Fergusson College (Autonomous), Pune
Proposed First Year MSc Curriculum as per NEP 2020

Department of Botany

M.Sc. Botany Structure

I	BOT -501	Systematics of Avascular Plants	4
	BOT -502	Metabolic processes in Plants	4
	BOT -503 OR	Industrial Techniques in Biology	4
	BOT -504	Biophysical Techniques	
	RM -510	Research Methodology	4
	BOT -520	Botany Practical I	2
	BOT -521	Botany Practical II	2
		Total Semester Credits	20
II	BOT -551	Systematics of Vascular Plants	4
	BOT -552	Cellular Processes in Plants	4
	BOT -553 OR	Plant Pathology	4
	BOT -554	Plant Interactions	
	BOT -560	OJT/FP	4
	BOT -570	Botany Practical III	2
	BOT -571	Botany Practical IV	2
		Total Semester Credits	20
Total PG-I Credits			40

Semester	Paper Code	Paper Title	Credits
	BOT601	Inheritance Biology & Evolution	4
	BOT -602	Molecular Processes in Plants	4
	BOT -603 OR	Principles of Plant Ecology	4
	BOT -604	Environmental Botany	
	BOT-605 OR	Biostatistics & Bioinformatics	4
	BOT-606	Industrial Botany	
	BOT -620	Botany Practical V	2
	BOT -621	Botany Practical VI	2
		Total Semester Credits	20
IV	BOT -651	Developmental Botany & Plant Tissue Culture	4
	BOT -652	Plant Biotechnology	4
	BOT -660	Research Proposal Writing	4
	BOT-661	Research Project	6
	BOT -670	Botany Practical VII	2
		Total Semester Credits	20
Total PG-II Credits			40

Teaching and Evaluation (Only for FORMAL education courses)

Course Credits	No. of Hours per Semester Theory/Practical	No. of Hours per Week Theory/Practical	Maximum Marks	CE 40 %	ESE 60%
1	15 / 30	1 / 2	25	10	15
2	30 / 60	2 / 4	50	20	30
3	45 / 90	3 / 6	75	30	45
4	60 / 120	4 / 8	100	40	60

Eligibility: As per the rules and regulations of Savitribai Phule Pune University (SPPU)

S.Y. M.Sc. Semester III	
Inheritance Biology & Evolution (BOT601) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	Recall basic concepts of Genetics and laws of inheritance
CO2	Compile basic processes of genetic inheritance
CO3	Predict gene interactions and translate the result into Neo-Mendelian ratios. Solve the problems based on Genetics and Interpret the results
CO4	Distinguish between structural and numerical alterations of chromosomes and analyse them.
CO5	Compare the traditional evolution theories and integrate them using modern molecular evolution theories.
CO6	Assemble the steps of origin of cell and metabolic processes to bring out the full picture of evolution.
Unit No.	**Title of Unit and Contents**
1	**Basics of inheritance biology:** 1.1 Principles of Mendelian inheritance 1.2 Cytoplasmic inheritance & maternal effect 1.3 Quantitative inheritance & complex traits 1.4 Gene inheritance in a population
2	**Genes & Alleles:** 2.1 Concept of gene, allele, multiple alleles, pseudo allele- complementation tests 2.2 Linkage and crossing over, Recombination, inducing transposition, Linkage maps, Mapping by 3-point test cross, Mapping by tetrad analysis
3	**Mutations:** 3.1 Causes, detection and types 3.2 Structural & numerical chromosomal aberrations
4	**Microbial genetics:** 4.1 Transformation, conjugation, transduction and genetic recombination 4.2 Generalized & specialized transduction in phage 4.3 mapping of bacterial & phage genome
5	**Evolution:** 5.1 Theories of evolution 5.2 Geological time scale 5.3 Origin of biological molecules, the first cell, prokaryotic & eukaryotic cell 5.4 Origin of new genes, proteins 5.5 Mechanism of evolution.

Learning Resources

1. Ahluwalia K.B (2005) (First Edition). Genetics New Age International Private Ltd. Publishers, New Delhi.
2. Albert B. Bray, D Lewis, J Raff, M. Robert, K. and Walter (1989), Molecular Biology of the Cell (Second Edition) Garland Publishing Inc, New York.
3. Atherly A.G., Girton J.R. and McDonald, J.F (1999). The Science of Genetics, Saunders College Publishing, Frot Worth, USA.
Burnham, C.R (1962). Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.

