Syllabus for MSc in Molecular Biology and Biotechnology (MBBT)

SEMESTER IV
PAPER CODE: MBB1001C
PAPER: CORE 12
BIOETHICS, BIOSAFETY AND IPR
CREDITS: 3+1+0

Unit 1: Bioethics, general concept

Fundamentals of bioethics; Animal rights, environmental protection, the complex nature of human society, social experimentation and role of ethics, right to information, ethical committee's role, biopiracy.

Biotechnology in agriculture and environment: ethical aspects of genetic testing, ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

5 Hours

Unit 2: Bioethics, plants and environment

GM crops: consumer wellbeing-food safety, allergenicity, antibiotic resistance genes, invasiveness, toxicity to wildlife, development of resistance; modern food system- functional foods-genetic modifications, GM foods- golden rice; Gaia hypothesis, sustainability and ethics.

6 Hours

Unit 3: Ethical implications of cloning

Reproductive cloning, therapeutic cloning; ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- genetically modified crops and genetically modified organisms, transgenic animals.

5 Hours

Unit 4: Case studies and issues in Bioethics

Silicon womb, IVF, cloning humans, designer babies, allotransplantation, stem cell research, sexing the unborn, sex discrimination, monopolizing economy and starvation, biodiversity, clinical trials.

7 Hours

Unit 5: Biosafety

Biosafety- definition, requirement, biosafety issues- biosafety for human health and environment, biosafety in relation to transgenic research.

Biosafety levels and containment facilities: introduction to biological safety cabinets, primary containment for biohazards, biosafety levels for microorganisms, plants and animals.

Biosafety guidelines: Institutional Biosafety committee (IBSC), RCGM, GEAC for GMO applications in food and agriculture; environmental release of GMOs, risk analysis, risk management and communication; overview of national regulations and relevant international agreements including Cartagena protocol.

10 Hours

Unit 6: Intellectual property rights

Introduction to Intellectual Property: types of IP: patents, trademarks, copyright & related rights, industrial design, traditionalknowledge, geographical indications, international framework for the protection of IP, IP as a factor in R & D; IPs of relevance to biotechnology; introduction to history of GATT, WTO, WIPO and TRIP.

Core areas of biotechnology involving IPR: pharmaceuticals, technology in genetic manipulations of cells and organisms, development of crop varieties, transgenic plants and animals, bioremediation, enzymes, vaccines, diagnostic tests.

15 Hours

Suggested Readings

1. BT guidelines, Biotech Consortium India Limited, New Delhi.
2. Galston. A. W. and Peppard. C. Z. Expanding horizons in bioethics. Springer, 2005.

3. Casey Chosewood, L and Deborah E. Wilson, Biosaftey in Microibiological and Biomedical Laboratories. 5th edition. U.S. Government Printing Office, 2007.
4. Krishna. V. S. Bioethics and Biosafety in Biotechnology. New Age International Publisher, 2007.

SEMESTER IV
PAPER: SPL 2
PAPER CODE: MBB1002SP1
PLANT FUNCTIONAL GENOMICS
CREDITS: 3+1+1

Unit 1: Structure of plant gene and genome
Variation of DNA-quantity; chromosome variation; origin of DNA variation- low copy, moderately repetitive, or highly repetitive sequences; polyploidy and its consequences; Methods for determination of genome size; typical organization of a plant gene and its regulatory sequences.

6 **Hours**

Unit 2: Introduction to functional genomics
Pre- and post-genomic era; major advancements in genomic approaches; epigenetics and metagenomics; forward versus reverse genetics.

5 Hours

Unit 3: The basic tool box—Acquiring functional genomic data
Cloning systems-Plasmid based vectors-ideal characteristics of a plasmid cloning vector, selectable markers; Large-insert vectors-Yeast artificial chromosome (YAC), Bacterial artificial chromosome (BAC), Generation and utilization of BAC libraries; cDNA and genomic DNA libraries, Substractive libraries; different sequencing strategies.

8 Hours

Unit 4: Next Generation sequencing Technologies
Sanger's method of DNA sequencing; History and evolution of sequencing technologies; 1st generation, 2nd generation and 3rd generation sequencing; Platform for DNA sequencing; comparative analysis of DNA sequencing platform in terms of cost and throughput.

9 Hours

Unit 5: Genome and transcriptome sequencing
Various sequencing approaches for genome, physical and genetic maps; Transcriptome library construction, sequencing and analysis for gene prediction and functional annotation.

