DEPARTMENT OF BOTANY (NORTH CAMPUS)

UNIVERSITY OF KASHMIR

SEMESTER-VI

Five-Year Integrated Masters Programme (FYIMP) in Botany

DEPARTMENT OF BOTANY (NORTH CAMPUS)
UNIVERSITY OF KASHMIR

SEMESTER-6				
Course Type	**Course Code**	**Course Title**	**Credit**	
			Theory	**Practical**
MAJOR-1	IBOTMJMB0623	Plant Molecular Biology	3	1
MAJOR-2	IBOTMJPB0623	Plant Breeding	3	1
MAJOR-3	IBOTMJGC0623	Genetics & Cytogenetics	3	1
MAJOR-4	IBOTMJBC0623	Biodiversity and Conservation Biology	3	1
MINOR	IXXXMNFB0623	Fermentation Biotechnology	3	1
Total			**20**	

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Semester	:	**VI**
Course Type	:	**Major-1**
Course Title	:	**Plant Molecular Biology**
Course Code	:	**IBOTMJMB0623**
Credits	:	**04 (Theory: 03; Practical: 01)**

COURSE OBJECTIVES: *This course is designed to familiarize the students with understanding the basic concepts in molecular biology, nucleic acids, gene expression mechanisms in prokaryotes and eukaryotes besides DNA damage and repair mechanisms.*

LEARNING OUTCOMES: *This course will allow students to understand the chemical and molecular processes of life based on the genetic constituents of the cell. Students will learn to comprehend the properties of the heritable material along with all the enzymes involved for proper replication fidelity.*

Theory (03 Credits):

Unit I:

DNA Structure: DNA as genetic material, Double helical structure (Watson-Crick model), Various forms of DNA.

DNA Replication: Mechanism of DNA replication in Prokaryotes and Eukaryotes; detailed mechanism of termination of replication; Methylation.

DNA Damage and Repair: Mechanisms of DNA damage and repair; Causes and types of DNA damage, Base excision repair, Nucleotide excision repair, Mismatch repair, Non-homologous end joining, Holiday Model.

Unit II:

Prokaryotic transcription: RNA polymerases, Sigma factor, Promoter, Initiation, Elongation, and Termination.

Eukaryotic transcription: RNA polymerases, Transcription factors, Promoters, Enhancers, Mechanism of transcription initiation, elongation, termination. Splicing and processing of pre-mRNA: 5' cap, Polyadenylation, splicing of tRNA and rRNA precursors, Splicing without protein enzyme.

Unit III:

Gene Expression Regulation: Operon concept (inducible, repressible systems), Genetic code characteristics; Gene regulation in eukaryotes.

Translation: Prokaryotic and Eukaryotic Translation, Ribosome structure, Assembly, Charging of tRNA, Aminoacyl-tRNA synthetases. Mechanism: Initiation, Elongation, Termination of polypeptides, Fidelity of translation; Inhibitors of translation, Post-translational modifications.

Practical Exercise (01 Credit):

- Preparation of solutions for molecular biology experiments.
- Extraction of DNA.
- Agarose gel electrophoresis for isolated DNA.
- Demonstration of quantification of DNA.
- Quantitative tests of Lipids & their separation by thin layer chromatography (TLC).
- Preparation of LB medium and raising *E. coli*.

Suggested Readings:

- Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
- Russell, P. J. (2010). i-Genetics- A Molecular Approach.Benjamin Cummings, U.S.A. 3rd edition.
- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Semester	:	**VI**
Course Type	:	**Major-2**
Course Title	:	**Plant Breeding**
Course Code	:	**IBOTMJPB0623**
Credits	:	**04 (Theory: 03; Practical: 01)**

***COURSE OBJECTIVES**: To impart theoretical knowledge and practical skills about plant breeding objectives, modes of reproduction and genetic consequences, breeding methods for crop improvement.*

***LEARNING OUTCOMES**: The course is designed to impart students with the understanding of important breeding procedures in self and crosses pollinated crops and exploitation of heterosis utilizing male sterility and other methods. Students will also learn about the fundamentals of crop improvement using modern techniques of molecular breeding*

Theory (03 Credits):

Unit-I

Plant breeding: Definition, history, aims and general objective of plant breeding, major achievements and future prospects; modes of reproduction in crop plants; Centres of origin/diversity of major crop plants.
Self-incompatibility: heteromorphic SI, homomorphic SI, utilization of self-incompatibility in plant breeding.
Male sterility: genetic consequences (Genetic MS, Cytoplasmic Genetic MS, Transgenic MS); Chemical Hybridizing Agents;

Unit-II

Population Genetics: Basic concept, Hardy-Weinberg Law, factors affecting Hardy-Weinberg Law;
Hybridization: Techniques, methods, back cross method, procedure for transfer of dominant and recessive gene through backcross method; Methods of breeding in self-pollinated crops.
Hybrid breeding: Heterosis and inbreeding depression, genetic basis/theories of heterosis & Inbreeding depression.
Wide hybridization: Definition, types, incompatibility barriers for wide hybridization, techniques for overcoming incompatibility barriers.