4. Burus and Bottino (1989). (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
5. Busch, H. and Rothblum. L. (1982). Volume X. The Cell Nucleus rDNA part A. Academic Press.
6. Gardner and Simmons Snustad (2005) (Eighth Edition). Principles of Genetics, John Wiley and Sons, Singapore.
7. Gupta P.K. (1988), Genetics and Cytogenetics, Rastogi Publications.
8. Hartl D.L and Jones, E.W (1998) (Fourth Edition) Genetics: Principles and Analysis. Jones and Bartlett Publishers, Massachusetts, USA.
9. Karp, G. (1999). Cell and Molecular Biology: Concept and Experiments. John Wiley and Sons, Inc., USA.
10. Khush, G.S (1973). Cytogenetics of Aneuploids. Academic Press, New York, London.
11. Lewin, B. (2000). Gene VII. Oxford University Press, New York, USA.
12. Lewis, R. (1997). Human Genetics: Concepts and Application (Second Edition). WCB McGraw Hill, USA.
13. Malacinski, G.M and Freifelder, D. (1998) (Third Edition), Essentials of Molecular Biology. Jones and B. Artlet Publisher, Inc., London.
14. Pawar C.B (2003) (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai.
15. Russel, P.J. (1998) (Fifth Edition) Genetics, The Benjamin/Cummings Publishing Company IND., USA.
16. Sariu C (2004) (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
17. Singh B.D 2004. Genetics, Kalyani Publication, Ludhiana.
18. Snustad, D.P and Simmons, M.J (2000). Principles of Genetics (Second Edition) John Wiley and Sons Inc., USA.
19. Strickberger (2005). (Third Edition) Genetics, Prentice Hall of India Pvt. Ltd., NewDelhi.
20. Verma and Agarwal (2010), Genetics, S. Chand Co, New Delhi

S.Y. M.Sc. Semester III	
Molecular Processes in Plants (BOT602) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	Describe structural details of nucleic acids and their properties.
CO2	Articulate the importance of different molecules for molecular processes.
CO3	Illustrate the molecular processes from synthesis of molecules to their breakdown.
CO4	Identify the different levels of gene regulation.
CO5	Determine use of different genetic engineering tools for better understanding molecular biology
CO6	Compile basic molecular processes of prokaryotes and eukaryotes.
Unit No.	**Title of Unit and Contents**
1	**DNA** 1.1 Types of base pairing, unusual structures 1.2 Physical, chemical, thermal, spectroscopic properties of DNA 1.3 Reassociation kinetics 1.4 Packing genomes in viruses, bacteria, organelles and nuclei. 1.5 DNA replication in prokaryotes & eukaryotes 1.6 DNA damage & repair
2	**RNA** 2.1 Organization of gene 2.2 Transcription in prokaryotes & eukaryotes 2.3 Processing of mRNA, rRNA & tRNA
3	**Protein** 3.1 tRNA charging, ribosomal organization 3.2 Protein synthesis in prokaryotes & eukaryotes 3.3 Proteases and their role in processing and degradation of proteins 3.4 Chaperones and protein folding 3.5 Targeting of proteins to membranes & organelles
4	**Gene Regulation** 4.1 Transcriptional gene regulation, operons, phage strategies, Transcription factors in eukaryotes, post transcriptional gene regulation 4.2 Translational and post translational gene regulation

Learning Resources

1. Lewin B. (2000). Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell. Garland Publishing Inc., New York.
3. Wolfe S.L (1993) Molecular and Cellular Biology, Wadsworth Publishing Co. California, USA.
4. Rost, T. et al (1998). Plant Biology. Wadsworth Publishing Company, California, USA.
5. Krishnamurthy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
6. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plant. American Society of Plant Physiologist, Maryland, USA.
7. De D.N (2000). Plant Cell Vacuoles: An Introduction. CISRO Publication, Collingwood, Australia.
8. Kleinsmith L.J and Kish V.M (1995). Principles of Cell and Molecular Biology (Second Edition). Happer Collins College Publishers, New York, USA.
9. Lodish H., Berk A., Zipursky, S.L Matsudaira P., Baltimore D. and Darnell J. (2000). Molecular Cell Biology (Fourth Edition). W.H. Freeman and Company, New USA.
10. David Freifelder (1996). Essentials of Molecular Biology, Panima Publishing Company, New Delhi.

11. Brow T.A (2007) Genomes – 3 – Garland Science House, New York.
12. Malacinski G.M (2006) (Fourth Edition). Freifelders Essentials of Molecular Biology, Narosa Publishing House, New Delhi.
13. Rastogi V.B (1995) Concepts in Molecular Biology.
14. Twxman R.M (2003) (Third Reprint). Advanced Molecular Biology. Viva Books Pvt. Ltd., New Delhi.
15. Watson J.D. et al. (2004) (Fifth Edition) Molecular Biology of Gene, Benjamin and Cummings Publishing Co., California.

