140, 1995.
3. King, M., Fisheries Biology: Assessment and Management, Fishing News Books. 1995.
4. Agarwal et. al., Biodiversity and Environment. APH., pp 351. 1996.
5. Carl E. Bond, Biology of Fishes, 2nd Edition, W.B. Saunders Company, Philadelphia, 1996.
6. Naskar K. and Mandal R., Ecology and Biodiversity of Indian Mangroves. Daya. pp 361, 1999.
7. Jeffrey S. Levinton, CD Marine Biology: Function, biodiversity, ecology (515pp) with cd-rom". 2001.
8. Artikeya, K., Biodiversity: Extinction and Conservation, (202pp) 2005.

MBTC 106 - INTRODUCTORY MATHEMATICS

Unit - I

Notation, error analysis, and probability

Scientific notation: significant digits, rounding off, scientific notation; Error analysis; Counting and Probability; Addition rules; Permutations; Combinations; Inclusion-exclusion rule; Sampling with and without replacement; Conditional probability: Bayes' theorem; Independence

Unit - II

Descriptive statistics and Random variables

Measures of central tendency: mean, median, mode; Expectation; Measures of spread: range, percentile, standard deviation; Higher moments: kurtosis, skew; Displaying data: Histograms, stem-and-leaf plots, box plots, frequency distributions; Discrete random variables: Bernoulli, Binomial, Poisson, Geometric distributions, Continuous random variables: Normal, Exponential distributions, Standard normal distribution

Unit - III

Inferential statistics and one sample hypothesis testing

Samples and populations: Random, stratified and cluster sampling. Single- and Double-blind experiments. Point and interval estimates, Sampling distributions: *t*, chi-square, F distributions, Hypothesis testing: null and alternative hypotheses, decision criteria, critical values, type I and type II errors, the meaning of statistical significance, power of a test, One sample hypothesis testing: Normally distributed data: *z*, *t* and chi-square tests. Binomial proportion testing.

Unit - IV

Multi-sample and nonparametric hypothesis testing

Two sample hypothesis testing; Nonparametric methods: signed rank test, rank sum test, Kruskal-Wallis test, Analysis of variance: One-way ANOVA. Curve fitting, Regression and correlation: simple linear regression, the least squares method, Analysis of enzyme kinetic data. Michaelis-Menten, Lineweaver-Burk and the direct linear plot, Polynomial curve fitting.

Unit – V

MINITAB

Introduction – Preliminary analysis of the popular tree data – Obtaining graphs –

Generate random data from a specified probability distribution – binomial Poisson – Paired T-Test – One way and Two way ANOVA – Regression analysis – correlation

REFERENCE BOOKS

1. G. B. Thomas and R. L. Finney, Calculus and Analytic Geometry, 9th Edition, ISE Reprint, Addison-Wesley, 1998.

2. E. Kreyszig, Advanced engineering mathematics, 8th Edition, John Wiley, 1999.

3. W. E. Boyce and R. DiPrima, Elementary Differential Equations, 8th Edition, John Wiley, 2005.

4. Sheldon M.Ross – Introductory Statistics, 2nd edition - Academic Press, 2006.

5. Alexander, M. Mood, Franklin, A Gray bill and Duance C. Boes, Introduction to the theory of Statistics, 5th reprint, TMGH, 2006.

MBTC 107 - COMMUNICATION SKILLS

Unit - I

Process of communication

Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding breakdowns. 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.

Unit - II

Presentation skills

Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point; Defending Interrogation; Scientific poster preparation and presentation; Participating in group discussions.

Unit - III

Technical Writing Skills

Types of reports; Layout of a formal report; Scientific writing. Problems in the preparation of a scientific document; Plagiarism; Scientific Publication Writing: Elements of a Scientific paper including Abstract, Introduction, Materials and Methods, Results, Discussion, References; Drafting titles and framing abstracts.

Unit - IV

Computing Skills for Scientific Research

Web browsing search engines Hidden Web and its importance in Scientific research; Internet as a medium of interaction of scientists; Effective e-mail strategy using the right tone and conciseness

REFERENCE BOOKS

1. Wren & Martin, 2000. A Simple course of English Grammer and Composition. S. Chand Publishers, New Delhi,376 pp
2. Ruby Lavel, 2001. Writing and Grammer – Communication in Aesian Prentice Hall Inc, 950 pp.
3. Mohan Krishna and N.P.2003. Singh, Speaking English Effectively, Mac Millan New Delhi,939pp.
4. Lonidray, D. 2011. Scientific writing – Thinking in words, CSIRO publishing, New Delhi

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MBTP 108 – Practical I (Covering courses MBTC 101 & 102)

PRACTICALS – MBTC 101 - Biochemistry

1. To prepare an Acetic-NaAcetate Buffer system and validate the Henderson –Hasselbach equation.
2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the Beer- Lambert's Law.
3. Titration of amino acids and separation of aliphatic, aromatic and polar amino acids by TLC
4. AN ENZYME PURIFICATION THEME (such as *E.coli* Alkaline phosphatase or any enzyme of the institutions choice).
   (a) Preparation of cell-free lysates
   (b) Ammonium Sulfate precipitation
   (c) Ion-exchange Chromatography
   (d) Gel Filtration
   (e) Affinity Chromatography
   (f) Generating a purification Table
   (g) Assessing purity by SDS-PAGE Gel Electrophoresis
   (h) Assessing purity by 2-D gel electrophoresis
   (i) Enzyme Kinetic Parameters: Km, Vmax and Kcat.

