Course Structure and Syllabus Content for the Master's Program

M.Sc. Plant Biology & Biotechnology

Department of Plant Sciences
School of Life Sciences
University of Hyderabad
Hyderabad-500046

July, 2019

DEPARTMENT OF PLANT SCIENCES, SCHOOL OF LIFE SCIENCES

M.Sc. Plant Biology & Biotechnology (78 credit hours)

I Semester (19 credit hours)				
S.No.	**Course code**	**Course title**	**Faculty teaching**	**Credits**
1	PB 401	Genetics	GP/KM/AMK	3
2	PB 403	Macromolecular Structure and Function	KPS/YS/RSM/PT	3
3	PB 406	Cell Biology	SDT/KAK/RK	2
4	AB 404	Molecular Biology I	SD/MS	2
5	PB 402	Microbiology	ARP/CHVR/KGN /JM	3
6	PB 405	Practicals (Computer Applications in Biology, Microbiology, Genetics and other exercises) + *Viva voce*	GP/CHVR/SDT/ SR	6

II Semester (21 credit hours)				
S.No.	**Course code**	**Course title**	**Faculty teaching**	**Credits**
1	PB451	Environmental Biotechnology	JM/RK/SRK	3
2	AB 454	Mol. Biology II and Genetic Engineering	SD/MS/ SDT	4
3	PB 503	Molecular Plant Pathology	ARP/RM/KGN	2
4	PB 453	Plant Biochemistry	ASR/SR	3
5	PB 454	*In Vitro* Plant Biology	GP	2
6	PB 456	Practicals (Environmental Biotechnology, Plant Biochemistry, Mol. Biology, *In Vitro* Plant Biology)+V*iva voce*	GP/KGN/RM/YS L/SRK	6
7	PB457	Seminar		1

III Semester (22 credit hours)				
S.No.	**Course code**	**Course title**	**Faculty teaching**	**Credits**
1	PB 501	Genomics	IAG	2
2	PB 502	Plant Physiology	RPS/ASR	3
3	PB 504	Proteomics	YSL	2
4	PB 452	Plant Systematics	RK	2
5		Elective		2
6	PB 522	Secondary Plant Products and Metabolic Engineering	ASR/SDT	3
7	PB 505	Practicals (Plant Physiology, Genomics and Proteomics, Plant Systematic) Project work + Seminar	IAG/ YSL/RK/ SRK + All Faculty	6

IV Semester (16 credit hours)				
S.No.	**Course code**	**Course title**	**Faculty teaching**	**Credits**
1	PB 551	Plant Developmental Biology	RPS/YSL	3
2	PB 552	Plant Biotechnology	RM/RK	3
3	PB 553	Comprehensive Viva-voce	All Faculty	2
4	PB 554	Project Work + Seminar	All Faculty	4

CORE COURSES AND ELECTVES (OPTIONAL COURSES) OFFERED FOR MSc Plant Biology & BiotechnologyPROGRAM

CORE COURSES:

Title of the Course	Course code	No. of Credit hours	Faculty Teaching
First Semester			
Genetics	PB401	3 Credit Hours	Prof. GP/ Prof. KM/ Dr. AMK
Microbiology	PB402	3 Credit Hours	Prof. ARP/Prof. ChVR/ Dr. KGN/Dr. JM
Macromolecular Structure & Function	PB403	3 Credit Hours	Dr. KPS/ Dr. YS/DRM
Cell Biology	PB406	2 Credit Hours	Prof. SDT/Dr. KAK/Dr. RK
Molecular Biology I	AB404	2 Credit Hours	Prof. SD/Prof. MS
Second Semester			
Environmental Biotechnology	PB451	3 Credit Hours	Dr. SRK / Dr. RK / Dr. JM
Molecular Plant Pathology	PB503	2 Credit Hours	Prof. ARP/Prof. RM/ Dr. KGN
Mol. Biology II&Genetic Engineering	AB454	4 Credit Hours	Prof. SD/Prof. MS/ Prof. SDT
Plant Biochemistry	PB453	3 Credit Hours	Prof ASR/Prof. SR
In vitro Plant Bilogy	PB454	2 Credit Hours	Prof. GP
Third Semester			
Genomics	PB501	2 Credit Hours	Dr IAG
Proteomics	PB504	2 Credit Hours	Dr. YSL
Plant Physiology	PB502	3 Credit Hours	Prof RPS/Prof ASR
Plant Systematics	PB504	2 Credit Hours	Dr. RK
Secondary Plant Products and Metabolic Engineering	PB522	3 Credit Hours	Prof ASR/Prof. SDT
Fourth Semester			
Plant Developmental Biology	PB551	3 Credit Hours	Prof RPS/Dr YSL
Plant Biotechnology	PB552	3 Credit Hours	Prof. RM/Dr. RK

OPTIONAL COURSES OFFERED By DEPT. of PLANT SCIENCES:

Title of the Course	Course code	Credit hours	Semester No.	Faculty Teaching
Molecular Plant Breeding	PB573	2 Credit Hours	IV	Prof. RM
Microbial Technology	PB572	2 Credit Hours	III	Prof. ARP/Dr. JM
Glycobiology	PB577	2 Credit Hours	IV	Dr. SRK