S.Y. M.Sc. Semester III	
Principles of Plant Ecology (BOT603) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	Recall basic concepts related to ecosystems, energy flow and productivity.
CO2	Compute parameters of demographic study and exemplify different life strategies
CO3	Classify biomes and apply this knowledge to study habitat ecology.
CO4	Categorize different components of communities and their succession
CO5	Appraise pollution and justify its role in global warming.
CO6	Propose adaptive responses of plants to variation in abiotic factors
Unit No.	**Title of Unit and Contents**
1	**Plant interaction with abiotic factors:** 1.1 Plant relations with the climatic factors and its effect on plant distribution: water, precipitation, temperature, light and radiation 1.2 Plant relation with the edaphic & topographic factors
2	**Population & Community Ecology:** 2.1 Ecological limits and the size of population, factors affecting population size, Demes Life history strategies 2.2 Concept of metapopulation, extinction events, population viability Analysis 2.3 Community structure and species diversity 2.4 Characters used to describe community structure 2.5 Plant Succession & serial communities
3	**Ecosystem & Biomes:** 3.1 Components and organization 3.2 Energy flow and productivity 3.3 Ecosystem types: Natural &Artificial 3.4 Classification and components of Biomes
4	**Eco-physiology:** 4.1 Adaptive responses of plants to variation in light, temperature & water availability
5	**Applied Ecology:** 5.1 Sources of pollution (air, water and soil) 5.2 Pollution monitoring: Physicochemical and biological analysis 5.3 Methods to study Ecology (vegetation studies and quality assessment of air, water and soil)

Learning Resources:

1 Ambhast, R. S. (1998). A Text Book of Plant Ecology, 9th edition, Friend and Co.
2. Barbour, M. G., Pits, W. D. and Burk, J. H. (1967). Terrestrial Plant Ecology, Addison-Wesley Publisher.
3. Begon, M., Townsend, C. R., Harper, J. L. (2005). Ecology: From Individuals to Ecosystems, 4thedition, Wiley Blackwell.
4. Canter, L. (1996). Environmental Impact Assessment, 2nd edition, McGraw Hill Publishing Company.
5. Coleman, D. C., Crossley, D. A., Handrix, P. F. (2004). Fundamentals of Soil Ecology, 2nd edition, Elsevier academic press.
6. Coller, B. D., Cox, G. W. and Miller, P. C. (1973). Dynamic Ecology, Prentice-Hall, Inc. EnglewoodCliffs, New Jersey.

7. Crawley, M., Crawley, J. And Crawley, M. (1997). Plant Ecology, 2nd edition,Wiley Blackwell.
8. De, A. K. (1994). Environmental Chemistry, Wiley Eastern publication.
9. Gurevitch, J., Scheiner, S. M., Fox, G. A. (2006). The Ecology of Plants, Sinauer associates.
10. Hynes, H. B. N. (1978). Biology of Polluted Water, 1st edition, Liverpool University Press.
11. Kershaw, K. A. (1978). Quantitative and Dynamic Ecology, 2nd edition, Edward Arnold Publication.
12.Kumar H. D. (1981). Modern Concept of Ecology, 8th edition, Vikas Publication.
13.Mishra, R. (1968). The Ecology of Work Book, Oxford and IBH Pub. Co.Kolkata.
14. Mukherjee, B. (1996). Environmental Biology, 1st edition, Tata McGraw Hill.
15. Mukherjee, B. (2000). Environmental Management: Basic and Applied Aspects of Management ofEcological Environmental System, 1st edition, Vikas Publication.
16. Odum E. P. (2007). Fundamentals of Ecology, 5th edition, Thomson Books.
17. Yadav, P. R. and Mishra, S. R. (2004). Environmental Biology, Discovery Piblications, New Delhi