MBTC 102 - Analytical Techniques & GLP

1. Biophysical methods (Circular dichroism spectroscopy, fluorescence spectroscopy).
2. Determination of mass of small molecules and fragmentation patterns by Mass Spectrometry.

MBTP 109 – Practical II (Covering courses MBTC 104 & 105)

PRACTICALS - Molecular Biology & Marine Bioresources, Biodiversity and Oceanography

MBTC 104 - Molecular Biology

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Agarose gel electrophoresis
5. Restriction Enzyme digestion of DNA
6. Purification of DNA from an agarose gel

7. DNA Ligation
8. Transformation of E.coli with standard plasmids, Calculation of transformation efficiency.
9. Polymerase chain reaction
10. 16srRNA & 18srRNA amplification
11. Transformation of yeast *Saccharomyces cerevisiae*

MBTC 105 – Marine Bioresources, Biodiversity & Oceanography

1. Identification of phytoplankton (diatoms and dinoflagellates)
2. Zooplankton, Seaweeds, Sea grasses and mangroves
3. Identification of commercially important crustaceans (prawns, Shrimps, lobsters and crabs), molluscs (pelecypods, gastropods and Cephalopods) and fishes (Cartilaginous & teleost) apart from dolphins & Whales.
4. Identification of larval stages of crustaceans (prawns, shrimps, lobsters and crabs), molluscan and fish eggs and larvae.
5. Food and feeding habits – Gut content analysis (crustaceans and fishes)
6. Assessment of age and growth - tags, morphometry, otolith, scales, vertebrae)
7. Reproduction – Gonadial maturity stages, GS index.
8. Working principles of Echo sounder
9. Crafts and gears – principles & operation. (Catamarans, dugout canoe & trawlers; cast net, push net, gill net, scoop net, purse seines, trawl net).

SEMESTER – II

MBTC 201 - Immunology

Unit I

Immunology- fundamental concepts and anatomy of the immune system

Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoiesis; Organs and cells of the immune system- primary and secondary lymphoid organs; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue (MALT & CALT); Mucosal Immunity; Antigens - immunogens, haptens; Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing.

Unit II

Immune responses generated by B and T lymphocytes

Immunoglobulin's-basic structure, classes and subclasses of immunoglobulin, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Principles of cell signaling; Immunological basis of self –non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation. Endogenous antingens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

Unit III

Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface Plasmon Resonance, Biosensor assays for assessing ligand – receptor interaction, CMI techniques-lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays.

Unit IV

Vaccinology

Active and passive immunization; Live, killed, attenuated, sub unit vaccines; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines, reverse vaccinology; Peptide vaccines, conjugate vaccines; Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies; Catalytic antibodies and generation of immunoglobulin gene libraries.

Unit V

Clinical Immunology

Immunity to Infection: Bacteria, viral, fungal and parasitic infections (with examples from each group); Hypersensitivity – Type I-IV; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy.

Reference Books

1 Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.

2. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.

3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications. 1999.

4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.

5. Goding, Monoclonal antibodies, Academic Press. 1985.

MBTC 202 - Marine Microbiology

Unit I

Types of marine microbes and their biology

Structure: Bacteria, fungi, algae, protozoa and viruses; Classification of microbes (Genetic level) -conventional and modern methods.

Biology of micro-organisms used in genetic engineering *(Escherichia coli, Rhizobium sp., Agrobacterium tumefaction's, Saccharomyces cerevisiae, phage lambda, Nostoc, Spirulina, Aspergillus, Pencillium and Streptomyces).*

Unit II

Microbial Assessment

Methods of studying the marine micro-organisms-Methods of collection, enumeration (total and viable counts), Isolation, culture & identification based on morphological, physiological and biochemical characteristics; Preservation of marine microbes; Culture collection Centres (ATCC, IMTECH, etc.).

Microbial nutrition - influence of environment factors on microbial growth, activity and distribution. Bioluminescence & Quarum sensing –mechanism, significance and regulation. Bar-coding of microbes and its application.

Unit III

Role of microbes in marine environment

Microbial nitrogen fixation; Carbon, nitrogen and phosphorus cycle; Decomposition of organic matter; Bioleaching and biodeteroriation of natural and synthetic materials.

Unit IV

Microbial metabolites Microbial interaction

Microbes of Biotechnological importance; Primary and secondary metabolites (enzymes, antibiotics, organic acid, toxins etc.) Seafood microbiology - normal genera associated with fish, food spoilage, fish & human pathogens; Indicator of Pollution - faecal coli forms; Prevention & control.

Unit V

Extremophiles

Thraustochytrids: features and biotechnological potential. Microbes of hydrothermal vents, seabed volcanoes, uncultivable, animal associated and deep sea forms: biology; adaptability to extreme conditions and uses.

Reference Books

1. Pelczar MJ Jr., Chan ECS and KreigNR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.

2. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.

3. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

4. Rheinhemer, G., 1980. Aquatic Microbiology, Johnwiley& Sons, pp. 235.

5. Elay, A.R.1992. Microbial food poisoning. Chapman and Hall, London, 191 pp.

MBTC 203 - Genetic Engineering

Unit I

Basics Concepts

Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II

Cloning Vectors & Expression

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and pBluescript vectors, T-vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo, retroviral, pichia vectors, Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Plant based vectors, Ti and Ri vectors, Yeast vectors, Shuttle vectors

Unit III

Cloning Methodologies

Insertion of foreign DNA into host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; phage display; Principles in maximizing gene expression

Unit IV

PCR and its Applications

Primer design; Fidelity of thermo stable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-Vectors; deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis and detection.

Unit V

Advances in Genetic Engineering

Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; siRNA technology; Micro RNA; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Gene targeting; Transgenic organism (in brief with an example); cDNA and intragenic arrays.

Reference Books

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Selected papers from scientific journals.

5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

MBTC 204 - Genetics, Genomics & Proteomics

Unit I

Genome organization & Principles

Organization of bacterial genome; Structure of eukaryotic chromosomes; Heterochromatin and Euchromatin

Mendalian law of genetics, allele, homozygous and heterozygous gene locus, discrete inheritance and Rediscovering of Mendal's law, chi-square test, Theory of Inheritance, autosomal gene inheritance, sex linked gene inheritance, sex determination with an example.

Unit II

Gene Analysis

Expression of genetic information – Multiple alleles, essential genes, co-linearity of genes and proteins, The genetic code - Recognition of coding and non-coding regions and annotation of genes. The complexity of eukaryotic genome – gene families, pseudogenes, repetitive gene sequences. Linkages and pedigree analysis- Physical and genetic mapping.

Unit III

Genome Sequencing

Genome sequencing – Microbes, plants and animals; Comparative genomics of relevant organisms such as pathogens and non-pathogens; Taxonomic classification of organisms using molecular markers –16S rRNA and COI typing/sequencing; Computational analysis; Sequences analysis; Similarity searches and pair wise alignment; Multiple sequences alignment; Phylogenetics and metagenomics.

Unit IV

Gene Expression studies

Functional Genomics; Global gene expression analysis; Micro-array; Comparative Transcriptomics; Differential gene expression. Regulation of gene expression by hormones in animal and plants

Unit V

Proteomics

Proteomics-definition; Identification and analysis of proteins by 2D analysis; Mass spectrophotometry; MALDI-TOF; LC-MS; SAGE and Differential display proteomics; Protein-protein interactions; Yeast two hybrid system and phage display; Pharmacogenetics - high throughput screening for drug discovery- identification of drug targets; Drug development.

Reference Books

1. Pennington. S. R and M.J. Dunn, Proteomics from Protein Sequences to Function, Vova Books private limited, India, 2002.

2. Peter Armitage and Theodore Colton, Biostatistics genetics and Genetic Epidemiology, John Wiley & Sons Ltd. England, 2002.

3. Gina Smith, The genomics Age, American Management Association, New York. 2005.

4. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, Benjamin Cummings 2007.

5. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.

MBTC 205 - Aquaculture Technology & Marine Pharmaceutical Chemistry

Unit 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.

Unit II

Manipulation Techniques

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

Unit III

Diseases and Controlling Measures

Shrimp major disease causing agents: WSSV, Yellow Head Virus, MBV, IHNV, Vibrio; Finfish major disease causing agents: EVS, Noda virus Vibrio and Fusarium infection.
Application of microbial biotechnology in culture ponds; Bioaugmentation; Bioremediation for soil and water quality improvement - nutrient cycle; Probiotics; Immunostimulants.

Unit IV

Introduction to marine pharmacology

Terms and definitions; Medicinal compounds from marine flora and fauna - approaches to discovery and development of natural products as potential new drugs, selection and optimization of lead compounds' sources, method of isolation and purification, marine toxins, antiviral, antimicrobial and anticancer agents. Drug development strategies – evaluation of molecules; pharmacodynamics; drug safety.

Unit V

Pharmaceutical Chemistry Basics

Significance of British and Indian Pharmacopeia; Therapeutic Index. Chemical analyses – key functional group of molecules; Characterisation of molecule through FTIR, Mass Spec, NMR,

Reference Books

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 lnterscience, New York. 1972.

3. Aquaculture, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

4. Aulton, Michael E. Aulton's pharmaceutics: The Design and Manufacture of Medicines. Churchill, Livingstone 2007.

5. Ahmed F. Abdel-Magid, Stephane Caron, Fundamentals of Early Clinical Drug Development: From Synthesis Design to Formulation, 354pp, Wiley, 2006.