Faculty-Teaching

RPS	Prof.R.P.Sharma	SD	Prof. S. Dayananda
ASR	Prof.A.S.Raghavendra	MS	Prof. ManjulaSritharan
ARP	Prof .P.Appa Rao	KM	Prof. Krishnaveni Mishra
CHVR	Prof.Ch. Venkata.Ramana	KPS	Prof. K. Padmasree
GP	Prof G.Padmaja	YS	Dr. Suresh Yenugu
SR	Prof. Raja Gopal	KAK	Dr. K. Arun Kumar
SDT	Prof. Sarada D. Tetali	RSM	Dr.RadeshyamMaurya
RM	Prof..RagibaMakandar	AMK	Dr. M. K. Arunasree
KGN	Dr.K.Gopinath	PT	Dr. Prasad Tammineni
SRK	Dr. Santosh R. Kanade		
IAG	Dr.Irfan A Ghazi		
YSL	Dr.Y.Sreelakshmi		
RK	Dr. Rahul Kumar		
JM	Dr. JogiMadhuprakash		

SEMESTER-WISE COURSE CONTENT
M.Sc.PLANT BIOLOGY & BIOTECHNOLOGY (PBB)

SEMESTER-I

GENETICS
(PB401) **3 Credit Hours**

- Mendelian Genetics and analysis: Extension of Mendelian analysis
- Chromosomal basis of Inheritance
- Chromosome characteristics: Chromosome structure, Euchromatin and heterochromatin, Coding and Non-coding sequences, transposons
- Genetic Recombination in Eukaryotes
  Linkage and Crossing Over, Chromosome mapping, Tetrad analysis and Gene Conversion
- Mutations and mutagenesis
  Detection, Molecular basis and Applications
- Chromosomal Changes: Number variation – Euploidy (auto and allopolyploidy), aneuploidy
  Structural variations – Deficiences, duplications, Inversions, translocations
- Interaction of Genotype and Environment, Twin studies, genetic environment, non-genetic environment, phenocopies, penetrance and expressivity
- Gene expression regulation during differentiation and growth
  Heterochromatization in human beings and other mammals, dosage compensation, mechanism, sex chromatin, position effect
- Quantitative inheritance
  Continuous traits – multigenic variability, dominance – additivity, norms of reaction
- Non-Mendelian Inheritance; Plastid mutations – nature and mode of transmission
  Mitochondrial traits – nature and mode of transmission; Applications
- Population Genetics: Genotype and allelic frequencies, the Hardy-Weinberg equilibrium, non-random mating, consequences of homozygosity, factors affecting gene frequencies, heterosis, mutation – effect on allele frequencies, migration and genetic drift
- Developmental Genetics: Model system *Drosophila*, Genetic screen, Pattern formation, Maternal effect, Homoetic transformations

References

1. Griffiths, A. J. F., Miller, J. H., Suzuki, D. T., Lewontin, R. C., Gelbart, W. M. An Introduction to Genetic Analysis, W. H. Freeman & Company, New York.
2. Strickberger, M. W. Genetics, 3rd Edition, Macmillan Publishing co., New York.
3. Gardner, E. J., Simmons, M. J. and Snustad, D. P. Principles of Genetics, 8th Edition, John Wiley & Sons, New York.
4. An Introduction to genetic analysis. Anthony A. J. F. Griffiths; Susan R. Wessler; Sean B. Carroll; John Deebly. 11th Edition
5. Genetics: A Conceptual approach. Benjamin A. Pierce. 5th Edition
6. Genetics: analysis of genes and genomes. Daniel L Hartl; Maryellen Ruvolo. 8th Edition.

MICROBIOLOGY
(PB402) **3 Credit Hours**

- Beginnings of microbiology: Discovery, Evolution of microbiology as a discipline
- Microbiological techniques,Pure culture techniques,Enrichment,Anaerobic culturing
- Importance of microorganisms in medicine,agriculture, environment and industry
- Nutritional requirements of microorganisms: Nutritional types, Requirements, Uptake of nutrients, Design and types of nutrient media
- Discovery of microorganisms: Bacterial and fungal diversity, Culture techniques, Bacterial systematics
- Microbial growth: Prniciples of growth,Kinetics of growth Methods of measuring growth, Batch and continuous growth, Synchronous culture, Diauxic growth
- Cell wall of bacteria and fungi,Gram+ve cell wall,Gram-ve cell wall,Cell wall of fungi and yeasts
- Micrbial Ecology,Denitrification,Phosphate solubilization,Free-living nitrogen fixation
- Plant-microbe interactions,Symbiotic nitrogen fixation,Mycorrhizae and Plant pathogens

References

1. Microbiology Edited by Prescott
2. Microbiology Edited by Torfora
3. Microbiology Edited by Peltzar
4. Microbiology Edited by Stanier
5. Biology of Microorganisms Edited by M.T. Medican, J.M. Martiniko and J. Parker

