U.P.College syllabus for B.Sc.(Ag.)

(As per recommendations of ICAR's 6th Deans' Committee)

Department of Genetics and Plant Breeding

SEMESTER WISE DISTRIBUTION OF COURSE SEMESTER

S.No	Coursetitle	Semester	Credit Hours	Total
1.	Principles of Genetics	III	3(2+1)	17 Credits (10+7)
2.	Basics of Plant Breeding	IV	3(2+1)	
3.	Fundamentals of Crop Physiology	V	3(2+1)	
4.	Crop Improvement (*Kharif* crops)-I	V	2(1+1)	
6.	Crop Improvement (*Rabi* crops)- II	VI	2(1+1)	
5.	Fundamentals of Agricultural Biotechnology	VI	2(1+1)	
6.	Fundamentals of Seed Science and Technology	VI	2(1+1)	
7.	Elective Courses (major or minor)	VII	4(3+1)	4 Credits
8.	Student READY: RAWE/ Industrial Attachment /Experiential Learning/Hands-on Training/ Project Work / Internship	VIII		2 Credits

Semester III
Principles of Genetics 3(2+1)

Objective

To make the students acquainted with both principles and practices in the areas of classical genetics, modern genetics, quantitative genetics and cytogenetics.

Theory

Pre and post Mendelian concepts of heredity, Mendelian principles of heredity, Architecture of chromosomes, chromonemata, , chromomeres, centromere, secondary constriction and telomere, special types of chromosomes, Chromosomal theory of inheritance- cell cycle and cell division-mitosis and meiosis. Probability and Chi-square. Dominance relationships, Epistatic interactions with example.

Multiple alleles, pleiotropism and pseudoalleles, Sex determination and sex linkage, sex limited and sex influenced traits, Blood group genetics, Linkage, crossing over, Structural and numerical variations in chromosomes and their implications, Use of haploids, dihaploids and double haploids in Genetics, Mutation, classification, Methods of inducing mutations, mutagenic agents and induction of mutation. Qualitative and quantitative traits, Polygenes and continuous variations, Cytoplasmic inheritance, Nature, structure and replication of genetic material,Protein synthesis, Transcription and translational.

Practical

Study of microscope, Study of cell structure, Mitosis and Meiosis cell division, Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross,Practice on mitotic and meiotic cell division, Experiments on probability and chi-square test, Determination of linkage and cross-over analysis (through two point test cross data), Study on sex linked inheritance in Drosophila. Study on models on DNA and RNA structures.

Suggested readings

1. Fundamentals of Genetics: B.D. Singh
2. Genetics: M.W.Strickberger.
3. Principles of Genetics: Gardner, Simmons and Snustad.
4. Principles of Genetics: Sinnott, Dunn and Dobzhansky

Semester IV
Basics of Plant Breeding 3(2+1)

Objectives

To acquaint with different techniques ranging from simply selecting plants with desirable characteristics for propagation, to more complex molecular techniques for breeding new varieties, which are higher yielding, resistant to biotic and abiotic stresses for ensuring food security.

Theory

Historical development, concept, nature and role of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and apomixes, self incompatibility and male-sterility-genetic consequences, Plant genetic resources, its utilization and conservation Domestication, Acclimatization and Introduction. Centres of origin/ diversity, Components of Genetic variation. Heritability and genetic advance. Genetic basis and breeding methods in self-pollinated crops mass and pure line selection, hybridization techniques and handling of segregating population.

Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross-pollinated crops. Population movement schemes- Ear to Row method, Modified Ear to Row, recurrent selection schemes. Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties. Breeding methods in asexually propagated crops, clonal selection and hybridization. Polyploidy in relation to plant breeding, mutation breeding. Participatory plant breeding. Intellectual Property Rights, Patenting, Plant Breeders and Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops, Study of floral structures of self pollinated and cross-pollinated crops, Emasculation and hybridization techniques in self and cross pollinated crops, Consequences of inbreeding on genetic structure of resulting populations, Study of male sterility system, Handling of segregating populations, Methods of calculating mean, range, variance, standard deviation, heritability, Designs used in plant breeding experiments, analysis of Randomized Block Design, To work out the mode of pollination in a given crop and extent of natural out-crossing, Prediction of performance of double cross hybrids, Maintenance of breeding records and data collection, Screening tests for biotic and abiotic stresses.

Suggested Readings

1. Principles of Plant Breeding (1st & 2nd Edition) by RWAllard.
2. Plant Breeding: Principles & Practices by JRSharma.
3. Plant Breeding- B.D.Singh.
4. Principles and Procedures of Plant Breeding- Biotechnical andConventional Approaches by G S Chahal and SS Gosal.
5. Principles of Plant Genetics and Breeding by George Acquaah.