S.Y. M.Sc. Semester III	
Environmental Botany (BOT604) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	Define and state the concepts of Biodiversity at different levels.
CO2	Discuss concepts and working in forestry and agrobiodiversity. Explain the values of Biodiversity and its importance
CO3	Examine different examples of restoration practices and waste management
CO4	Analyse conservations actions at International, National and Local levels
CO5	integrate modern day techniques to solve various problems at local, regional level to attain far-reaching goal of sustainability
CO6	Compare different policies and agreements regarding climate change and sustainable development goals.
Unit No.	**Title of Unit and Contents**
1	**Natural resources:** 1.1 Forest, minerals, water, soil, energy etc. 1.2 Forest resources: Types of vegetation and floristic composition, Types of forest, Role of forest 1.3 Water Resources: Types of water resources, River ecosystems and conflicts
2	**Biodiversity:** 2.1 Definition, scope and constraints 2.2 Genetic diversity, species diversity, Agrobiodiversity 2.3 Values and uses of biodiversity, Loss of biodiversity 2.4 Biodiversity prospecting
3	**Conservation:** 3.1 *In situ* and *ex situ* conservation strategies 3.2 IUCN Categories 3.3 Phytogeography and Endemism 3.4 Environmental monitoring and impact assessment 3.5Environment protection act and Conservation of biodiversity act 3.6 Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves, Man and Biosphere Programme)
4	**Bioremediation practices:** 4.1 Waste water management: Microbial systems: Aerobic and anaerobic degradation of the wastes 4.2 Solid waste management practices, composting and biogas production 4.3 Mechanisms of phytoremediation 4.4 Hazardous waste management 4.5 Biomedical waste management
5	**Sustainable Development:** 5.1 Environmental policies; International, national and local 5.2 Sustainable agricultural practices: Use of bio fertilizers and biopesticides, 5.3 Concept of organic farming, Sustainability of wetlands 5.4 Management of water resources for irrigation and drinking

Learning Resources

1. Environmental Impact Assessment: A Guide to Best Professional Practices. 2011, Charles H. and Eccleston.CRC Press.
2. Environmental Impact Assessment: A Comparative Review. 2014, Chris Wood. Routledge.

3. Peter Wathern. 2015, Taylor & Francis. Environmental Impact Assessment: Theory and Practice.
4. Introduction to Environmental Impact Assessment .2005, John Glasson. Spon Press.
Medicinal Plants of India's Hotspots. Daya Publishing House, New Delhi.
5. Gary K Meffe and Ronald Carroll C .1994, Principles of Conservation Biology. Sinauer Associates Inc., Massachusetts.
6. Groombridge B (Ed.) 1992. Global Biodiversity Status of the Earths Living Resources. Chapman & Hall, London.
7. IUCN. 1992.Global Biodiversity and Strategy.
8. Sharma PD .2000. Ecology and Environment. Rastogi Publications, Meerut, India.
9. Singh MP, Singh BS and Soma S. Dey .2004. Conservation of Biodiversity and Natural Resources. Daya Publishing House, New Delhi.
10. Virchow D .1998. Conservation and Genetic Resources, Springer-Verlag, Berlin.
11. Singh B, 1992.Social Forestry for Rural Development, Anmol Publishers, New Delhi.
12. Murthy J.V.S., 1994, Watershed Management in India.
13. John Wiley ,1984, Raymond F Dasmann, Environmental Conservation.
14. Kato, M. The Biology of Biodiversity, 1999, Springer Verlag, Tokyo.
15. Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and Protected areas, 2002. Agrobios, India.
16. Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice, 2003. Oxford and IBH Publishing, New Delhi.
17. Negi, S.S., 1993. Biodiversity and its conservation in India. Indus Publishing Co., New Delhi
18. Singh and Vijaykumar, 2001. Economics of PA's and its effect on biodiversity. APH Publishing Corporation, New Delhi.

S.Y. M.Sc. Semester IV	
Biostatistics and Bioinformatics (BOT605) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	List the applications of different biostatistics and bioinformatics tools. Recall basic concepts of biostatistics to solve problems
CO2	Articulate different bioinformatics tools for in-silico analysis. Discuss principles and guidelines of designing the experiment.
CO3	Compute given statistical problems with right hypotheses and calculations to propose solution.
CO4	Identify the sampling processes and their role by using different bioinformatics tools and techniques for data analysis.
CO5	Compare different statistical and bioinformatics tools and select proper methods. Explain correlation and regression concept.
CO6	Justify solution to any given problem with application of correct statistical and bioinformatics tools.
Unit No.	**Title of Unit and Contents**
1	**Introduction to Statistics** 1.1 Basic terms used in statistics. 1.2 Sampling and sampling distributions – concept of sample and population, sampling distribution, methods of sampling 1.3 Measures of central tendency: mean, mode, median and their properties 1.4 Measures of dispersion: variance, standard deviation 1.5 Symmetry and skewness: measures of skewness, kurtosis. 1.6 Correlation: Concept, types and methods. 1.7 Regression: Equations of regression line using least square method, regression estimate and its standard error
2	**Design of experiments** 2.1 Principles of design, Guidelines for designing the experiments, size of plot, number of replications, CDR, RBD
3	**Experimental statistics:** 3.1 Analysis of variance table (ANOVA), standard error, critical difference for pairs of treatments 3.2 Tukey's test for pairwise comparison of treatments 3.3 Testing of hypothesis, T-test, Chi-square test
4	**Introduction to Bioinformatics** 4.1 Introduction, scope and applications of bioinformatics in various fields. 4.2 Basic concepts of sequence similarity, identity and homology. Definitions of homologues, orthologues and paralogues. 4.3 Databases Nucleic acid sequence databases (NCBI, EMBL, DDBJ), protein sequence databases (SWISS-PROT, TrEMBL, PIR, Uniprot), Literature databases (PubMed, MEDLINE, BMC, PLOS), Metabolic pathway databases (KEGG, MetaCyc, EcoCyc), Structural Databases (PDB, NDB, PubChem)
5	**Data analysis using Bioinformatics** 5.1 Scoring Matrices: PAM and BLOSUM series 5.2 Sequence Analysis: Pair wise comparison of DNA and protein sequences, dynamic programming algorithms, FASTA and BLAST, Multiple sequence alignments, progressive methods, iterative methods, localized alignments.