MACROMOLECULAR STRUCTURE AND FUNCTION
(PB403) **3 Credit Hours**

- Review of basic concepts of solution chemistry- acid, base, ionic strength, ion salvation; principles of thermodynamics: chemical potential, free energy, entropy, enthalpy, heat capacity; dimensions of atoms, bonds, and molecules; covalent and non-covalent bonds
- Dihedral angles, steric conflict, potential energy
- Classes of organic compounds and functional groups
- Amino acids and peptides: chemical reactions and physical properties
- Proteins and enzymes: secondary structures- helices, beta sheets, loops, turns, conformational map, tertiary structure and quaternary structure.
- Glycobiology (glycomics): sugars and polysaccharides: chemistry, classification, and function; glycoproteins: structure and function
- Nucleic acids: nucleotides, single and double-stranded structures, uncoiling.
- Ribonucleoprotein and ribozyme
- Lipids (lipidomics):fatty acids- saturated, unsaturated, and eicosanoids; phospho- and spingolipids- structure, classification, lipoprotein, liposomes
- Brief discussion of EM, AFM, crystallography, and NMR

References

1. Biochemistry text book by LubertStryer
2. Reading material shall be provided by Course-In-Charge

CELL BIOLOGY
(PB 406) **2 Credit Hours**

- Comparison of prokaryotic and eukaryotic cells
- General methods in cell biology
- Ultrastructure of plasma membrane
- Plant Cell membrane-structure and function
- Cytoskeletal elements
- Mitochondria- structure, biogenesis and evolution
- Mitochondria and male sterility
- Chloroplast –structure, organization, Function, Protein Import, Biogenesis, Genome and genetic manipulation
- Chloroplast mitochondrial interaction
- Lysosomes- biogenesis, pathophysiology
- Peroxisomes, glyoxysomes
- Plant vacuoles
- Plant cell wall, Plasmodesmata
- Cell growth and division (mitosis, meiosis and cell differentiation)
- Biosynthetic process in ER and Golgi Apparatus
- Vesicular Traffic from ER through Golgi Apparatus
- Transgolgi Network, endocytosis and exocytosis
- Programmed Cell Death

References

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science.
2. Pollard T.D., Earnshaw W.C, Schwartz J.L. Cell Biology. Elsevier Publishing Co.
3. H.Lodish and A.Berk, Molecular Cell Biology, W.H.Freeman Publishers
4. D.E.Sadava Cell Biology, CBS Publishers
5. Latest review articles from Peer reviewed journals

MOLECULAR BIOLOGY I
(AB 404) **2 Credit Hours**

- **Genetic material**: a) Classical experiments - Evidence of DNA as genetic material. RNA viruses –RNA as genetic material. Fine structure of gene - Benzers classical studies on rII locus.
- **Organization of genome in prokaryotic and eukaryotic cells.** a) Differences between prokaryotic and eukaryotic gene organization: concept of the operon; split genes in eukaryotes. b) Supercoiling of DNA - general concepts and role of topoisomerases c) Eukaryotic DNA: Chromatin and nucleoid structure-role of histones, denaturation-renaturation kinetics, repetitive DNA, satellite DNA.c) Extrachromosomal DNA: Plasmids, transposons, insertion elements, mitochondrial and chloroplast DNA. d)Horizontal transfer of bacterial genome-Construction of genetic maps.
- **Replication of DNA.** a) Semi-conservative theory of Meselson and Stahl.

b) Semiconservative and discontinuous mechanism of DNA replication – leading, lagging strand, Okazaki fragments

c) Prokaryotic replication – origin of replication *oriC*, enzymatic machinery including the role of topoisomerases, helicases, DNA polymerases, primases, ligases etc.

d)Replication of bacterial viruses – detailed study of the replication of bacteriophage λ, Φx174, M13 – rolling mechanism of replication,

e) Eukaryotic DNA replication – eukaryotic DNA polymerases, replication of linear DNA – role of telomerases.

- **Recombination at the molecular level.** Crossing over during cell division-breakage and rejoining of intact DNA molecules, Holliday model of homologous recombination – events at the molecular level; role of recA,recBC and chi sequences, Site- specific recombination – eg. bacteriophageλ; FLP/FRT and Cre/Lox recombination.
- **Mutation and repair of DNA.** Nature of mutations, mutagens – chemical, UV radiations etc., DNA repair – Nucleotide excision repair; Mismatch correction; SOS repair; Photoreactivation.

References

1. Lewin B. Genes. Jones & Bartlett Publishers.
2. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science
3. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and LosickR.Molecular Biology of the Gene. . Benjamin-Cummins Publishing Co.,
4. Freifelder D. Molecular Biology. Narosa Publishing House.

