Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post graduate program
w.e.f. Session 2022-23
M. Sc. (Ag.) Genetics and Plant Breeding
Semester – I

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGS)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
GPB 501	**Principles of Genetics**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3			√				√	
GPB 502	**Principles of Plant Breeding**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3			√		√		√	
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
MBB 517	**Stress Biology and Genomics**	**Minor**	2	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	2:0:0	2			√		√			
STAT 511	**Experimental Designs**	**Supporting**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	
BIOCHEM 505	**Techniques in Biochemistry**		2	0	4	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:2	4	√	√	√					
MCA 512	**Information Technology in Agriculture**		1	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	1:0:1	2	√	√	√					
Total																	**								
PGS503 (e-Course)	**Intellectual Property and Its Management in Agriculture**	**Common**	1	0	0	20	10	**30**	-	-	-	-	**30**	**70**	**100**	1:0:0	1	√	√	√				√	
PGS504	**Basic Concepts in Laboratory Techniques**		0	0	2	0	0	**0**	-	25	25	75	**25**	-	**100**	0:0:1	1	√	√	√					
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester*

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-I
Course Title: Principles of Genetics
Course Code: GPB 501
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Beginning of genetics, early concepts of inheritance, Mendel's laws; Discussion on Mendel's paper, Chromosomal theory of inheritance; Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage-detection, estimation; Recombination and genetic mapping in eukaryotes, Somatic cell genetics, Extra chromosomal inheritance.

Unit-II
Mendelian population, Random mating population, Frequencies of genes and genotypes, Causes of change: Hardy-Weinberg equilibrium.

Unit-III
Nature, structure and replication of the genetic material; Organization of DNA in chromosomes, Genetic code; Protein biosynthesis, Genetic fine structure analysis, Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters; Regulation of gene activity in prokaryotes and eukaryotes; Molecular mechanisms of mutation, repair and suppression; Bacterial plasmids, insertion (IS) and transposable (Tn) elements; Molecular chaperones and gene expression, RNA editing.

Unit-IV
Gene isolation, synthesis and cloning, genomic and cDNA libraries, PCR based cloning, positional cloning; Nucleic acid hybridization and immunochemical detection; DNA sequencing; DNA restriction and modification, Anti-sense RNA and ribozymes; Micro-RNAs (miRNAs).

Unit-V
Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Gene silencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.

Practical:
Laboratory exercises in probability and chi-square; Demonstration of genetic principles using laboratory organisms; Chromosome mapping using three-point test cross; Tetrad analysis; Induction and detection of mutations through genetic tests; DNA extraction and PCR amplification; Electrophoresis: basic principles and running of amplified DNA; Extraction of proteins and isozymes; Use of *Agrobacterium* mediated method and Biolistic gun; Detection of transgenes in the exposed plant material; Visit to transgenic glasshouse and learning the practical considerations.

Suggested readings:

- Daniel LH and Maryellen R. 2011. Genetics: "Analysis of Genes and Genomes".
- Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006
- Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education India; Tenth edition
- Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018
- Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co
- Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)
- Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition International Student Version edition
- Stansfield WD.1991. Genetics.Schaum Outline Series Mc Graw Hill

- Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015
- Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7 edition
- Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

COURSE OBJECTIVES:

- Introduction to genetics and historical perspective of genetics.
- Detection of linkage and estimation.
- To aware the students about the fine structure of genes
- To impart the knowledge of induction, detection and mechanism of mutation.
- To study about the extranuclear inheritance and polygenic inheritance.

.**COURSE OUTCOME (CO):**

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	able to know what are the basic laws and discoveries in genetics.
CO2	able to detect and estimate the linkage and recombination frequency
CO3	Students learned about the fine structure of gene or gene concept
CO4	Students know how to induce, detect and the knowledge of mechanism of mutation.
CO5	Learned about the inheritance of cytoplasmic genes and polygenes.

CO-PO-PSO mapping

	PO										PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	1	2	3	1		2		3	3	3	3	3
CO2	3	3	2	3	2	1		2		2	3	3	2	3
CO3	3	2	1	3	2	1		1		3	3	3	2	3
CO4	3	2	2	3	3	2		2		3	3	2	3	3
CO5	3	1	2	3	3	1		2		3	3	3	2	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-I
Course Title: Principles of Plant Breeding
Course Code: GPB 502
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Early Plant Breeding; Accomplishments through plant breeding; Objectives of plant breeding; Patterns of Evolution in Crop Plants: Centre of Origin, Agro-biodiversity and its significance. Pre-breeding and plant introduction and role of plant genetic resources in plant breeding.