MBTP 206 – Practical - III
(Covering course MBTC 201)

Practical – MBTC 201 - Immunology

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation and Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from fish serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays
7. Blood smear identification of fish leucocytes by Giemsa stain
8. Separation of leucocytes by dextran method
9. Demonstration of Phagocytosis by latex beads
10. Separation of mononuclear cells by Ficoll-Hypaque
11. Lympho proliferation by mitogen / antigen induction
12. Immunodiagnosis using commercial kits

MBTP 207 – Practical - IV
(Covering courses MBTC 202 & 205)

Practical – MBTC 202 - Marine Microbiology

1. Sterilization, Preparation of culture media, agar slants, isolation & identification of microbes, and maintenance of cultures. Gram's Staining, morphological, physiological, biochemical characterization of microbes, measuring growth rate, checking markers, penicillin selection for auxotrophy.
   a) Estimation of coli forms from water samples
   b) Sea food quality –
      i) Estimation of coagulase + ve *Staphylococci*
      ii) Estimation of *Vibrio* spp
      iii) Estimation of *Salmonella* spp.
   c) Isolation and identification of important marine fungi.
   d) Isolation and identification of marine cyanobacteria

2. Aseptic techniques - Staining - Preparation of competent *E. coil* cells for transformation.

Practical - MBTC 205 - Aquaculture Technology & Pharmaceutical Chemistry

1. Dissect and display the lymphoid organs from fishes and mammals
2. Observation of lymphoid organs in fishes (C.S. of Thymus, spleen, anterior kidney, Gut)
3. Observation of lymphoid organs in birds (C.S. of Bursa of fabricus, spleen
4. Observation of lymphoid organs of mammals (C.S. of lymph node, C.S. of spleen, C.S. of tonsil, C.S. of Peyer,s patches, C.S. of thymus, C.S. of bone marrow)
5. Smear preparation of lymphoid organs in fishes (anterior kidney and spleen)
6. Techniques in isolation of bioactive principles
7. FTIR (Demo)

MBTP 208 – Practical - V
(Covering course MBTC 203)

Practical- **MBTC 203 - Genetic Engineering**

1. Isolation of genomic DNA from *E.coli*
2. Primer designing and PCR amplification of a gene and analysis by agarose gel electrophoresis
3. Preparation of plasmid, pET-28a from E-coli DH5a and gel analysis
4. Restriction digestion of vector (gel analysis) and insertion of gene of interest
    a. Vector and Insert litigation
    b. Transformation in E.Coli DH5a
5. Plasmid isolation and confirming recombinant by PCR and RE digestion
6. Transformation of recombinant plasmid in E.coli BL21 (DE3) strain
7. Induction with IPTG and analysis on SDS-PAGE
8. a) Random Primer labeling b) Southern hybridization.
9. Purification of protein on Ni-NTA column and analysis by SDS-PAGE (Demonstration)

SEMESTER – III

MBTC 301 Bioprocess Technology

Unit I

Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes; Microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); Strain improvement for increased yield and other desirable characteristics.

Unit II

Concepts of fermentation processes

Bioreactor designs; Types of fermentation and fermenters; Upstream processing: Media formulation; Sterilization; Aeration and agitation in bioprocess; Measurement and control of bioprocess parameters; Scale up and scale down process.

Unit III

Downstream processing

Bioseparation; Filtration; Centrifugation; Sedimentation; Flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging; Treatment of Effluent and its disposal.

Unit IV

Industrial production of chemicals

Alcohol, acids, solvent, antibiotics, amino acids and single cell protein; Fermentation economics of large-scale production.

Unit V

Enzyme production

Production, recovery and scaling up of enzymes and their role in food and other industries; Immobilization of enzymes and their industrial applications.

Reference Books

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury, RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, McGraw-Hill Book Co., Newyork, 1986.
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, Univ of Tokyo press, Tokyo, 1973.

MBTC 302 - Marine Environmental Biotechnology

Unit I

Marine organisms and environment interaction

Types of marine environment - Physical, Chemical and Biological aspects and their interaction with marine life; Air – Sea interaction; Green house gases (CO_2 and Methane)

Unit II

Pollution

Marine pollution-major pollutants (heavy metal, pesticide, oil, thermal, radioactive, plastics, litter and microbial); Biological indicators (Marine microbes, algae and crustaceans) and accumulators: Application of Protein biomarkers; Biosensors and biochips.

Unit III

Biomaterial interaction

Biodegradation and Bioremediation; Biodegradation of natural and synthetic waste materials; Bioremediation; Separation, purification and bio removal of pollutants.

Unit IV

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.

Unit V

Wastewater bio treatment

BOD, COD; Biosensors; Biomolecules; membrane and transducer; Bioaugmentation-estimation of microbial load; Methods of Inorganic and Organic waste removal.

Reference Books

1 Recent Advances in Marine Biotechnology Volume 3 – Milton fingerman et al., 1999.

5. Cynobacterial and Algal Metabolisms and Environment Biotechnology – Tasneem Fatma, 1999.
3. Environmental Biotechnology and cleaner Bioprocess – Olguni, E.J. et al., 2000
4. Environmental Biotechnology Theory and applications – Evans et al., 2000.
5. Environmental Biotechnology – Gareth M.Evams et al., 2003
6. Biotechnology, Recombinant DNA Technology, Environmental Biotechnology – S.Mahesh et al., 2003.

MBTC 303 - Endocrinology & Reproduction of Marine Animals

Unit I

Invertebrate endocrinology

Endocrine system in marine invertebrates; Vitellogenesis; Oogenesis & Spermatogenesis; Basic concepts of neuroendocrine structures and functions in annelid, molluscan and echinoderm; Molluscan neuroendocrine control of growth; Reproduction.