SEMESTER-II:

ENVIRONMENTAL BIOTECHNOLOGY
(PB451) **3 Credit Hours**

- Environment: Basic concepts and issues
- Air pollution
- Water pollution
- Soil pollution
- Biotechnological approaches for pollution control.
- Basic Microbiology of waste water treatments.
- Environmental Microbiology – Basic concepts and issues
- Biogeochemical cycles: hydrologic cycle, gaseous nutrient cycles (nitrogen, carbon) and sedimentary (sulphur and phosphorus)
- Bioremediation of inorganics (Metals and radionuclides) and organics (TCE/petroleum hydrocarbons/ solvents/ explosives etc.) in the environment.
- Biopesticides integrated pest management
- Hazardous waste management; recycling of waste; production of biofuels.
- Biodiversity conservation strategies
- Global environmental issues: Greenhouse gases and their impact on the environment; biotechnological approaches for sustainable development

References

1. Prasad, M.N.V.andKaimin Shih (Eds) (2016) Environmental Materials and WasteResource Recovery and Pollution Prevention. Elsevier. ISBN 9780128038376http://store.elsevier.com/Environmental-Materials-and-Waste/isbn-9780128038376/ pages 728
2. Prasad, M.N.V.(Ed) (2016) Bioremediation and Bioeconomy. Elsevier, ISBN 978-012-802872-8 http://store.elsevier.com/Bioremediation-and-Bioeconomy/isbn-9780128028308/pages 698
3. S C Bhatia, **Environmental Biotechnology.** Atlantic Pub, 2008, 3vols, ISBN : 81-269-0948-3
4. Parvaiz Ahmad & Prasad MNV (eds) (2012) Abiotic Stress Responses in Plants: Metabolism, Productivity and Sustainability. Springer. USA (in press) 1st Edition., 2012, XIX, 551 p. 63 illus., 14 in color. Hardcover, ISBN 978-1-4614-0633 http://www.springer.com/life+sciences/plant+sciences/book/978-1-4614-0814-7
5. Parvaiz Ahmad & Prasad MNV (eds) (2012) Environmental Adaptations and Stress Tolerance of Plants in the Era of Climate Change. Springer. USA (in press) 1st Edition., 2012, XIV, 498 p. 86 illus., 41 in color.Hardcover, ISBN 978-1-4614-0814-7 http://www.springer.com/life+sciences/plant+sciences/book/978-1-4614-0633-4
6. Prasad MNV (2011) A State-of-the-Art report on Bioremediation, its Applications to Contaminated Sites in India. Ministry of Environment & Forests, Government of India. New Delhi. Pages 90 http://moef.nic.in/downloads/public-information/BioremediationBook.pdf

MOLECULAR BIOLOGY II AND GENETIC ENGINEERING
(AB454) **4 Credit Hours**

Part A – MOLECULAR BIOLOGY II

- **Prokaryotic Transcription**: a) Transcription unit – start site, upstream promoter regions, terminator; b) Structure and function of RNA polymerases, sigma factors; c) mechanism of transcription-initiation, elongation and termination – Rho-dependant and independent termination d) Promoter polymerase interactions –DNA foot printing techniques e) Promoters-Constitutive and Inducible promoters, other regulatory elements - upstream activating sequences (UAS); anti-termination, f) inhibitors of transcription.
- **Operon concept.** Operon concept – inducible and repressible operons. Eg. lac, trp, ara, and his operons; global nutrient (carbon, nitrogen) status sensing mechanisms – link to gene expression. Bacterial small RNA (sRNA) and its role in regulation of gene expression.
- **Eukaryotic transcription.** a) RNA polymerases I, II, III - structure and assembly; b) Basal transcription apparatus for the three polymerases with specific promoters and transcription factors, c) Other regulatory elements – enhancers, silencers, response elements, d) Transcriptional factors – general features, motifs - zinc fingers, leucine zippers, helix-turn helix, homeodomains etc.
- Gene Splicing& post-transcriptional modifications. a) Splicing – mechanism, catalytic role of RNA, b) Group I, II and nuclear introns, nuclear splicing and role of snRNA, tRNA splicing, c) modification of mRNA - 5' cap formation, 3' polyadenylation; RNA editing. RNA interference (RNAi)- mechanism and significance.
- **Translation.** a)Genetic code – universality and degeneracy, Wobble hypothesis, Chemical synthesis of the gene by Khorana b) Translation machinery – ribosomes; charging of tRNA molecules and formation of aminoacyltRNA; mechanim - initiation, elongation and termination, c) post-translational modifications of proteins – glycosylation, amidation, lipidation, processing of pre-proteins etc., d) Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation, e) Inhibitors of protein translation.

Rferences

1. Lewin B. Genes. Jones & Bartlett Publishers.
2. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science.
3. Watson J.D, Baker T.A, Bell S.P, Gann A, Levine M and LosickR.Molecular Biology of the Gene. . Benjamin-Cummins Publishing Co.,
4. Freifelder D. Molecular Biology. Narosa Publishing House.