Semester V
Fundamentals of Crop Physiology 3(2+1)

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption;Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Imbibition;Field capacity,permanent wilting point and available soil moisture; Apoplast, symplast and trans membrane,

Significance of transpiration. Stomatal opening and closing mechanisms. Overview ofplant cell-organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II.

Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O_2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers;Introduction to C_3, $C_4$and CAM pathways: Calvin Cycle, Hatch and Slack Cycle,CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C_4plant: Productivity of C_4plant,CAM:an adaptive mechanism); Factors affecting photosynthesis (light,temperature, CO_2, O_2etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration(O_2, temperature, CO_2 etc.).Terminologies/Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight,dry weight,linear dimension,area etc.). Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photo periodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal,sequential etc),relation with abscission.Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR),Plant growth inhibitor.Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 –D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C_3 and C_4plants.

Semester V
Crop Improvement (*kharif* crops)–I 2(1+1)

Objectives

1. ToprovideknowledgeaboutSelf-pollinatedand crosspollinated*Kharif*crops
2. Tolearnaboutoriginanddistributionof*Kharif*crops
3. Todesignbreedingobjectivesofmajor*kharif*crops
4. Toimpart informationondifferentcropvarietiesfor*Kharif*season

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cash crops; vegetable and other horticultural crops of *kharif* season; Plant genetic resources, its utilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetativelypropagated crops. Major breeding objectivesand procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technology in maize, rice, sorghum, pearl millet and pigeopea etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botany of crops, Floral biology, emasculation and hybridization techniques in different crop species, viz. rice, jute, maize, sorghum, pearl millet, ragi, pigeopea, urdbean, mungbean,soybean, groundnut, sesame, castor, cotton, cowpea, tabacco, brinjal, okra and cucurbitaceous crops. Maintenance breeding of different *kharif* crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seed production in *kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

SemesterVI

Fundamentals of Agricultural Biotechnology 3(2+1)

Objectives

Tofamiliarizethestudentswiththe fundamentalprinciplesofbiotechnology, various developments in biotechnology and its potential applications

Theory

Introduction to Plant Tissue Culture and Genetic Engineering: History; Cellular tot potency and cytodifferentiation;Callusculture,Single-cell/suspensioncultureandtheirapplications;Organogenesisandsomaticembryogenesis;Somaclonalvariationanditsuseincrop improvement;Embryorescuetechniqueanditssignificanceinhybriddevelopment;*Invitro* fertilization,ovulecultureanditssignificanceinhybriddevelopment;Protoplastisolation,culture and regeneration;Somatic hybridization(somatic hybridsand cybrids) and itsapplication incrop improvement;Anther and pollenculture for haploid production;Developmentof disease-free(virusfree)plantsthroughapicalmeristemculture;Micropropagationtechniqueforthe generationofqualityplantingmaterial;Syntheticseedsanditsapplications;National certification and Quality management of TC plants-secondary metabolite production- *in vitro* germplasm conservation.

Introduction to Molecular Biology: DNA structure, structure and function; DNA replication, transcription and translation, RNA, types and function; Structure of prokaryotic and eukaryotic gene; Central dogma of life - DNA replication, transcription, genetic codes translation and protein synthesis; Lac Operon concept - Nucleic acid hybridization; Polymerase chain reaction-DNA sequencing – Sanger method; PCR and its applications. Introduction to recombinant DNA technology:DNAmodifyingenzymesand vectors; plant genetictransformation–physical(Gene gun method), chemical (PEG mediated) and Agrobacterium-mediated gene transfer methods; Transgenic and its importance in crop improvement with successful stories; biosafety. Introduction to various molecular markers: RFLP, RAPD, SSR, SNP etc.; Marker-assisted breeding in crop improvement

Practical

Introduction to Plant Tissue Culture Laboratory; Good Laboratory Practices; Media Preparation andsterilization;Glasswaresterilization;Micropropagation;Callus inductionand culture;Anther culture; Apical meristem culture; Preparation of synthetic seeds; Isolation of plasmid DNA; Quantification of DNA; Agarose Gel Electrophoresis and visualization of plasmid DNA; Restriction digestion of plasmid DNA and agarose gel electrophoresis; Isolation of Plantgenomic DNA; PCR amplification of DNA; Gel electrophoresis of amplified DNA; Visit to tissue culture units /biotech labs.

SEMESTER VI

Crop Improvement (*Rabi* crops)-II 2(1+1)

Objectives:

1. Toprovideknowledgeaboutself-pollinatedand cross-pollinated*rabi*crops
2. Tolearnaboutoriginanddistributionof*rabi* crops
3. Todesignbreedingobjectivesofmajor*rabi* crops
4. Toimpartinformationondifferentcropvarietiesfor*rabi*season

Theory

Centres of origin, distribution of species, wild relatives in different cereals; pulses; oilseeds; fibres; fodders and cashcrops;vegetable and other horticulturalcrops;Plant genetic resources, it sutilization and conservation, study of genetics of qualitative and quantitative characters; Important concepts of breeding self-pollinated, cross-pollinated and vegetatively propagated crops. Major breeding objectives and procedures including conventional and modern innovative approaches for development ofhybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Hybrid seed production technologyinwheat,oat, chickpea, rapeseed and mustard etc. Ideotype concept, climate resilient crop varieties for future.