Unit II

Shell fishes reproductive biology

Reproductive Biology in crustaceans; Factors influencing; Role of GIH; Role of 'x' and 'y' organs; Chemical nature of reproductive hormones; Neuro regulators – control mechanisms; Induced maturation & spawning; Moulting- moulting cycle and hormonal regulation in moulting.

Unit III

Finfish reproductive biology

Reproductive biology in finfishes; Migratory pattern; Maturity stages; Pigmentation; Structure and functions of pineal gland; Ovary and testis; Spawning and Fecundity; Gonado somatic Index.

Unit IV

Regulatory mechanisms

Role of endocrine glands in reproduction; Hormonal regulation in the ovarian pigmentation; Gonadotropins

– structure, synthesis – sex hormones; Hermaphroditism – protandrous and protogynous, sex reversal.

Unit V

Stem cell

Scope of stem cells, properties; Stem cells –Factors influencing differentiation, hormone role in differentiation. Preservation protocols.

Potential uses - Cellular Therapies, Vaccines, Gene Therapy, Immunotherapy, Tissue Engineering, Blood and Bone Marrow, T cells.

Reference Books

1. Kenneth, C. Highnam and Leonard Hill, 1969, The comparative endocrinology of the invertebrates, Edward Arnold Ltd.
2. Tombes, A.S., 1970, An Introduction to invertebrate endocrinology. Academic press, INC
3. Barrington, E.J.W., 1975, An introduction to general and comparative endocrinology, Oxford University press.
4. Bentley, R.J. 1976, Comparative Vertebrate Endocrinology, Cambridge University press
5. Hoar, W.S., D.J.Randall and E.M.Donaldson., 1983. Fish Physiology; Reproduction tissues and Hormones. Academic press INC
6. Wolf engels., 1984. Advances in invertebrates reproduction, 665pp, Elsevier Science publishers.

MBTC 304 - IPR & Biosafety

Unit 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
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

Unit II

Concept of 'prior art'

Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit III

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

Unit IV

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

Unit V

Biosafety

Introduction; Historical Backround; 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.

Important Links

http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html

MBTC 305 ELECTIVE – I

MBTP 306 – Practical VI (Covering courses MBTC 301 & 302)

PRACTICALS – MBTC 301 - Bioprocess Technology & MBTC – 302 Marine Environmental Biotechnology

MBTC 301 - Bioprocess Technology

1. Isolation and screening of industrially important microorganisms.
2. Determination of thermal death point and thermal death time of microorganisms.
3. Studying the kinetics of enzymatic reaction by microorganisms.
4. Production and purification of various enzymes from microbes.
5. Comparative studies of Ethanol production using different substrates.
6. Microbial production of Citric acid using *A. niger*.
7. Microbial production of antibiotics (eg., Penicillin)
8. Various immobilization techniques of cells/enzymes, use of alginate for cell immobilization.
9. Studying various types of fermenters, bioprocess simulation and control and production of microbial products in bioreactors.
10. Various techniques of downstream processing.

MBTC 302 - Marine Environmental Biotechnology

1. Estimation of dissolved oxygen, salinity, H_2S, BOD and COD
2. Estimation of heavy metals (Cu, Cd, Pb, Hg).
3. Demonstration – estimation of pesticide residues, petroleum hydrocarbons using GC
4. Experiment on heavy metal removal using biosorbent.
5. Microscopic studies of biofilm using test panels.
6. Identification of organisms involved in fouling and boring.
7. Experiment of prevention of fouling and boring using test panels.

MBTP 307 – Practical VII (Covering course MBTC 303)

Practical –MBTC 303 - Endocrinology and Reproduction of Marine Animals

1. Spotters (slides) Pituitary gland (cross section) Interregnal gland
   Adrenal gland
   Pancreatic tissue
   Thymus
   Ultimobranchial gland
   Corpasus of stannicus
   Testis & Ovary

2. Dissection
   Nervous system in shrimp and crab
   Reproductive system in fishes

3. Hypophysation technique in fish
4. Dissection and location of 'x' and 'y' organs in shrimps
5. Dissection and location of testis and ovary in fishes
6. Maturity stages of ovary in crustaceans and finfish

SEMESTER IV

MBTC 401 - Elective – II
MBTC 402 - Project Work

SUGGESTED ELECTIVES

MBTE 01 - Computational Biology

Unit I

Databases

Primary and Secondary Databases; GenBank, EMBL, DDBJ, Swissprot, MIPS, PIR, TIGR, Hovergen, TAIR, PlasmoDB, ECDC, Protein and Nucleic Acid Sequences,

Unit II

Search Algorithm

Scoring Matrices and their use; Computational complexities; Analysis of Merits and demerits; Sequence pattern; Pattern databases; PROSITE, PRINTS, Markov chains and Markov models; Viterbi algorithm; Baum-Welch algorithm; FASTA and BLAST Algorithm; Needleman-Wusch & Smith-Waterman algorithms

Unit III

Structure and Analysis

Representation of molecular structures; External and internal co-ordinates; Concept of free energy of molecules; Introduction to various force fields; Molecular energy minimization techniques; Monte Carlo and Molecular Dynamics simulation

Unit IV

Experimental Methods

Molecular structure Determination; Principle of X-ray crystallography and NMR spectroscopy; 2D Protein Data bank and Nucleic Acid Data bank; Storage and Dissemination of molecular structures

Unit V

Modeling

Homology modeling; Threading; Structure prediction; Structure-structure comparison of macromolecules; Simulated docking; Drug design; 2D and 3D QSAR; Ligand databases

Reference Books

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis 2nd Edition, CSHL Press, 2004.
2. A. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. 4. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd Edition, Garland Publishing, 1999.