Part B –GENITIC ENGINEERING

- **Generation of DNA fragments:** Mechanical shearing, restriction endonucleases (REs) – classification, mechanism of action, use of REs for molecular cloning, PCR technology and its application in recombinant DNA technology, cDNA synthesis – strategies for isolation of full length cDNAs, chemical synthesis of a DNA fragment.
- **Vectors used in molecular cloning.** a) Plasmids – general concepts, eg. pUC, pBlueScript, pGEM vectors; Expression vectors; pMal, GST-based, pET vectors; b) Bacteriophage λ vectors – λgt10, λgt11, λ ZAP and replacement vectors - EMBL c) Phagemids - M13-derived vectors, d) cosmids - Artificial chromosome vectors (YACs; BACs); d) Other viral vectors: SV-40, vaccinia, baculovirus& retroviral vectors**.**
- **Cloning strategies & Introduction of recombinant DNA into hosts:** a) Other enzymes used in cloning - DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase b) cloning strategies – basic concepts of cohesive and blunt end ligation; directional cloning, use of linkers and adaptors; c) Homopolymer tailing, d) T-vectors and cloning of PCR products, e) Introduction of recombinant DNA into suitable hosts - transformation, conjugation, transduction, transfection, particle bombardment techniques, f) Ti plasmids and Agrobacterium-mediated transformation; particle bombardment.
- **Construction and screening of genomic libraries:** a)Construction of genomic and cDNA libraries – using for eg. λgt11, λ ZAP vectors, b) Screening: DNA probe-based screening - molecular hybridization techniques: Preparation of nucleic acid probes by nick translation, random primer labeling and end labeling, hybridization techniques for identification of clones with gene of interest, c) Screening by antibody-based methods: induction of protein expression, immunodetection using specific antibodies, radioactive and chemiluminescent methods of detection.
- **Characterization of cloned genes:** a)Sequencing of DNA- Sanger's enzymatic method and Gilbert's chemical sequencing method; automated DNA sequencing; b) Identification of promoters and regulatory elements – promoter reporter fusions c) Site directed mutagenesis.
- **Expression of recombinant proteins.** a) Protein expression in E. coli as a host - Factors influencing the expression of recombinant proteins. Purification of recombinant proteins - His-tag, GST-tag, MBP-tag etc.; commercially available E. coli hosts for expression of recombinant proteins, b) examples of alternate expression systems – yeast, baculovirus, mammalian systems and plants. Molecular Pharming.

References

1. Primrose, Twymand and Old. Principles of Gene Manipulation. Blackwell Science.
2. Sambrook J and Russell D. Molecular Cloning: A laboratory Manual. Cold Spring Harbor Laboratory Press.

MOLECULAR PLANT PATHOLOGY
(PB 503) **3 Credit Hours**

- An overview of nature of pathogens and pests, pathogen penetration, establishment, colonization in host.
- Genetic and molecular basis for disease resistance, Flor's hypothesis, Koch postulates, disease epidemics and epidemiology.
- Preformed plant defenses, induced host defenses, biochemical and physiological responses, host-pathogen interaction mechanisms,
- Physiology and biochemistry of plant disease, Primary metabolism, Secondary metabolism, role of cell wall in plant defense
- Molecular determinants of pathogenicity, effectors, elicitors, defensins, phytoalexins, common phenolics, plant cell wall degrading enzymes, host specific toxins, host non-specific toxins, hormones and signaling.
- Plant disease resistance, classes of resistance genes, adapted host resistance, non-adapted host resistance, Systemic acquired resistance, Induce Systemic acquired resistance, Pathogenesis-related (PR)-proteins
- Transgenic and genetic manipulation approach and molecular marker approach to tag disease resistance and avirulence genes

Reference Material:

1. Plant Pathology, T.N. Agrios, Academic Press, 2001
2. Introduction to Plant Pathology, Richard N Strange, 2003, Springer publication
3. Host Pathogen Interactions, Lucas, 2001, Blackwell publication
4. Annual Review of Phytopathology
5. Annual Review of Plant Biology
6. Current Opinion in Plant Biology

PLANT BIOCHEMISTRY
(PB 453) **3 Credit Hours**

- Plant Organelles
  Structure, Function and biogenesis of chloroplasts, Mitochondria and microbodies (peroxisomes and glyoxysomes)
- Enzymes and its functions
  Principles, nomenclature and kinetics
  Enzymes, how enzymes work and isozymes
  Enzyme kinetics
  Enzyme regulation
- Photosynthesis
  Evolution of photosynthesis,
  Photosynthetic electron transport, Components of photosynthetic apparatus and their role, phosphorylation, C_3, C_4 and CAM pathways, Photorespiration and Starch and sucrose formation, Carbon partitioning
- Respiration
  Glycolysis, Pentose Phosphate Pathway, TCA cycle
  Oxidative electron transport and phosphorylation
  Interactions among primary metabolic pathways
- Nitrogen Metabolism
  Symbiotic and asymbiotic nitrogen fixation
  Biosynthesis of amino acids
- Fat metabolism
  Glyoxylate cycle, Fatty acid Formation/Oxidation
- Sulfur Metabolism
  Sulfate assimilation pathway, Glutathione synthesis and function

Reference Books

1. Biochemistry and Molecular Biology of Plants
   Buchannan B, Gruiseem W, Jones R, ASPP, Maryland; First Edition 2000
2. Plant Biochemistry
   Hans-Walter Heldt; 2006 Edition
3. Plant Biochemistry and Molecular Biology
   Lea PJ, Leegood RC; Second Edition 1999John Wiley & Sons
4. Plant Physiology
   Taiz L and Zeiger E; Fourth Edition 2006, Sinauer Associates, INC
5. Taiz L and Zeiger E. (2006) Plant Physiology, 4th Edition, Sinauer Associates Inc. Publishers, Massachusetts, USA