7 Hours

Unit 6:RNAi and functional genomics
Introduction to RNAi; Mechanism of RNAi; RNA silencing pathways in plants; types of small RNA; RNAi as a tool for gene silencing.

4 Hours

Unit 7: Computational functional genomics
Introduction to biological databases; DNA, RNA and Protein databases; gene prediction methods, ORF finding, functional annotation of genome and transcriptome.

4 Hours

Unit 8: Genome Editing and functional genomics in plants
Introduction to genome editing; Genome editing tools; Genome editing for crop improvement; The CRISPR/Cas9 System and its Applications in plant breeding.

5 Hours

Practical
1. Isolation of high quality gDNA from plant tissue
2. Construction of cDNA library and selection of Transformants.
3. Analysis of Transcriptome data for identification and functional annotation of genes

Suggested Reading

1. Plant Functional Genomics- Methods and protocol; Edited by J M walker, Humana Press.
2. Bioinformatics and Functional Genomics- Jonathan Pevsner; Wiley Blackwell publisher.
3. Plant Functional Genomics- Methods and Protocols, Edited by J M walker, Humana Press.
4. Plant Genomics and Proteomics- Christopher A. Cullis, A John Wiley & Sons, Inc., Publication

SEMESTER IV
PAPER CODE: MBB1003OE1
PAPER: OPE 2
BIODIVERSITY AND CONSERVATION GENETICS
CREDITS: 3+1+0

Unit 1: Introduction

Biodiversity concept; Levels of biological diversity; genetic diversity and need of biodiversity conservation; Ex-situ and In-situ conservation; Biodiversity hot-spots.

Genetics in conservation; recognition of genetic factors in conservation biology, Genetic versus demographic and environmental factors in conservation biology.

5 Hours

Unit 2: Biodiversity Documentation and Assessment

Morphological and molecular characterization of biodiversity; introduction to biodiversity databases; endemism; Red data book; germplasm conservation and biological repository.Data submission and data retrieval; phylogenetic tree.

7 Hours

Unit 3: Genetics and Extinction

Genetic and evolutionary consequences of small population size in plants, ecological implications of genetic variation; Genetics and the fate of endangered animal species, relationship between inbreeding and extinction, Relationship between loss of genetic diversity and extinction.

6 Hours

Unit 4: Population Genetics

Hardy-Weinberg equilibrium, Low genetic diversity and threatened species, Genetic drift, Mutation, Natural selection, Migration and gene flow, Bottleneck and Founder effect.Evolution in large populations; Importance of mutation, migration and their interactions with selection in conservation, Selective value of mutations, Migration–selection equilibria and clines.Loss of genetic diversity in small populations; Changes in genetic diversity over time, Relationship between population size and genetic diversity in wild populations, effective population size.

8 Hours

Unit 5: Genetic management for reintroduction

Conservation strategies for genetic diversity; hybridization in rare plants, off-Site breeding of animals and implications for plant conservation strategies, conservation of rare trees in tropical rain forests, correlations between species traits and allozyme diversity, sampling strategies for genetic variation in *Ex Situ* collections of endangered plant species.

Reintroduction, supportive breeding in animals, genetic changes in captivity that affect reintroduction success, genetic adaptation to captivity, reintroduction success; case studies.

8 Hours

Unit 6: Use of molecular genetics in forensics

Use of molecular genetics to understand species biology; Forensics: detecting illegal hunting and collecting, Gene trees and coalescence, population size and demographic history.

6 Hours

Unit 7: Molecular Tools and Techniques for Biodiversity Conservation

Allozymes; Microsatellites; RFLP; RAPD; AFLP; ISSR; SSR; VNTRs; SNPs; Chloroplast DNA; Mt DNA; DNA barcoding; DNA sequencing. 8 **Hours**

Suggested Readings

1. Wilson. E. O, Biodiversity. National Academy Press, Washington, D.C, 1988.
2. Frankham. R, Ballou.J.D and Briscoe.D.A, A primer of Conservation Genetics. Cambridge University Press, 2004.
3. Falk. R, Genetic Analysis: A History of Genetic Thinking. Cambridge University Press, 2011.
4. Hamilton. M. B, Population Genetics. 1st Ed, Wiley - Blackwell, 2009.
5. Nei. M and Kumar. S, Molecular Evolution and Phylogenetics. 1st Ed, Oxford University Press, 2000.
6. Mayr. E and, Ashlock. P. D, Principles of Systematic Zoology, Mcgraw-Hill Book Comp., 1991.
7. Radford. A. E. and Caddell. G. M., Fundamentals of Plant systematics, Harper and Row, 1986.