Unit-II
Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection; Nature of variability, components of variation; Heritability and genetic advance, genotype environment interaction; General and specific combining ability; Types of gene actions and implications in plant breeding.

Unit-III
Pure line theory, pure line and mass selection methods; pedigree, bulk, backcross, single seed descent and multiline breeding; Population breeding in self-pollinated crops with special reference to diallel selective mating; Transgressive breeding.

Unit-IV
Breeding methods in cross pollinated crops; Population breeding: mass selection and ear-to-row methods; S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds, breeding approaches for improvement of inbreeds, predicting hybrid performance; seed production of hybrid and their parent varieties/ inbreeds. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.

Unit-V
Breeding methods in asexually/ clonally propagated crops, clonal selection. Special breeding techniques: Mutation breeding, Breeding for abiotic and biotic stresses; Concept of plant ideotype and its role in crop improvement, concept of MAS, concept of polyploidy and wide hybridization, doubled haploidy. Cultivar development: testing, release and notification, maintenance breeding, Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.

Practical:
Floral biology in self and cross pollinated species; Selfing and crossing techniques; Selection methods in segregating populations and evaluation of breeding material; Analysis of variance (ANOVA); Estimation of heritability and genetic advance; Maintenance of experimental records; Learning techniques in hybrid seed production using male-sterility in field crops; Prediction of performance of double cross hybrid.

Suggested Readings:

- Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
- Chahal GS and Gossal, SS. 2002. Principles and Procedures of Plant Breeding Biotechnological and Conventional approaches. Narosa Publishing House.
- Chopra VL. 2004. Plant Breeding. Oxford & IBH.
- George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.
- Gupta SK. 2005. Practical Plant Breeding. Agribios.
- Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular Approach, Narosa Publications, New Delhi

- Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
- Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
- Sharma JP. 2010. Principles of Vegetable Breeding. Kalyani Publ, New Delhi.
- Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.
- Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

COURSE OBJECTIVES:

- Introduction to genetics and historical perspective of genetics.
- Detection of linkage and estimation.
- To aware the students about the fine structure of genes
- To impart the knowledge of induction, detection and mechanism of mutation.
- To study about the extranuclear inheritance and polygenic inheritance.

Course Outcome (CO):

After completion of the course, a student will be able to

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CO1	able to know what are the basic laws and discoveries in genetics.
CO2	able to detect and estimate the linkage and recombination frequency
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CO5	Learned about the inheritance of cytoplasmic genes and polygenes.

CO-PO-PSO mapping

	PO										PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	1	2	3	1		2		3	3	3	3	3
CO2	3	3	2	3	2	1		2		2	3	3	2	3
CO3	3	2	1	3	2	1		1		3	3	3	2	3
CO4	3	2	2	3	3	2		2		3	3	2	3	3
CO5	3	1	2	3	3	1		2		3	3	3	2	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.)
SEMESTER-I
Course Title: Stress Biology and Genomics
Course Code: MBB 517
w.e.f. Session 2022-23

2(2+0)

Unit-I

Different kinds of stresses (biotic and abiotic) and adaptation strategies: Plant cell as a sensor of environmental changes; role of cell membranes in signal perception; Ways of signal transduction in cells and whole plants as a response to external factors. Abiotic stresses affecting plant productivity – Drought, salinity, water logging, temperature stresses, light stress and nutrient stress; Drought stress – Effects on plant growth and development; Components of drought resistance; Physiological, biochemical and molecular basis of tolerance mechanisms; Biotic stress (insect and pathogen) resistance mechanism.

Unit-II

Strategies to manipulate drought tolerance – Osmotic adjustment and Osmoprotectants - synthesis of proline, glycine betaine, poly amines and sugars; ROS and antioxidants; hormonal metabolism - ABA signaling; signaling components – transcription factors. Water logging stress – effects on plant growth and metabolism; adaptation to water logging, tolerance mechanisms -hormones and flooding tolerance. Strategies for improving submergence tolerance. Salinity stress – effects on physiology and metabolism of plants, SOS pathways and ion homeostasis,Strategies to improve salinity tolerance in plants. Water logging stress – effects on plant growth and metabolism; tolerance mechanisms. Physiological and biochemical changes – High & Low temperature tolerance mechanisms - molecular basis of thermo tolerance. Morphological and physiological changes in plants due to high and low light stresses - photo oxidation -plastid development. Characters of heliophytes and sciophytes – solar tracking – sieve effect and light channeling. Heavy metal stress – Al and Cd stress - effects on plant growth and development, biotech Strategies to overcome heavy metal stress Nutrient stress effects on plant growth and development. Genetic manipulation strategies to overcome the stress effects.