***In vitro* Plant Biology**
(PB 454) **2 Credit Hours**

- Historical developments and landmarks in plant tissue culture
- Basic techniques in plant tissue culture. Formulation of media for plant tissue culture. Plant growth regulators – Involvement in plant differentiation and morphogenesis
- Concept of totipotency.Induction of morphogenesis *in vitro*. Somatic embryogenesis and Organogenesis. Factors affecting somatic embryogenesis and organogenesis
- Molecular overview of somatic embryogenesis, Synthetic seeds and their applications
- Initiation and maintenance of callus cultures, cell suspensions – Continuous and Batch cultures, Mass cultivation of plant cells using bioreactors
- Genome reorganization induced *in vitro*, somaclonal and gametoclonal variations, *in vitro* mutant isolation, their characterization and uses
- Meristem culture, Zygotic Embryo culture, Endosperm culture - Importance and applications
- Micropropagation and its uses, commercial exploitation of micropropagation
- Production of haploids using anther, pollen and unfertilized ovule cultures, their characterization and applications
- Production of secondary metabolites from cell cultures and ha
- iry root cultures, strategies used for enhanced production of secondary metabolites, Biotransformations using plant cell cultures
- Isolation, purification and culture of protoplasts, Methods used for protoplast fusion, Somatic hybridization/cybridization –Selection systems for somatic hybrids/cybrids, their characterization and applications
- Germplasm storage *in vitro*, cryopreservation

Recommended Books:

1. Plant Cell and Tissue Culture
   Edited by Indra K. Vasil and Trevor A. Thorpe, Kluwer Academic Publishers
2. Plant Tissue Culture: Theory and Practice
   By S. S. Bhojwani and M. K. Razdan Elsevier Publishers
3. *In Vitro* Cultivation of Plant Cells BIOTOL Biotechnology by Open Learning
   Butterworth/Hernemann Ltd.
4. Plant Cell Biotechnology By R. Endress, Springer-Verlag
5. Plant Tissue Culture: Applications and Limitations By S. S. Bhojwani
6. Plant Tissue Culture By Kalyan Kumar De

SEMESTER-III:

GENOMICS
(PB501) **2 Credit Hours**

- Structural organization of genome in Prokaryotes & Eukaryotes, packaging, Organelle genome, DNA sequencing principles
- Gene Density, Repetitive DNA in nuclear genome, C-value paradox
- Genome Mapping: Genetic Mapping; RFLP, SSLP, SNPs
- Physical Mapping; DNA fingerprinting, Restriction map, FISH, STS
- Genome Sequencing Projects: Shotgun and Contig approach, Assembly DNA Sequence, Cloning Vectors, Accessing and retrieving genome project information from web, Analysis of genome sequence-tools and web resources
- Analysis/understanding a genome sequence (Genome annotation):A bioinformatics approach
- Experimental techniques for gene location; Exon-intron boundaries, determining function of individual genes
- **Next generation sequencing**

- **Reverse genetics approach; Chemical mutagenesis; TILLING**
- Transcriptome analysis
- Microarrays, DNA Chips
- Comparative genomics

References:

1. GENOMES 3: TA Brown, 3rd Edition, Garland Science Publishing, Taylor and Francis Group.
2. Principles of Genome analysis and Genomics: SB Promrose and RM Twyman; 3rd Edition. Blackwell Publishing.

Proteomics
(PB504) **2 Credit Hours**

- Overview of Proteomics
- Protein extraction and fractionation techniques
- Choice of material, handling and sample preparation for proteomics
- 2D-electrophoresis, Difference gel electrophoresis (DIGE) and data analysis
- Mass Spectrometry and its application to proteomics
- HPLC and its applications
- Shotgun/MUDPIT approaches for global proteomics
- Quantitative proteomics (label-based and label-free approaches)
- Identification of post-translational modifications, protein-protein
- interactions and targeted quantification of proteins
- Bioinformatics and data analysis

References

1. Latest reviews/research articles from journals like Mass spectrometry reviews, Molecular and cellular proteomics, Proteomics, Science, Nature, Journal of Proteome research, etc.

2.Methods in Enzymology, Volume 182: Guide to Protein Purification (Methods in Enzymology) by John N. Abelson (Editor), Melvin I. Simon (Editor), Murray P. Deutscher (Editor) Academic. Press, New York.

PLANT PHYSIOLOGY
(PB 502) **3 Credit Hours**

- Plant and water

Introduction to concepts of physiology
Water relation of a plant cell- Laws of diffusion and permeability
Concept of chemical potential
Surface tension and capillary rise
Water potential and its component
Soil Plant Atmosphere continuum- Water movement in soil and root, root pressure
Cohesion theory of water uptake
Hydraulic liftAquaporins

- Solute Transport

Nernst potential and Goldman equation
Membrane transport- active and passive transport
Channels, carriers and pumps
Potassium transport
Calcium transport
Phosphate transport
Nitrogen transport
Iron transport
Zinc transport
Aluminum transport
Sulfate transport
Micro- and macronutrients and key to mineral deficiency
Phloem transport
Long distance transport in phloem

- Stress physiology

Water stress
Heat Stress
Cold stress
Flooding and ROS Formation
Oxidative stress

- Transpiration
- Transpiration and stomatal movement

References

1. PlantPhysiology, Sixth Edition" by Lincoln Taiz and Eduardo Zeiger
2. Biochemistry & Molecular Biology of Plants by Bob Buchanan**,** Gruissen W and Jones R L