Practical

Botanyofcrops,Floralbiology,emasculationandhybridizationtechniquesindifferentcrop species,viz.wheat,oat,rapeseed andmustard,pulses,potato,sugarcane,tomato,chilli,onion etc.Studyoffieldtechniquesforseedproductionandhybridseedproductioninrabicrops; Estimationofheterosis, inbreedingdepressionand heritability;Studyofqualitycharacters, donor parents for different characters; Visit to seed production plots; Visit to AICRP breeding plots of different crops.

SEMESTER VI

Fundamentals of Seed Science and Technology 2(1+1)

Objectives

1. Toimpart basicand fundamentalknowledgeonprinciplesandpracticesseed scienceand technology
2. Toimpartpracticalskillsonscientificseedproductionandpost-harvestqualitymanagement

Theory

Introduction to seed technology, definition and importance; Seed quality -definition, charactersof good quality seed; Causes of deterioration of varietal purity and assessment of genetic purity, different classes of seed. Foundation and certified seed production of important cereals, pulsesand oilseed, field inspection, importance and procedures;Post-harvest seed quality management; seed processing procedures, seed drying; Seed treatment, its importance, method of application and seed packing; seed storage - general principles, stages and factors affecting seed longevityduring storage; Seed health management during storage. Seed Certification and legislation; Seed Act and Seed Act enforcement, dutyand powers of seed inspector, offences and penalties. Seeds ControlOrder1983,basicsofseedqualitytesting;NewSeedBill2019;Seedquality enhancement techniques.

Practical

SeedStructure,Seedsampling,Physicalpurity,Moisturedetermination,Germinationtest, Seedandseedlingvigourtest, SeedViability, Geneticpuritytest:Growouttest, Field inspection, Seed health testing using blotter and agar plate method. Visit to seed production farms, seed testing laboratories and seed processing plant.

Semester VII

[Elective course 6]

Commercial Plant breeding 4(3+1)

Objectives

1. To discuss about hybriddevelopment andvariouscropimprovement aspectsoffieldcrops viz.,rice, wheat, maize, pearlmillet, sorghum, pigeonpea, chickpea, greengram, blackgram, lentil,soybean, groundnut, rapeseed-mustard, cotton etc.
2. Toprovideunderstandingontissueculture andbiotechnologicalapproachesasalternative strategies for development of line and cultivars
3. Toimpart knowledgeonseedproduction,releaseandnotificationofvarietiesandPPV&FR Act, 2001

Theory

Typesofcropsandmodesofplantreproduction.Linedevelopmentandmaintenancebreeding in self- and cross- pollinated crops (A/B/R and two-line system) for development ofhybrids and seed production. Genetic test of commercial hybrids. Advances in hybrid seed production of maize, rice, sorghum, pearl millet, castor, sunflower, cotton pigeon pea, Brassica etc. Speed Breeding,BreedingManagementsystems,High-throughputphenotypingandgenotyping platforms, Quality seed production of vegetable crops under open and protected environment. Alternative strategies for the development of the line cultivators: haploid inducer, tissue culture techniquesand biotechnologicaltools. IPR issues incommercialplant breeding:DUStestingand registrationofveritiesunderPPV andFR Act. Varietytesting, releaseand notificationsystems in India. Principles and techniques of seed production, types of seeds, quality testing in self- and cross- pollinated crops.

Practical

Floralbiologyin self- and cross- pollinated species, selfing and crossing techniques. Techniques ofseedproductioninself-andcross-pollinatedcropsusingA/B/Randtwo-linesystem. Learning techniques inhybrid seed productionusing male- sterility in field crops. Understanding thedifficultiesinhybridseedproduction.Toolsandtechniquesforoptimizinghybridseed production. Concept ofrouging in seed production plot. Concept of line its multiplication and purification in hybrid seed production. Role of pollinators in hybrid seed production. Hybrid seed production techniquesinsorghum,pearlmillet,maize,rice,rapeseed-mustard,sunflower,castor,pigeon pea,cottonandvegetablecrops.Samplingandanalyticalproceduresforpuritytestingand detectionofspuriousseed.Seeddryingandstoragestructureinqualityseedmanagement. Screening techniques during seed processing, viz. grading and packaging. Visit to public private seed production and processing plants.

SemesterVIII
[For student opting 4year BSc. (Hons.) degree]

Student READY(RAWE) /Experiential Learning/Hands on Training/Industrial Attachment /Project Work/Internship etc.

SKILLENHANCEMENTCOURSE(SEC)

S.No	Course title	Total credits
1.	Seed Production and Testing Technology	2(0+2)