Unit-III

Genomics; transcriptomes, small RNAs and epigenomes; functional genomics; transfer of tolerance/resistant genes to model plants and validation of gene function. Different techniques for the functional validation of genes. Signaling pathway related to defense gene expression, R proteins, RNAi approach and genes from pathogens and other sources, coat protein genes, detoxification genes, transgenic and disease management. Bt proteins, resistance management strategies in transgenic crops, ecological impact of field release of transgenic crops. Bioinformatics approaches to determine gene function and network in model plants under stress.

Suggested Readings:

- Buchanan, B.B., Gruissem, W. and Jones R. 2015. Biochemistry and Molecular Biology of Plants, 2nd edition, Wiley and Blackwell Publications.
- Sarwat, M., Ahmad, A., Abdin, M.Z. 2013. Stress Signaling in Plants: Genomics and Proteomics Perspective, Volume 1, Springer.
- Heribert Hirt. 2010. Plant Stress Biology: From Genomics to Systems Biology, John Wiley.
- Pandey, G.K. 2015. Elucidation of Abiotic Stress Signaling in Plants, Stringer.

COURSE OBJECTIVES:

- Knowledge and concept of different kind of stress
- To provide advanced knowledge on genomics with reference to abiotic stress tolerance and biotic stress resistance in plants tolerance
- Basic concepts of plant bioinformatics

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Concept of different kind of biotic and a biotic stresses
CO2	Basics of crop biotechnology and its application
CO3	Study of morphological and physiological changes in plants
CO4	Concept of functional genomics; transfer of tolerance/resistant genes to model plants

CO-PO-PSO MAPPING

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	2	2	3	2	3	3	3	2	2	3	3	3
CO2	2	3	2	2	2	2	2	1	2	1	2	2	3	2
CO3	3	3	3	3	3	3	2	2	3	1	2	3	3	2
CO4	3	3	2	2	2	2	1	1	2	1	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Experimental Designs
Course Code: STAT 511
w.e.f. Session 2022-23

3(2+1)

Unit-I
Experiments: Absolute Experiments, Comparative experiments, need for designing of experiments, characteristics of a good design. Treatment, experimental unit, blocks, yield, uniformity trials, size and shape of plots and blocks. Principles of design of experiment: randomization, replication and local control.

Unit-II
Designs of experiments: Completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance. factorial design; symmetrical and asymmetrical. Confounding in symmetrical factorial experiments, factorial experiments with control treatment, advantages and disadvantages of confounding.

Unit-III
Analysis of covariance for two-way classification (Randomized Block Design). Split plot design: comparison between split-plot design and factorial design, advantages and disadvantages of split plot design. Missing Plot techniques: Analysis of missing plot design (Fisher's Rule), analysis of Randomized Block Design with one missing observation, analysis of Latin Square Design with one missing observation

Unit-IV
Balanced Incomplete Block Design (BIBD), parameters of BIBD, Incidence matrix, Symmetric BIBD, Analysis of BIBD, efficiency of BIBD relative to Randomized Block Design, Response Surfaces.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Cochran, W.G. and Cox, G.M. Experimental Design. Asia Publishing House.
- Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
- Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
- Casella, G, (2008). Statistical Design. Springer.
- Gupta, S.C. and Kapoor, V.K. Latest Revised Edition 2015. Fundamentals of Applied Statistics.

COURSE OBJECTIVES:
- Basic concepts of Experiments, designs and analysis of covariance
- Comparative experiments, need for designing of experiments
- In depth knowledge of principles of design of experiment: randomization, replication and local control
- Knowledge of completely randomized design, Randomized Block Design and Latin square design and their analysis of variance
- Balanced Incomplete Block Design (BIBD) and its parameters

- Analysis of missing plot design (Fisher's Rule),analysis of Randomized Block Design with one missing observation

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of Experiments, designs and analysis of covariance
CO2	Students will have knowledge of Comparative experiments
CO3	The students will be able to prepare their experimental fields on the basis of designs
CO4	Students can have the knowledge of completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance
CO5	Students can analyze their results according to the designs

CO-PO-PSO MAPPING

	PO										PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	2	2	2	1	1	2	2	2	2	2
CO2	2	3	2	2	2	2	1	1	1	3	2	2	2
CO3	2	3	2	2	2	2	1	1	2	3	2	2	2
CO4	2	3	2	2	2	2	1	1	2	3	3	2	2
CO5	2	3	2	2	2	2	1	1	2	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution													

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Techniques in Biochemistry
Course Code: BIOCHEM 505
w.e.f. Session 2022-23

4(2+2)

Unit-I
General scheme for purification of biocomponents. Methods of studying cells and organelles, sub cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cells. Ultra-filtration, sonication, freeze drying and fractional precipitation. Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Unit-II
Basic principles, instrumentation, working and applications of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.