	5.3 Phylogenetic Relationships: Determining phylogenetic relationships using DNA and protein sequences (CLUSTAL, PHYLIP) 5.4 Protein structure prediction and drug discovery Use of Ramchandran Plot and protein folding in protein structure prediction, Molecular visualisation of protein, protein conformation and visualisation tool (RASMOL), Protein structure classification (SCOP, CATH). 5.5 Role of bioinformatics in drug discovery, target discovery, lead discovery, docking and prediction of drug quality

Learning Resources:

1. Lab Math – Adams, D.S. I.K. Internations Pvt Ltd. New Delhi, 2004
2. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989
3. Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983
4. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H., John Wiley, New York, 2001
5. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003
6. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003
7. Bioinformatics and Molecular Evolution – Higgs PG and Attwood

S.Y. M.Sc. Semester IV	
Industrial Botany (BOT606) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	List and get acquainted with different industrial facets of Botany.
CO2	Summarize upcoming trends of industries in Botany.
CO3	Outline case studies of micropropagation of commercially important medicinal plants and examine the ways of increasing the yield of secondary metabolites.
CO4	Relate the floriculture aspects of Botany and integrate the knowledge to plan a start up and become an entrepreneur.
CO5	Evaluate the resource potential of algae, fungi as pharmaceuticals and nutraceuticals in national and international markets.
CO6	Specify different types of plant resources and their uses.
Unit No.	**Title of Unit and Contents**
1	**Algal, Fungal and Biopesticide Technology**: 1.1 Resource potential of algae, commercial utility of algae- food and feed, pigments, Pharmaceuticals and nutraceuticals, fine chemicals, fuel and bio fertilizers, seaweeds extract as bio fertilizers, Seaweed farming 1.2 Concept and significance of bio-pesticides, types of biopesticides and their applications, Herbal, Insect predators/parasites, Trichoderma 1.3 Production of yeast biomass, mycoproteins, traditional fungal foods, mushrooms
2	**Production of secondary metabolites using PTC:** 2.1 Scope, applications and types of culture systems of in vitro secondary metabolite production, Bioreactors 2.3 Improving Secondary Metabolite Production by manipulation of nutrient media, precursor additions, Immobilization, Elicitation, Biotransformation, Screening and selection of high secondary metabolite producing cell lines 2.4 Pathway Engineering
3	**Micropropagation:** 3.1 Case studies of micropropagation: Micropropagation of banana, sugarcane, lily, orchids, gerbera and medicinal plants (*Catharanthus roseus*, *Justicia adhathoda* and *Withania somnifera*) with respect to: Selection of elite plants, Preparation of explants, Surface sterilization, Initiation of cultures, Subculture, In-vitro rooting/ In-vivo rooting, Acclimatization of tissue cultured raised plants, Market potential (National, International)
4	**Green House Technology & Floriculture**: 4.1 Green House Technology: Selection of land, infrastructure, types, maintenance, Selection of propagules of crop, hardening, harvesting and postharvest processing, marketing, 4.2 Floriculture: Importance of floriculture in developing country, its scope for domestic and export market, factors affecting flower production, production of cut flowers and maintaining its quality, prolonging of vase life, packaging of cut flowers, cultivation of Carnation, Gerbera, Gladiolus, Rosa, Gypsophilla, Orchids, starts ups, Government schemes and economics of cultivation
5	**Plant Resources:** Plants as source of spices, beverages, edible oils, essential oils, narcotics,

	insecticides, timber, dyes, cellulose, starch.