MBTE **02 - Bioentrepreneurship**

Unit I: Accounting and Finance

Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks; Funds from bank for capital expenditure and for working; Statutory and legal requirements for starting a company/venture; Budget planning and cash flow management; Basics in accounting practices: concepts of balance sheet, P&L account, and double entry bookkeeping; Estimation of income, expenditure, profit, income tax etc.

Unit II: Marketing & Negotiations/Strategy

Assessment of market demand for potential product(s) of interest; Market conditions, segments; Prediction of market changes; Identifying needs of customers including gaps in the market, packaging the product; Market linkages, branding issues; Developing distribution channels; Pricing/Policies/Competition; Promotion/ Advertising; Services Marketing

With financiers, bankers etc.; With government/law enforcement authorities; With companies/Institutions for technology transfer; Dispute resolution skills; External environment/changes; Crisis/ Avoiding/Managing; Broader vision–Global thinking

Unit III: Information Technology

How to use IT for business administration; Use of IT in improving business performance; Available software for better financial management; E-business setup, management.

Unit IV: Human Resource Development (HRD)

Leadership skills; Managerial skills; Organization structure, pros & cons of different structures; Team building, teamwork; Appraisal; Rewards in small scale set up.

Unit V: Fundamentals of Entrepreneurship & Role of knowledge centre and R&D

Support mechanism for entrepreneurship in India

Knowledge centres like universities and research institutions; Role of technology and upgradation; Assessment of scale of development of Technology; Managing Technology Transfer; Regulations for transfer of foreign technologies; Technology transfer agencies.

Reference Books

1. Handbook of bioentrepreneurship, Patzelt,H. & T.Brenner (Eds.) International Handbook Series on Entrepreneurship, Springer Science + Business media LLC, 2008, 294pp.
2. Hine,D. & J. Kapeleris, Innovation & Entrepreneurship in Biotechnology, An International Perspective- Concepts, Theories and Cases, Edward Elgar Publishing Limited, UK 2006, 259pp.
3. International Marketing Research Opportunities and challenges in the 21st Centuary, Alex Rialp, Josep Rialp (Guest Editors), Advances in International Marketing Vol 17 , Series Editor S.Tamer Cavusgail, 2007, Elsevier Ltd., 426pp.
4. Malinowshi,M.J. & B.E.Arnold, Biotechnology, law, business and regulations, Aspen Publishers Inc., 2004, 994 pp.
5. Stiles,C.H. & C.S. Galbraith, Ethnic Entrepreneruship, Structure and Process In. International Research in the Business Disciplines Vol4, Elsevier Ltd., 2003, 332 pp.
6. Educational Infrastructure for biotechnology in India, Mishra,R.K., B.Navin, P.Geeta & Ch.Lakshmi Kumari(Eds.), Concept Publishing Company, New Delhi (India), 2006, 232 pp.

MBTE 03 - Nanobiotechnology

Unit I

Introduction to Nano-Biotechnology; Nanotechnology definition and concepts; Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications

Unit II

Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy

Unit III

Thin films; Colloidal nanostructures; Nanovesicles; Nanospheres; Nanocapsules

Unit IV

Nanostructures for drug delivery, concepts, targeting, routes of delivery and advantages

Unit V

Nanostructures for diagnostics and biosensors; Nanoparticles for diagnostics and imaging; Nanodevices for sensor development

Reference Books

1. Multilayer Thin Films, Editor(s): Gero Decher, Joseph B. Schlenoff Publisher: Wiley-VCH Verlag GmbH & Co. KGaA ISBN: 3527304401

2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley-Liss ISBN: 047141719X

3. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press ISBN: 0-8247-2579-4

MBTE 04 Marine Food Technology

Unit I

Preservation and processing – chilling methods, phenomena of rigor mortis, spoilage changes – causative factors. Drying – conventional methods. Salt curing, pickling and smoking. Freezing and cold storage, Canning procedures. Role of preservatives in processing.

Unit II

Packing – handling fresh fish, frozen packs, IQF, layered and shatter packs. Fishery by – products, cannery waste, feeds, silage, fish gelatin, fish glue, chitin and chitosan, pearl essence, fertilizer.

Unit III

Seafood microbiology – factors influencing microbial growth and activity. Seafood borne pathogens – bacteria, fungi, viruses. Spoilage factors in seafood. Toxins influencing food spoilage. Microbes as food – SCP, microbial neutraceuticals.

Unit IV

Quality management – concepts, planning, system, quality control, quality assurance, quality improvement. Certification standards – ISO and HACCP. Principles of quality related to food sanitation, contamination, pest control, human resource and occupational hazards.