Unit-III

Breeding methods in asexually propagated crops: Clonal selection (definition, procedure, merits and demerits); Mutation breeding concept (definition, procedure and scope); Breeding for important biotic and abiotic stresses (insect resistance, draught and salt stress tolerance); Molecular breeding (basic concept and marker assisted selection-brief account).

Practical Exercise (01 Credit)

- Plant Breeder's kit.
- Study of germplasm of various crops.
- Study of floral structure of cross pollinated crops
- Emasculation and hybridization techniques in self & cross pollinated crops using suitable growing crop plant in the field.
- Methods of calculating mean, range, variance, standard deviation, heritability.
- Designs used in plant breeding experiments, analysis of Randomized Block Design.

Suggested Readings:

- Plant Breeding Principles and Methods by B. D. Singh Kalyani Publication New Delhi.
- Essentials of Plant Breeding by Phundan Singh Kalyani Publication New Delhi
- Principles and Practices of Plant Breeding by J. R. Sharma McGraw Hill Publishing Company Limited, New Delhi.
- Plant Breeding Theory and Practices by V. L. Chopra Oxford and IBH. Publishing Company, New Delhi.
- Introduction to Plant Breeding by R. C. Choudhary Oxford and IBH. Publishing Company, New Delhi.
- Elementary Principles of Plant Breeding by R. C. Choudhary Oxford and IBH. Publishing Company, New Delhi.

Semester	:	**VI**
Course Type	:	**Major-3**
Course Title	:	**Genetics & Cytogenetics**
Course Code	:	**IBOTMJGC0623**
Credits	:	**04 (Theory: 03; Practical: 01)**

***COURSE OBJECTIVE**: This course is aimed at understanding the basic concepts of genetics; provide insight into structure and functions of chromosomes, polyploidy and cytogenetic aspects of crop evolution.*

***LEARNING OUTCOMES**: The course will help students to develop their analytical, quantitative and problem- solving skills in the field of genetics and cytogenetics.*

Theory (03 Credits)

Unit I:

Chromosomes: Morphology; organization of chromosome (nucleosome), solenoid concept.
Gene concept: Allele concept, multiple alleles, isoalleles, pseudoallele
Molecular organization: Centromere and telomere; euchromatin and heterochromatin, transposons.
Specialized chromosomes: Structure, occurrence and behavior of B- and sex chromosomes; polytene and lampbrush chromosomes.
Nucleolus and NORs: Structure and function

Unit II:

Haploid and monoploid: Origin, occurrence, production and meiosis of monoploids and haploids
Autopolyploids: Origin and production of autopolyploids: concept of chromosome and chromatid segregation
Allopolyploids: Origin and production of allopolyploids-evolution of major crop plants (Wheat, Cotton and Brassica).
Aneuploidy: Origin, occurrence, production, meiosis and detection of monosomics, trisomics (primary, secondary, tertiary), nullisomics and tetrasomics.

Unit III:

Chromosome aberrations: Origin and meiotic behavior of translocation heterozygotes; breeding behavior and genetics of inversion heterozygotes; Robertsonian translocations;.
Molecular Cytogenetics: *In situ* hybridization, principles and applications of FISH, and GISH.
Linkage: Concept and types of Linkage, gene mapping using 3-point test cross.

Practical Exercises (01 Credit)

- Meiotic chromosome study and behaviour (*Ranunculus* sp., *Tulipa* Sp., *Allium cepa*. *Tradescantia canaliculata*, and *Papaver somniferum*)
- Techniques of preparation of permanent and semi-permanent slides
- Study of somatic chromosomes from root tip squash technique.
- Study of polytene chromosomes in *Chironomus*.
- Study of characteristics and behavior of B chromosomes in an appropriate material
- Study of Mendelian and non-Mendelian inheritance pattern.

Suggested Readings:

- Cytology, Genetics and Evolution by Gupta, P. K. Rastogi Publications, Meerut.
- Genetics by Gupta, P. K. Rastogi Publications, Meerut.
- Cytogenetics by Gupta, P. K. Rastogi Publications, Meerut
- Chromosomal Abberrations: Basic and Applied aspects by Obe.G. and A.T. Natarajan-Springer Verlag, Berlin.
- Cytogenetics, Plant Breeding and evolution by U.Sinha and SunitaSinha ,Vikas Publishing House Private, Limited.
- Cytology, Genetics and Molecular Biology by P.K.Gupta,Rastogi publications.
- Elements of Genetics by PhundanSingh, Kalyani Publishers.
- Genetics, by Weaver, Hendrick and Brown.
- Instant notes in Genetics by P.C.Winter et al., Viva Books Pvt.Ltd.
- Principles of Genetics by E.J.Gardener, M.J.Simmons and D.P.Snustad.J.Wiley and Sons pubs.
- Principles of Genetics by Sinnott, E.W., L.C. Dunn & J. Dobshansky-McGraw Hill Publishing Co., N.Y. Toronto, London.
- Genetics by Winchester, A.M., Oxford & IBH Publishing House, Calcutta, Bombay, New Delhi. 1963).
- Genetics by Strickberger, M.W., MacMillan Publishing Co., Inc., N.Y., London.
- Genetics: Principles and AnalysisbyHartl, D.L. and Jones, E.W., Jones & Bartlett Publishers, Massachusetts, USA.