References:
1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture Prospects for the 21st century (Academic press).
4. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory &
5. Practice (Elsevier)
6. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press) Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
1. Hand book of horticulture, ICAR, New Delhi
2. Floriculture in India, Randhawa and Mukhopaddhay
3. Gardening in India, Bose and Mukherjee, Oxford
4. Introductory ornamental horticulture, Arora, Kalyani publishers
5. Gardening in India, Bose and Mukherjee, Oxford
9. H K das Textbook of Biotechnology 4th edition
10.Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH.

S.Y. M.Sc. Semester III	
Botany Practical V (BOT620) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	Identify different stages of mitosis and meiosis.
CO2	Categorize different fossil types with respect to the geological time scale
CO3	Execute the methods to demonstrate cytological preparations.
CO4	Analyse the different concepts of genetics and solve problems based on them.
CO5	Evaluate the results of the problems based on the types of inheritance
CO6	Plan and perform the experiments, compile the observations, draw conclusions and propose the result.
Unit No.	**Title of Unit and Contents** (Any 15)
1	Preparation of stains, Fixatives, Preservatives and pretreatments to plant material
2	Preparation of somatic C- metaphase chromosomes of appropriate material
3	Study of Karyotype in *Allium*
4	Study of meiotic configuration in *Rhoeo*
5	Study of meiotic configuration in *Tradescantia*
6	Study of Meiotic abnormalities
7	Induction of mutation in plant material using suitable mutagen
8	Study of polygenic inheritance
9	Problems based on estimation of gene frequencies and heterozygotic frequencies, population genetics.
10	Problems based on recombination and linkage mapping
11	*Neurospora* tetrad analysis.
12	Study of *Drosophilla* sexual dimorphism and mutants
13	Study of Mendelian inheritance using Chi square test
14 &15	Study of monohybrid and dihybrid crosses and interactions
16	Use of Colchicine for induction of polyploidy in appropriate plant material
17	Case study of latest available commercial varieties of important crops
18	Study of fossil types
19	Study of Geological time scale
20	Visit to any Palaeontological institute/ plant breeding centre

S.Y. M.Sc. Semester III	
Botany Practical VI (BOT621) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	Describe DNA and protein gel electrophoresis technique.
CO2	Purify DNA, RNA and proteins using appropriate technique and quantify them. Conclude various properties of DNA based on experimental findings.
CO3	Carry out analysis of vegetation using appropriate ecological method.
CO4	Assess the result of molecular biology techniques.
CO5	Validate air and water quality with relevant parameters
CO6	Plan and perform the experiments, compile the observations, draw conclusions and interpret the result.

Practicals based on Molecular Processes in Plants (Any 10)

Unit No.	Title of Unit and Contents
1	Isolation of plasmid DNA
2	Isolation of plant genomic DNA
3	Quantification of DNA
4	Electrophoresis of DNA
5	Electrophoretic separation of plasmid isoforms
6	Isolation of RNA
7	Electrophoresis of RNA
8	Restriction digestion of plasmid DNA
9	Gel electrophoresis of restriction digested products and molecular weight determination of DNA fragments.
10	Effect of temperature and alkali on absorbance of DNA – hyperchromicity
11 & 12	SDS-PAGE separation of proteins

Practicals based on Principles of Plant Ecology (Any 5P)

1&2	Study of morphological and anatomical characteristics of plants under stress
3	Allelopathic analysis of the plants
4	Finding minimum size of sampling unit for studying specific plant community
5 & 6	Determination of frequency, density, abundance, dominance and IVI of the plant Community
7	Determination of species richness, similarity and diversity indices in different plant communities

OR

Practicals based on Environmental Botany (Any 5P)

1 & 2	Study of polluted water with respect to DO, free CO2, phosphates and Palmer's algal Indices
3 & 4	Comparison of stomata index, chlorophyll contents and pollen fertility of the plants from polluted and non-polluted area
5	Physicochemical analysis of water (EC, TS,TDS, TSS, Chloride and Hardness)
6 & 7	Interpretation of satellite images and aerial photographs with respect to

	major vegetation/landforms/ land use patterns.