Unit V

Novel product development, marketing and sea food export – MPEDA, marketing, government policies, export finance, economic importance. Novel products – nutrition promotion, consumer studies qualitative and quantitative research methods

REFERENCE BOOKS

1. Kreuzer, R., 1974. Fishery Products, FAO Fishing News (Books) Ltd., England, 280 pp.

2. Anon, 1979. Handling, Processing and Marketing of Tropical Fish. Tropical Products Institute, London.

3. Miller, M.D., 1990. Ciguatera Seafood Toxins, CRC Press New York.

4. Carison, V.R. and R.H. Graves, 1996. Aseptic Processing and Packing of Food : A Food Industry Perspective, CRC Press, New York.

5. Gopakumar, K., 1997. Tropical Fishery Products. Oxford & IBH Publications, New Delhi, 190 pp.

6. Oliveira, F.A.R. and J.C. Oliveira, 1999. Processing Foods : Quality Optimization and Process Assessment, CRC Press, New York.

7. Chandran, K.K., 2000. Post Harvest Technology of Fish and Fishery Products, Daya Publishing House, New Delhi, 440 pp.

8. Wilson, C.L., S. Droby, 2000. Microbial food contamination, CRC Press, New York.

9. Balachandran,K.K, 2001. Post Harvest Technology of fish and fish products, Daya Publishing House, New Delhi 440 pp.

10. Novak, J.S., G.M. Sapres and V.K. Juneja, 2002. Microbial safety of minimally processed foods, CRC Press, New York.

11. Weidenborner, M., 2003. Encyclopedia of food mycotoxins, Springer Verlag,USA.

MBTE 05 - Ornamental Fish Culture & Aquarium Keeping

Unit I

Introduction

Fresh and marine water aquaria - Global and Indian status of aquarium keeping - Ornamental fish trade Advantages and benefits - Criteria for choosing aquarium fishes - Common aquarium fishes - collection techniques.

Unit II

Culture and hatchery production

Breeding of fresh and marine water ornamental fishes - collection - conditioning - brood stock development

-feeding - spawning - larval rearing - Live feeds - stock and mass culture.

Unit III

Designing, Aeration, filtration and lightings

In door and out door aquaria - Tank designs - fabrication - choosing of right tank - Air pumps - filters biofilters - devices - aquarium lights - water quality maintenance - test kits.

Unit IV

Setting up of aquarium

Fresh and marine water set up - aquascaping - adding decorative materials - aquarium plants - community aquarium.

Unit V

Health management

Basic diets - pellet feeds - formulation - Diseases - diagnosis and health management - treatment methods Colour enhancement - induced breeding

Reference Books

1. Dawes,J., 1995. Live bearing Fishe (A guide to their Aquarium care, Biology and Classification). 1st Edition, Cassell Pvt., London . 240 pp.

2. Adey, W. H. and K. Loveland, 1998. Dynamic Aquaria Building Living Ecosystems. 2nd Edition, Academic Press,US. 498 pp.

3. Axelrod, H. R and L. P.Schultz, 2000. Hand book of trophical aquarium Fishes. 1st Edition, orinocobooks - Sheffield SYK United Kingdom. 717 pp.
4. Grist, C., D. Mills and A. Caine, 2002, he Practical Encyclopedia Of The Marine Aquarium. Interpet Publishing-US. 208 pp.

5. Kuravamveli, S. J., 2002. The Aquarium Handbook. 1st Edition, Amity Aquatech pvt. Ltd Cochin. 256 pp.

6. Hemdal J.F., 2003.Aquarium Fish Breeding. 1st Edition, Barron's Educational Series-US. 176 pp.

7. Stephen Spotte,2005 . Marine Aquarium Keeping the Science Animals and Art. las vegas, 1st Edition, NV, USA. 171 pp.

8. Sundararaj, V and J.M. Sathish, 2005. Tropical marine aquarium. 1st Edition, Yegam publications, Chennai. 160 pp.

9. Fletche,r A.M., 2006. unusual aquarium Fishes. 1st Edition, Mishawaka, IN, USA. 397 pp.

10. Yoan, N., 2011. Live-Bearing Aquarium Fish. 1st Edition, Miss Press,US. 52 pp.

MBTE 06. Genomics and Proteomics

Unit 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.

Unit 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.

Unit III

Proteomics

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; 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.

Unit IV

Pharmacogenetics

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

Unit V

Functional genomics and proteomics

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

REFERENCE BOOKS

1. Glick BR & Pasternak JJ,1998. Molecular Biotechnology, 3rd Edition, ASM Press, 683 pp.
2. Voet, D., Voet, J.G. and Pratt, C.W., 2006. Fundamentals of Biochemistry, 2nd Edition. Wiley, USA. 931 pp.
3. Brown, T.A., 2006. Genomes, 3rd Edition. Garland Science, New York. 736 pp.
4. Primrose, S., and Twyman, R., 2006. Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 390 pp.
5. Campbell, A.M. and Heyer, L.J., 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings, 447 pp.

