Course Title: Plant Molecular Biology
Course Code: MBB 601
Credit Hours: 3 (3+0)

UNIT I (10)

Model Systems in Plant Biology (Arabidopsis, Rice etc.) Forward and Reverse Genetic Approaches. Organization expression and interaction of nuclear, mitochondrial and chloroplast genomes. Cytoplasmic male sterility.

UNIT II(12)

Transcriptional and Post-transcriptional Regulation of Gene Expression, Isolation of promoters and other regulatory elements, RNA interference, Transcriptional Gene Silencing, Transcript and Protein Analysis.

UNIT III(12)

Plant Developmental Processes, ABC Model of Floral Development, Role of hormones (Ethylene, Cytokinin, Auxin and ABA, SA and JA) in plant development. Regulation of Flowering, Plant photoreceptors and light signal transduction, vernalization, Circadian Rhythms.

UNIT IV (14)

Abiotic Stress Responses: Salt, Cold, Heat and Drought. Biotic Stress Responses. Molecular Biology of Plant-pathogen Interactions, Molecular Biology of *Rhizobium* and *Agrobacterium*- Plant interaction. Role of programmed Cell Death in Development and Defense.

Suggested Readings:

- Buchanan, B. B., Gruissem, W. and Jones R,(2015) Biochemistry and Molecular Biology of Plants, 2nd edition, Wiley and Blackwell Publications.
- Slater, A., Scott, N. W.,& Fowler, M.R.(2003).The genetic manipulation of plants. *Plant Biotechnology Oxford, England: Oxford University Press*.
- Walker, J. M., Rapley, R.,(2008) Plant Biotechnology and Genetics: Principles, Techniques and Applications.

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Course Title: Plant Genome Engineering
Course Code: MBB 602
Credit Hours: 3 (3+0)

UNIT I (14)

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement. Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients etc.); edible vaccines, etc.

UNIT II (12)

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of trans genes for crop improvement;

UNIT III(12)

Gene stacking; Pathway engineering; Marker-free transgenic development strategies; Genome editing: principles and methods, Development of genome edited plants; High throughput phenotyping of transgenic plants.

UNIT IV(10)

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Suggested Readings

- Christou, P., & Klee, H.,(2004)*Handbook of Plant Biotechnology*. John Wiley & Sons.
- StewartJr,C.N.(2016).*Plant biotechnology and genetics: principles ,techniques, and applications*. John Wiley & Sons.
- Kirakosyan, A., & Kaufman, P.B.(2009). *Recent advances in plant biotechnology* (p.409). Dordrecht: Springer.

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Course Title: PlantOmics and Molecular Breeding
Course Code: MBB 603
Credit Hours: 3 (3+0)

Objective:

- To discuss the specialized topics and advances in field of genomics and genomics assisted molecular breeding.

UnitI(12)

Complex traits and genetic architecture, Mapping genes and QTLs, statistical concepts in QTL mapping, high-throughput genotyping using automated platforms, genetic and physical mapping of genomes, study of population structure and kinship, association genetic analysis of QTL, case studies on QTL mapping using different approaches, map-based of cloning genes and QTLs – case studies.

UnitII (12)

Marker assisted breeding (MAB):Principlesandmethods,markerassistedforegroundand background selection, marker assisted recurrent selection, whole genome selection, case studies in MAS, requirement for successful marker assisted breeding, cost ofMAB.

UnitIII(12)

Concepts and methods of next generation sequencing (NGS), assembly and annotation of NGS data, genome resequencing, DNAsequence comparison, annotation and gene prediction.Genome-wide insertion mutagenesis and its use in functional genomics, transcriptome profiling using microarrays and deep sequencing, study of methylome andits significance, proteome analysis using mass spectrometry, crystallography and NMR,analysis of proteome data, study of protein- protein interactions.

UnitIV(12)

Study of themetabolome, use of 1D/2D NMR and MS in metabolome analysis, multivariate analysis and identification of metabolite as biomarkers, study of ionome using inductively coupled plasma – mass spectroscopy (ICP-MS), correlating the data from genome, transcriptome, proteome, metabolome and ionome with phenome.