S.Y. M.Sc. Semester IV	
Developmental Botany and Plant Tissue Culture (BOT651) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	Define the basic concepts of plant development
CO2	Discuss the vegetative and reproductive development of higher plants
CO3	Interpret the results of molecular development.
CO4	Relate the role of different genes with plant development.
CO5	Assess the role of hormones in the plant development.
CO6	Integrate morphological, anatomical, molecular and biochemical data to design a complete picture of plant development.
Unit No.	**Title of Unit and Contents**
1	**Processes basic to plant development** 1.1 Basic terms in developmental botany 1.2 Concept of Polarity and symmetry. 1.3 Juvenility and transition to adult phase
2	**Vegetative Development:** 2.1 Meristem types and activities of meristems, organization of meristems. Regulation of meristem size, lateral organ initiation from root and shoot meristems. 2.2 Leaf development, development of trichomes and stomata. 2.3 Vascular elements – differentiation of xylem, phloem. 2.4 Secondary growth – cambium, gross structure of wood. 2.5 Secretory tissues – Nectaries, laticifers, resin ducts. 2.6 Molecular genetics of root, shoot and leaf development
3	**Reproductive Development:** 3.1 Transition from vegetative to reproductive phase, molecular Basis-ABC & ABCE Model. 3.2 Development of male and female reproductive structure, sporogenesis & gametogenesis, molecular basis 3.3 Fruit & seed development 3.4 Embryogenesis, molecular basis.
4	**Regulation of Development:** 4.1 Light mediated regulation, Photoreceptors, Signal transduction leading to photomorphogenesis and photoperiodic responses, Circadian rhythms 4.2 Hormonal regulation Perception, signaling and regulation of gene expression by hormones, role of hormones.
5	**Plant Tissue Culture:** 5.1 Major landmarks in the development of Plant Tissue Culture Nutritional requirements of the explants in PTC, role of PGRs and additives. 5.2 Micropropagation: Stages, pathways and applications. 5.3 Somatic Embryogenesis & synthetic seeds 5.4 Protoplast Isolation, Culture & Somatic hybridization 5.5 Somaclonal variation: introduction, types, causes, selection methods 5.6 Applications of PTC: Production of disease/virus free plants, production of haploids and triploids, production of secondary metabolites, Germplasm

	conservation 5.7 Advantages of tissue culture technique over conventional methods of crop Improvement

Learning

Resources:

1. Bhojwani S.S. and Soh W.Y. (2001). Current Trends in Embryology of Angiosperms Kluwer Academic Publishers.
2. Fahn A. (1989) Plant anatomy (Third edn) Pergamon Press
3. Gilbert (2006). Developmental biology (8th Edition). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
4. Graham C.F. and Wareing P.F. (1984). Developmental Controls in Animals and Plants
5. Blackwell Scientific Publications.
6. Jermy Burgess (1985) An Introduction to Plant Cell Development. Cambridge University Press.
7. Johri B. M. and Srivastava P. S. (2001). Reproductive biology of plants. Narosa Pub. House, New Delhi.
8. Krishnamurthy K.V. (1988) Methods in Plant Histochemistry
9. Lewis Wolpert (2002), Principles of Development (2nd edition). Oxford University Press.
10. Lyndon R.F. (1990) Plant Development- The Cellular Basis. UNWIN HYMAN
11. Raghavan V. (2000) Developmental Biology of Flowering Plants. Springer Verlag.
12. Razdan M.K. (2003) Plant Tissue Culture, Oxford IBH
13. Wareing P. F. and Philips I. D. J. (1981) Growth and Differentiation in plants. Pergamon Press
14. Wada M., Shimazaki K., Iino M. (2005). Light sensing in plants. Springer.
15. Davies P. J. (2004) Plant hormones. Kluwer.
16. Buchanan B. B., Gruissem W. and Jones R. L. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Physiology, Maryland

S.Y. M.Sc. Semester IV	
Plant Biotechnology (BOT652) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	List the advanced techniques of plant biotechnology.
CO2	Summarize the different methods of biotechnology.
CO3	Apply the basics of molecular biology for better understanding of the techniques.
CO4	Compare different techniques of biotechnology on the basis of principles.
CO5	Evaluate the different techniques in the specified area of biotechnology.
CO6	Integrate the knowledge of techniques of biotechnology to find solutions to different problems of society.
Unit No.	**Title of Unit and Contents**
1	**Genetic Engineering** 1.1 Steps in rDNA technology 1.2 Enzymes used in genetic engineering 1.3 Vectors: Plasmids, Phages, Cosmids, Phagemids, BACs and YACs, Expression vectors, Ti based vectors 1.4 Gene transfer methods: Direct and indirect gene transfer methods, Factors affecting transformation, Screening for transformants.
2	**Fundamental Techniques** 2.1 PCR: Methods & Applications 2.2 Gene & cDNA library: Construction, Screening by Hybridization 2.3 DNA Sequencing & Genome Sequencing 2.4 Molecular markers: types, uses and applications
3	**Techniques to study gene expression** 3.1 Northern hybridization, Subtractive Hybridization, Differential display PCR 3.2 SAGE 3.3 cDNA-AFLP 3.4 Gene tagging, plasmid rescue, Promoter & enhancer traps 3.5 Insertional, site directed mutagenesis, TILLING, Genome editing using CRISPER CAS system 3.6 Gene Silencing by RNAi, antisense, cosuppression
4	**Applications of Agriculture Biotechnology:** Case studies 4.1 Transgenics for Abiotic stress tolerance (Draught, Salinity & Cold) 4.2 Transgenics for Biotic stress tolerance (Fungi, Virus, Insect & Nematode) 4.3 Transgenics for Herbicide Resistance 4.4 Transgenics for Biopharmaceuticals (Antibody and vaccine) 4.5 Transgenics for Quality Improvement (Protein, Carbohydrates, Lipids & Vitamins) 4.6 Concerns related to GMOs.