MBTE 07. Vaccines

Unit I

Innate Immunity; Activation of the Innate Immunity through TLR mediated signaling; Adaptive Immunity; T and B cells in adaptive immunity; Immune response in infection; Protective immune response in bacterial; Viral and parasitic infections; Correlates of protection

Unit II

Vaccination and immune response; Appropriate and inappropriate immune response during infection: CD4+ and CD8+ memory T cells; Memory B cells; Generation and Maintenance of memory T and B cells; Dendritic cells in immune response

Unit III

Adjuvants in Vaccination; Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial, Liposomal and Microparticles as adjuvant; Chemokines and cytokines; Role of soluble mediators in vaccination; Oral immunization and mucosal Immunity

Unit IV

Conventional vaccines; Bacterial vaccines; Live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccine

Unit V

New Vaccine Technologies; Rationally designed Vaccines; DNA Vaccination; Mucosal vaccination; New approaches for vaccine delivery; Engineering virus vectors for vaccination; Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine

Reference books

1. Stefan H.E. Kaufmann (Ed.), 2004. Novel Vaccination Strategies, Wiley-VCH Verlag GmbH & Co. KgaA, 628 pp.

2. Topley and Wilson's, 2005. Microbiology and Microbial Infections Immunology Edited by Stefan H.E. Kaufmann and Michael W. Steward Holder Arnold, ASM Press, 1033 pp.

3. Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark J. Shlomchik, 2005. Immuno Biology, The Immune system in health and Disease, 6th Edition, Garland Science, New York, 635 pp.

MBTE 08 - Bacteriology

Unit I

Introduction to historical development of cellular organization; Genetic and chemical characteristics of eukaryotic and prokaryotic cells

Unit II

Classification, nomenclature and identification; Genetic characterization and numerical taxonomy; Bacterial cell structure, physiology and antigenic structure.

Unit III

Determinants of pathogenicity and its molecular basis; Bacteriophages: temperate and virulent phages; lysogeny and lysogenic conversion

Unit IV

Bacterial genetics: bacterial variation, genetic transfer mechanisms (transformation, transduction and conjugation); Plasmids, transposons and drug resistance; Recombinant DNA technology.

Unit V

Systemic study of following bacteria: Gram negative- aerobic rods and cocci, family Pseudomonadaceae, Legionellaceae, Neisseriaceae, and genus Brucella; Facultative anaerobic Gram negative rods, family-Vibrionaceae, Pasteurellaceae, Enterobacteriaceae and other genera.

Practicals

Morphological characterization, Cell fractionation, Enrichment and isolation technology, Various methods used in growth measurement and bacterial preservation, Gene transfer experiment. Detailed characterization(isolation, biochemical, serological, pathogenicity etc.) of bacteria.

REFERENCE BOOKS

1. Glen, S. J. and W. Karen., 2004. Veterinary Microbiology: Bacterial and Fungal Agents of Animal Diseases, 1st edition, Saunders., 448pp.
2. Prescott, L., Harley. J. P., and **D. A. Klein,** 2004. Microbiology, 6th. Edition. Wm C. Brown - McGraw Hill, Dubuque, IA, USA., 992 pp.
3. Salle, A. J., 2007. Fundamental Principles of Bacteriology, Envins Press, USA., 636pp.
4. Buchanan and D. Stelle., 2007. Bacteriology, Buchanan Press, USA., 540pp.
5. Williams, U. Herbert., 2008. A Manual of Bacteriology, Home Farm Books, UK., 480pp.
6. Griffiths, A. B., 2008. A Manual of Bacteriology, Goldstein Press, USA., 360pp
7. Tortora, G.J., B.R. Funke, and C.L. Case., 2009. Microbiology: An Introduction.10th edition, Benjamin Cummings. USA., 960pp.
8. Gradmann and Christoph, 2009. Laboratory Disease: Robert Koch's Medical Bacteriolog, Johns Hopkins University Press, USA., 318pp.

MBTE 09. PLANT AND ANIMAL CELL CULTURE TECHNOLOGY

Unit I

Structure and organization of animal cell - Cell proliferation – Cell differentiation – Cell adhesion – Senescence – Cell transformation

Unit II

Cell culture media: Components, physicochemical properties – Serum: Components, advantages and disadvantages, serum free media – Use of Antibiotics – Primary cell culture: Initiation of cell culture, mechanical and enzymatic disaggregation – Cell lines: Development, characterization, maintenance – Cell separation

Unit III

Adherent & non adherent cell lines – Culture methods – Subculture – Cryopreservation – Contamination in animal cell culture – Quantification and cytotoxicity – Embryonic stem cells – cancer stem cells.

Unit IV

Plant tissue culture – Introduction, cellular totipotency, basic requirements for plant tissue culture laboratory, tissue culture media (constituents and preparations), types of culture – cell, protoplast, callus, suspension culture and its applications.

Unit V

Explant, surface sterilization, plant growth hormones, micropropagation (direct and indirect method), somatic hybridization, plant transformation technique using *Agrobacterium tumefaciens*, applications of plant tissue culture.

REFERENCE BOOKS

1. Razdan, M. K., 2003. Introduction to plant tissue culture (2nd Edition), Science Publishers, USA. 375 pp.

2. Martin Clynes, 1998. Animal Cell Culture Techniques. Ed. Springer, NY, 618 pp.

3. Rudolf Endreb, 2004. Plant cell biotechnology –Springer publications, NY, 368 pp.

4. Robert N. Trigiano and Dennis J. Gray, 2004. Plant tissue culture concepts and laboratory exercises (2nd Edition), CRC, USA, 454 pp.

5. Gerald Karp, 2008. Cell and Molecular Biology, Wiley Press, USA, 843 pp.