PLANT SYSTEMATICS
(PB452) **2 Credit Hours**

- Plant Systematics – Global and Indian Perspectives
- Plant Classifications – a Conspectus
- Systematics in practice
- Origin & Objectives of the Plant Systematics
- Herbaria and Botanical Gardens
- Principles and Procedures of Plant Identification
- International Code of Nomenclature for algae, fungi, and plants, and Biocode
- Biology of Plants (i.e. Bryophytes, Pteridophytes, Gymnosperms and Angiosperms)
- Morphology, Anatomy and Plant Physiology in Plant Systematics
- Sero, Chemo and Molecular Plant Systematics

Reference Books &Periodicles:

1. Jones, Jr. S.B. and Luchsinger, A.E. 1987: Plant Systematics and Evolution, McGraw-Hill International Editions, New Delhi.

2. Gurucharan Singh, 2014: Plant Systematics – Theory and Practice, 3rd Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India

3. Manilal, K.S. and Kumar, M.S.M, 1998: A Handbook on Taxonomy Training, Department of Sciences and Technology, Govt. of India, New Delhi.

4. Lawrence, G.H.M., 1967: Taxonomy of Vascular Plants, Oxford & IBH Publishing Co., New Delhi

5. Other Books/Journals/Periodicals of online subscribed/purchased by IGML, UOHYD.

SECONDARY PLANT PRODUCTS AND METABOLIC ENGINEERING
(PB 522) **3 Credit Hours**

- Introduction to Secondary Plant Products: Pathways & Significance/Functions
- Structure and biosynthesis of:
    - Nitrogenous compounds: alkaloids, seed proteins
    - Isoprenoids: terpenoids, carotenoids & steroids
    - Phenolics: cinnamates, coumarins, benzoates, Flavonoids, lignans, lignins, Tannins
- Occurrence, biological and economic importance of
    - Flavor substances, volatiles and colourants
    - Medicinal plants
    - Insecticidal compounds
    - Non-saccariferoussweetners
- Plant poisons
- Polyamines and non-protein aminoacids
- Pathway Engineering: Principles and case studies

Reference Books:

1. Plant Biochemistry (2000)
   by P.M. Dey& J. B. Haroborne, Indian Edition, Academic Press
2. Natural Products from Plants (2006)
   by Leland J. Cseke, CRC Press
3. Natural Products from Plants (1999)
   by Peter B. Kaufman et al., CRC Press LLC
4. Chemicals from Plants: Perspectives on Plant Secondary Products (1999)
   by N.J. Walton, Diane E. Brown, Imperial College Press and World Scientific Publishing Co. Ltd.
5. Biochemistry & Molecular Biology of Plants by Bob Buchanan**,** Gruissen W and Jones R L
6. Peer reviewed publications from Journals/Periodicals online/Scopus indexed

SEMESTER-IV:

PLANT DEVELOPMENTAL BIOLOGY
(PB551) **3 Credit Hours**

- Introduction to plant development- Comparison of Plant and animal development, Evolution of developmental complexity from algae to angiosperm.
- Role of Plant Cell Division and Expansion in development, Plant cell cycle-endoreduplication and control of plant cell size.
- Regulation of Plant Architecture **, S**hoot apical meristem, Root apical meristem and positional control of root development, Phyllotaxy , Lateral organ development- Leaf primordia imitation, Leaf development, Generation of patterns-regulation of stomatal patterning in plants.
- Plant Hormones- biosynthesis and mode of action of Auxin, Gibberellins, Cytokinins, Ethylene, Abscisic acid, Brassinosteroids, Salicyclic and Jasmonic acid, Strigolactones, karrikins, Peptide and other novel hormones of plants.
- Environmental regulation of Plant Development**,** Photoperiodism and circadian rhythms and biological clock, Phytochrome, cryptochrome, UVR8 and phototropins, Vernalization of plants.
- Seed germination and dormancy, Plant Senescence
- Reproductive development of Plants**,** Inflorescence initiation, Flower development in plants, Embryogenesis in higher plants.

References

1. The molecular life of plants by Jones et al Wiley
2. Biochemistry and Molecular Biology of Plants, 2nd Edition - Bob Buchanan et al Wiley
3. Plant Physiology, Taiz and Zeiger Sixth edition Sinaeur
4. Teaching Tools in Plant Biology (www.aspb.org)

PLANT BIOTECHNOLOGY
(PB552) **3 Credit Hours**

- Components of plant genetic engineering
- Methods for analysis of differential gene expression in plants
- Enhancer trap, Promoter tagging, gene tapping gene tagging, Insertional mutagenesis, Activation tagging
- Tissue specific promoters, characterization of plant promoters
- Agrobacterium and Ti Plasmid based and physical DNA delivery methods.
- Analysis of transgenic plants.
- Approaches to marker-free transgenics
- Developing herbicide resistance in crops: Target of herbicide action and Detoxification of herbicides.
- Engineering male sterility in crop plants.
- Genetic engineering of plants for Insect resistance: Bt toxins And use of protease inhibitors
- Transgenic plants for disease resistance
- Engineering plants for abiotic stress tolerance.
- Biopolymer Production through transgenic plants
- Fatty acid modification and oleosin technology
- Functional genomics, Validation of gene function
- Gene silencing, PTGS, RNai, Antisense technology, Applications.
- Chloroplast transformation, Molecular Pharming
- Biosafety, Bioethics and plant biotechnology
- Genome Editing tools- ZFNs, TALENs and CRISPR-Cas9