SuggestedReadings:

1. Speicher,D.W.(Ed.).(2004).*Proteomeanalysis:interpretingthegenome*.Elsevier.
2. Tomita, M., &Nishioka, T. (Eds.). (2006).*Metabolomics: the frontier of systems biology*. Springer Science & Business Media
3. Horst,L.,&Wenzel,G.(Eds.).(2007). *Molecularmarkersystemsinplantbreedingandcrop improvement* (Vol. 55). Springer Science & Business Media.
4. StewartC.N.,(2008)PlantBiotechnologyandGenetics:Principles,Techniquesand Applications.
5. Singh, B. D., Singh, A.K. (2015). Marker-Assisted Plant Breeding: Principles and Practices Springer (India) Pvt. Ltd.

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Course Title: Commercial Plant Tissue culture
Course Code: MBB 604
Credit Hours: 2(2+0)

Objectives:

- Toprovideawarenessintodevelopmentofcommercial scaleplanttissueculture units.
- Toprovideaninsightintothecommercialapplicationsofplanttissueculture inagriculture,medicineand industry.
- Toeducateaboutbiosafety,regulatoryaswellasentrepreneurship opportunities.

UNITI (8)

Micro-propagationofcommerciallyimportantplantspecies;plantmultiplication,hardening,andtransplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNITII(8)

Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNITIII(9)

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethical issues; management and commercialization.

UNITIV(7)

Project planning and preparation, economics (entrepreneurship, cost profit ratio), government policies (incubators, different facilitation projects, loan opportunities). Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

SuggestedReading:

1. Honda, H., Liu, C., Kobayashi, T.(2001) Large-ScalePlant Micropropagation. In: ZhongJ.J. et al.(eds) Plant Cells. Advances in Biochemical Engineering/Biotechnology, vol 72. Springer, Berlin, Heidelberg
2. Bhojwani,S.S.,&Razdan,M.K.(1986).*Planttissueculture:theoryandpractice*(Vol.5).Elsevier.

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Course Title: Plant Microbe Interaction
Course Code: MBB 605
Credit Hours: 2 (2+0)

Objective:

- Todiscussthespecializedtopicsandadvancesinfieldofplantmicrobeinteractionforunderstandingtheir potential in enhancing crop growth and development.

UnitI(8)

Microbial communities in the soil and atmosphere, Community dynamics and population interactions with particular reference to plant–microbe and microbe-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions, effects of microorganisms on plants, effects of plants on microorganisms. Recognition processes and signal exchange, Molecular aspects of Plant Growth Promoting Rhizobacteria (PGPR), Symbiotic diazotrophs: Rhizobia and association with legumes. Mycorrhizalassociations: Ectomycorrhizae, Endomycorrhizae with particular emphasis to AM fungi, Ectendomycorrhizae. Biocontrol agents and their action, endophytes associations

UnitII (8)

Enzymes, toxins, pili, siderophores, secretion systems of microbes and plants determining soil health, nutrient availability and uptake defense responses in plants: pamp-triggered immunity,effector-triggered susceptibility,qualitative resistance, r genes, structure and function, effector-triggered immunity, regulation of plant cell death, plant hormones in immunity,Plant parasite interactions and its molecular basis and impact on plant functions including photosynthesis, respiration, nitrogen metabolism and translocation

UnitIII(8)

Quorum sensing in bacteria, understanding microbiome,phytobiomes,dynamics,Applied and ecological aspects of symbioses and pathogen defense, techniques to study plant microbe interaction including microbe tagging, metagenomics and use of organismal databases to identify genes involved in interactions. Industrial application of agriculturally important microbes.

UnitIII(8)

Resistance mechanisms against attack by plant pathogens, gene-for-gene interactions; induced resistance; non- host resistance. Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Plant and microbialgeneexpressionandsignal exchange,specific regulatorsfor differentinteractions includingtransgenic plants. Recognition mechanism and signal transduction during plant - pathogen interaction

SuggestedReadings:

1. Rangaswamy,G.Bhagyaraj,(1993)AgriculturalMicrobiology,PrenticeHallIndia.
2. Stacey,G.,&Keen,N.T.(Eds.).(1996). *Plant-microbeinteractions*.SpringerScience&BusinessMedia.
3. Dickinson M. (2005)*MolecularPlantPathology*. Bios Scientific Press, Taylor and Francis group.
4. Kosuge, T., and Nester, E. W. (1989). *Plant-Microbe Interactions: Molecular and Genetic Perspectives.*VolsI-IV. McGraw Hill.

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