Unit-III
Electrophoretic techniques - slab, capillary, 2-D, pulse field, polyacrylamide/agarose gel electrophoresis. Blotting techniques: Western, Southern and Northern blotting- principle and methodology.

Unit-IV
Fundamental principles of flourescene & phosphorescence, absorption, transmission of light, Beer – Lamberts law, Colorimeter, flame photometry. Principle, instrumentation, working and application of – UV, visible and IR spectroscopy, atomic absorption spectrometry, Nuclear Magnetic Resonance (NMR), Mass spectroscopy - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization- Time-of-Flight Mass spectroscopy (MALDI-TOF MS), X-ray crystallography.

Unit-IV
Basic principles, instrumentation and applications of microscopy. Bright field, phase contrast, fluorescence and confocal microscopy. Electron microscope – scanning and transmission electron microscopy. Nature of radioactivity, decay and types of radiation. Radiation hazards and precautions taken while handling radioisotopes. Radiation detection and measurements: Geiger Muller counter, scintillation counter and pulse height analyzer. Application of radioisotopes in biological science- autoradiography.

Practical:
Methods for lysis of plant and microbial cells; Centrifugation; Verification of Beer-Lambert's law and determination of absorption coefficients; Paper chromatography – Separation of amino acids and carbohydrates in a mixture; Thin layer chromatography of fatty acids; Column chromatography – Separation of a mixture of proteins and salt using Sephadex column; Electrophoresis. Staining of bacteria – Simple staining, differential staining, staining of spores.

Suggested Readings:

- Principles and Techniques of Practical Biochemistry by Keith Wilson, John Walker (eds), Cambridge University Press; 5th edition.
- Principles and Techniques of Practical Biochemistry by Wilson, K., Walker, J. (eds.), Cambridge University Press, Cambridge, 2000, 5th edition.
- Lehninger Principles Of Biochemistry by David L. Nelson, Michael M. Cox, W. H. Freeman, 6th edition.

COURSE OBJECTIVES:

- Knowledge and concept of Biomolecules.
- Basic concepts and principles of different biochemical techniques.
- Applications of different bioanalytical techniques.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Understand about the cells and apply the concept of centrifugation.
CO2	Explain classification, principle and application of chromatography.
CO3	Discuss principle and application of electrophoresis and blotting techniques
CO4	Understand working principle of spectrophotometer and able to handle different spectrophotometric techniques
CO5	Understand the concept of microscopy and radiations.

CO-PO-PSO MAPPING

	PO										PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	1	2	1	2	1	2	3	3	2
CO2	3	2	1	1	2	2	1	1	1	1	3	3	3
CO3	3	3	2	1	2	1	1	2	2	1	2	3	2
CO4	3	2	1	2	1	1	2	1	1	1	3	3	2
CO5	3	3	1	1	1	1	1	2	1	1	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution													

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Information Technology in Agriculture
Course Code: MCA 512
w.e.f. Session 2022-23

2(1+1)

Unit-I
Introduction and Applications of e-Agriculture, Introduction to Online Agricultural resources: Consortium for e-resources in Agriculture (CeRA), e-agriculture community, Agriculture: National Portal of India. Agricultural Datasets and Databases: Agricola, Agris. Need of Biological databases in Agricultural Sciences.

Unit-II
Smartphone Apps in Agriculture for farm advisory, Weather forecasting, types, methods, tools & techniques, Use of ICT in Agriculture, Computer Models for understanding plant processes.

Unit-III
Crop models, concepts & techniques, types of crop models, spatial data and their management in GIS; Remote sensing concepts and application in agriculture, Global positioning system (GPS), components and its functions.

Unit-IV
Agricultural Journalism – Meaning, Scope and Importance, Sources of news, Kisan call centers, e-chaupal, RRA, PRA tools and techniques KVK, Adopter categories, MANAGE, EEI: extension education institute.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Agri Informatics: An Introduction (Industry Series), by R Chakravarthy, ICFAI University Press.
- E-Agriculture: Concepts and Applications (Agriculture Series), Rahul Gupta (Author), ICFA University Press.
- Yadav, D S, Foundations of IT, New Age, Delhi.
- Introduction to Bioinformatics by Teresa Attwood, David Parry-Smith 1st edition; Prentice Hall publications
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette (Eds), 2nd Edition; Willey & Sons publications.
- Bioinformatics: Sequence, Structure, and Databanks: A Practical Approach by Des Higgins, Willie Taylor; OUP.
- BIOS Instant Notes in Bioinformatics by Charlie Hodgman, Andrew French, David Westhead, Taylor & Francis publishing; 2 edition.