References

1. Methods in Plant Molecular Biology and Biotechnology by B.R.Glick, 2014
2. Plant Biotechnology-The genetic manipulation of plants, Second Edition by Adrian Slater, Nigel Scott, and Mark Fowler, 2008
3. International Society for Acquisition of Agribiotech Applications- www.isaaa.org, an open resource for Agricultural Biotechnology related applications, world status of Agricultural Biotechnology
4. Review articles on individual topics form the major basis for this course as no single book covers all the topics listed above

OPTIONAL COURSES:

OFFERED BY THE DEPARTMENT OF PLANT SCIENCES:

MICROBIAL TECHNOLOGY

(PB572) **2 Credit Hours**

- Scope of importance of Microbial Biotechnology
- Single cell protein, microbial flavours and food colorants
- Energy recycling and production using micro-organisms.
  Hydrogen evolving bacteria
  Microbial degradation of cellulose and lignocellulose
  Biogas process, methanogenesis.
- Microbial technology for agriculture:
  Mycorrhizae
  Rhizobacteria
  Viruses as pest control agents
  Bacterial pest control –Microbial toxins for insect and weed control
- Microbial transformations

References

1. Microbial Biotechnology (Fundamentals of Applied Microbiology)
   Alexander N. Glazer, Hiroshi Nikaido, W.H. Freeman and Company
2. Biotechnology: A Text Book of Industrial Microbiology,
   WulfCrueger&AnnelieseCrueger
3. Annual Review of Microbiology
4. Current opinion in Microbiology
5. Current Opinion in Biotechnology

MOLECULAR PLANT BREEDING
(PB573) **2 Credit Hours**

- Introduction to Plant Breeding – genetic basis of Plant Breeding – creation of variability
- Reproduction and pollination control – molecular mechanisms of self and cross fertilization, gametogenesis and embryogenesis, molecular basis of male sterility, self compatibility and apomixis.
- Domestication, plant introduction, acclimatization, genetic variation, crop genetic resources, germplasm conservation and molecular basis of varietal adaptation.
- Biometric techniques in Plant Breeding – assessment of variability, statistical tools in genetic analysis of variation.
- Genetic basis of self pollinated crops- breeding procedures for self pollinated crops – concepts and methods – case studies.
- Genetic basis of cross pollinated crops- breeding procedures for cross pollinated crops – concepts and methods – case studies.
- Breeding for vegetatively propagated plants- clonal selection – distant hybridization and in vitro techniques.
- Genetic and molecular basis of heterosis and inbreeding depression- hybrids and synthetic production.
- Mutation breeding and selection of mutations for crop improvement.
- Innovative approaches in crop improvement – Molecular markers for tagging disease resistance, insect resistance, quality and special characteristics - gene transfer in crop breeding program through ransgenic approach.

References

1. Principles of Plant Breeding - R.W. Allard. John Willey and sons Inc., New York.
2. Plant Breeding- Theory and Practice – Neal C. Stoskpf, Dwight T. Tomes and B.R. Christie. First Indian Print, 1999. Scientific Publishers, India.
3. Plant Breeding – V.L. Chopra. Reprint 1994oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
4. Plant Breeding Principles and Methods – B.D. Singh, fourth edition, 1990. Kalyani Publishers, New Delhi, India.
5. Crop Science- Journal; Trends in Genetics- Journal; Plant Breeding- Journal

GLYCOBIOLOGY
(PB577) **2 Credit Hours**

- Review of carbohydrate chemistry nomenclature, protein-glycan interaction. Glycocalyx. Biosynthesis and metabolism and functions: N glycans, O-glycans, glycospingolipids, proteoglycans and glycoprotein, sialic acids. Structures common to different types of glycans, glycosyl transferases, degradation and turnover of glycans.

- Discovery of lectins- Animal and plant lectins, classification, structure functions and application of lectins and lectin array.

- Glycomics and Glycoproteomics: Structure and function relation of glycans, plant glycans, glycans in genetic disorders and disease, genetic disorders of glycosylation, glycosylation changes in diseases.

- Methods and application, Structural analysis and sequencing of glycans, chemical and enzymatic synthesis of glycans, inhibitors of glycosylation, Glycobiology in medicine. Glycoproteomic analysis, Functional glycomics. Glycan array analysis

Suggested Readings

1. Essentials of Glycobiology- Varki, Cummings, Esko, Freeze, Hanlx, Marth, 2017, CSH.Lab Press.
2. Principles of Biochemistry, 4th edition- Lehninger, Nelson and Cox. W.H. Freeman and Co. ISBN 0-7167-4339-6.
3. Cell and Molecular Biology by- G.Karp
4. Molecular Biology of the Cell Bruce Alberts, Johnson, Lewis et al.