Semester	:	**VI**
Course Type	:	**Major-4**
Course Title	:	**Biodiversity and Conservation Biology**
Course Code	:	**IBOTMJBC0623**
Credits	:	**04 (Theory: 03; Practical: 01)**

COURSE OBJECTIVES: *This course has been introduced purely with an objective to make students understand the importance of biodiversity and its conservation for sustainable livelihood..*

LEARNING OUTCOMES: *The students will get familiarized with regional biodiversity, its economic and ecological value for sustainable development and will be trained in quantitative metrics of biodiversity.*

Theory (03 Credits)

Unit: I

Biodiversity: Concept of biodiversity (a historical perspective); magnitude of global biodiversity (an overview); components of biodiversity (species richness and evenness); levels of biodiversity -- organizational (genetic, species and ecosystem), spatial (alpha, beta, gamma, delta); values of biodiversity (direct use, indirect use, option and existence values)

Unit: II

Principles and characteristics Conservation biology; genetic variation (magnitude, loss and its consequences); species extinction (concept and causes - ultimate and proximate); the IUCN scheme of threatened species, summary of latest IUCN Red List; IUCN scheme of threatened ecosystems; ecosystems at risk (tropical rain forests, coral reefs, mangroves, wetlands).

Unit: III

Conservation strategies and policies: *in situ* conservation strategies (concept of protected areas network); IUCN's scheme of PA management categories; National Parks and Wildlife Sanctuaries in India (an overview); Biosphere Reserve (concept, design and distribution in India); *ex situ* conservation strategies (botanical gardens, field gene banks, seed banks, *in vitro* repositories, cryobanks, DNA banks); biodiversity hotspots (concept, criteria and conservation implications); global conservation efforts (organizations & conventions); Indian conservation efforts (legislations and policies).

Practical Exercises (01 Credit)

- Evaluation of threat status of medicinal plants using IUCN criteria
- Preparation of an inventory of threatened plants (*Vulnerable, Endangered* and *Critically Endangered* plants)
- Measurement of species diversity by using various biodiversity indices.
- Measurement of species evenness and similarity index.
- Study of various economically and ethno-botanically important plants of Kashmir.
- Field demonstration of *in situ* and *ex situ* conservation strategies through visit to the national parks, sanctuaries, botanical garden, herbaria and museums.

Suggested Readings:

- Cardinale, B., Primack, R., and Murdoch, J. 2019. Conservation Biology. OUP USA
- Chaurasia, O. P., Ahmad, Z. and Ballabh. B. 2007. Ethnobotany and Plants of Trans Himalaya. SSPH
- Christopher, E., Steven, M., Grodsky, M., and Rupp, S. P. 2019. Renewable energy and wildlife conservation, Hopkins University Press, Baltimore, USA.
- Laladhas, K.P., Nilayangod, P. and Oommen, O. 2017. Biodiversity for sustainable development. Springer.
- Dietl, P. and Flessa, K. L. 2018. Conservation Paleobiology: science and practice. Gregory University of Chicago Press, Chicago, USA
- Fred, V. O. and Lamb, R. L. 2016. Conservation Biology. Springer Nature Switzerland AG

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Minor Courses for Five-Year Integrated Masters Programme (FYIMP) in Botany

Semester	:	**VI**
Course Type	:	**Minor-6**
Course Code	:	**IXXXMNFB0024**
Course Title	:	**Fermentation Biotechnology**
Credits	:	**04 (Theory: 03; Practical: 01)**

COURSE OBJECTIVES: *To study the process and significance of fermentation. Learn through examples of different products obtained by fermentation technology and their eventual use for human welfare.*

LEARNING OUTCOMES: *By the end of course students would be aware about fermentation, its applications and the biochemical processes involved therein. Students will obtain the knowledge on different tests to be carried out for identification of fermentation products.*

Theory (03 Credits):

UNIT I

Definition and Scope of Industrial Microbiology. Basic Concepts of Fermentations. Fermentation Introductions. Fermenter design - parts & their functions. Types of microbial culture and its growth kinetics. Types of fermenter - batch, FedBatch and Continuous.

UNIT II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT III

Production of Single cell Protein, biogas,biofertilizers,biopesticides. Microbial production of ethanol, amylase and lactic acid.Introduction to downstream processing, product recovery and purification.Quality Control including testing for sterility, toxicity, pyrogenicity. Effluent treatment. Good Manufacturing Principles, Practices and requirements.

Laboratory Exercise (01 Credit):

- Bacterial growth curve.
- Production, analysis and or estimation of ethanol.
- Demonstration of crude recovery of amylase enzyme
- Production and analysis of lactic acid.
- Visit to fermentation lab and/or an Industry.

Suggested Readings:

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Aditya books(P) Ltd, New Delhi and Elsevier Science Ltd.
- El-mansi E.M.T., Bryce C.F.A., Demain A.L., Allman A.R., (2009) Fermentation microbiology and biotechnology, 2nd ED,CRC Press.