Learning Resources:

1. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
2. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 (Blackwell Publ)
3. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture.Prospects for the 21st century (Academic press).
4. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)

5. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
6. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
7. Rai M (2009) – Fungal Biotechnology (IK International)
8. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
9. H K Das, Textbook of Biotechnology, 4th Edition

S.Y. M.Sc. Semester IV	
Research Proposal Writing (BOT660) **Credits:4**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	Perform the ground work for research in terms of identifying a relevant research topic
CO2	Identify the queries and write literature review.
CO3	Define well formulated, specific aims and objectives that help develop the overall research methodology
CO4	Compile the data in proper format
CO5	Write the research proposal and if possible procures the funding.
CO6	Present the proposal in form of presentation.
Students can refer the college website for detail syllabus	

S.Y. M.Sc. Semester IV	
Research Project (BOT661) **Credits:6**	
Course Outcome (CO) **On completion of the course, the students will be able to:**	
CO1	Carry out a substantial research-based project
CO2	Develop capacity to analyze data and process research findings
CO3	Write a quality review of research papers
CO4	Standardize the protocols of the experiments, test the hypothesis and compare the work with relevant national and international research papers.
CO5	Design, perform the experiments, compile the observations, draw conclusions, interpret the results, write a thesis and integrate the work in form of presentation.
CO6	Present Poster/ Oral in seminars/ conferences outside/arranged by the institute
Students can refer the college website for detail syllabus	

S.Y. M.Sc. Semester IV	
Botany Practical VII (BOT670) Credits:4	
Course Outcome (CO) On completion of the course, the students will be able to:	
CO1	Describe the procedures of basic biotechnology experiments.
CO2	Extend the basic knowledge of Botany for industrial applications.
CO3	Apply appropriate statistical and bioinformatics tool to solve the given problem.
CO4	Identify and trace the vegetative and reproductive pathways of development of plant organs.
CO5	Assess the results of experiments with correct observations and calculations.
CO6	Plan and perform the experiments, compile the observations, draw conclusion and interpret the result.

Practicals based on Developmental Botany and PTC (Any 5)

Unit No.	Title of Unit and Contents
1	Isolation of shoot apical meristems from seedling, young and mature vegetative plant.
2	Tracing the course of stomatal development and observations on stomatal types.
3	Dissection of haustorial endosperm
4	Dissection of dicotyledonous embryo and developmental stages of embryogenesis.
5	Histochemical analysis and comparison between vegetative SA and reproductively induced SA.
6	Preparation of sterilized medium.
7	Callus culture.
8	Organ/ Anther Culture.

Practicals based on Biotechnology(Any 5P)

1 to 4	Isolation of DNA and RNA from plant tissues and electrophoresis.
5 to 7	Restriction digestion and electrophoresis of plant genomic DNA, Southern blotting and Southern hybridization.
8 to 10	Separation and detection of specific proteins using Western blotting.

Practicals based on Biostatistics and Bioinformatics (Any 5P)

1 & 2	Measurement of central tendency (mean, mode and median), variance, standard deviation, coefficient of variance and standard error from the given grouped and ungrouped data.
3	Examples based on t – test
4	Analysis of variance on the given data (ANOVA)
5	Databases and database searching and DNA and protein sequence comparisons
6	Pairwise comparison of DNA and protein sequences – BLAST
7	Multiple sequence alignments, progressive methods, CLUSTAL
8	Determining phylogenetic relationships using DNA and protein

	sequences

OR

Practicals based on Industrial Botany (Any 5P)

1	Study of any six sea weeds with applications
2	Study of any four bio-pesticides and their market products
3	Study of any eight fermentation products of commercial importance from local market with reference to source and applications
4	Micropropagation of banana, sugarcane and Lilium
5	Study of plant resources
6	Immobilization of yeast cells and study of enzyme activity in immobilized yeast cells
7	Study of effect of various concentrations of PGRs for callus induction
8	Visit to nearby industry