COURSE OBJECTIVES:
- To gain basic knowledge of information technology in agriculture
- The aim of improving communication and learning processes between various sectors in agriculture locally, regionally and worldwide
- They gain knowledge of weather forecasting to increase the production and productivity of Agriculture
- Type of education and Agricultural Journalism
- Knowledge of Innovative Information sources.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Use of Information and Communication Technology in Agriculture
CO2	Know about crop models concepts & techniques
CO3	Know about computer models for understanding plant processes.
CO4	Knowledge of education and their Characteristics and Agricultural Journalism
CO5	Knowledge of contact methods, Kissan Call center and e-Chaupal.

CO-PO-PSO MAPPING

	PO										PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	3	3	1	1	2	3	3	2	2
CO2	3	3	3	2	1	3	2	1	3	2	2	3	2
CO3	3	3	1	2	2	2	3	1	2	3	2	3	3
CO4	3	3	3	2	3	3	2	1	3	2	3	1	2
CO5	3	3	2	3	1	3	1	1	2	2	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution													

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-I
Course Title: Intellectual Property and Its Management in Agriculture
Course Code: PGS503
w.e.f. Session 2018-19

1(1+0)

Unit-I
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Unit-II
Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks.

Unit-III
Protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture.

Unit-IV
Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings:

- Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

COURSE OBJECTIVES:
- Knowledge, concept and introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
- Basics of Legislations for the protection of various types of Intellectual Properties
- Fundamentals of patents, copyrights, geographical indications, designs and layout
- Basic concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
- Study of Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Concept of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
CO2	Knowledge of Legislations for the protection of various types of Intellectual Properties
CO3	Concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO4	Knowledge of Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO5	Knowledge of Socio-economic impact, Research collaboration Agreement, License Agreement

CO-PO-PSO MAPPING:

	PO										PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	3	3	1	1	1	3	3	2	3	2	2
CO2	2	3	2	2	1	1	1	1	2	3	2	2	2
CO3	3	3	3	3	1	1	2	2	3	3	2	2	2
CO4	3	3	2	2	1	1	1	1	2	3	3	2	2
CO5	3	3	2	3	1	1	1	3	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution													

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Basic Concepts in Laboratory Techniques
Course Code: PGS504
w.e.f. Session 2018-19

1(0+1)

Practical:
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/ chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings:

- Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
- Gabb MH & Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

COURSE OBJECTIVES:
- Basic concepts of Safety measures while handling instruments, chemicals, glasswares, etc. in lab
- Use of different instruments, chemicals, glasswares, etc. of lab
- Preparation of different agrochemical doses in field and pot applications
- Preparation of buffers of different strengths and pH values
- Preparation of media and methods of sterilization
- Seed viability testing, testing of pollen viability

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of handling and safety measures of instruments, chemicals, glasswares, etc. in lab before and after use
CO2	Students will have knowledge of usage of different type of lab equipments, instruments, glasswares, plasticwares, etc.
CO3	The students will be able to prepare different agrochemical doses in field and pot applications
CO4	Students can have the knowledge to prepare media, acid and bases of different strengths and buffer solutions
CO5	Students can also perform seed and pollen viability testing

CO-PO-PSO MAPPING:

	PO										PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	1	2	1	2	2	2	2	2	2
CO2	2	2	2	2	1	2	1	2	1	2	2	2	2
CO3	3	3	3	2	1	2	1	2	2	2	2	2	2
CO4	3	3	3	2	1	2	1	2	2	2	2	2	2
CO5	3	3	3	2	2	2	1	2	2	2	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution													

Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post graduate program
w.e.f. Session 2022-23
M. Sc. (Ag.) Genetics and Plant Breeding
Semester – II

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGS)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
GPB 503	**Fundamentals of Quantitative Genetics**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√		√	
GPB 506	**Molecular Breeding and Bioinformatics**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√		√	
Total																									
GPB 511	**Crop Breeding-I (Kharif Crops)**	**Optional**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√			√	√	
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
MBB 504	**Techniques in Molecular Biology I**	**Minor**	0	0	6	0	0	**-**	-	-	-	25	**75**	**0**	**100**	0:0:3	3#	√	√	√		√		√	
MBB 509	**Plant Tissue culture**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3#	√	√	√		√		√	
Total																	**								
PGS502	**Technical Writing and Communications Skills**	**Common**	0	0	2	0	0	**-**	-	-	-	25	**75**	**0**	**100**	0:0:1	1	√		√				√	4
PGS505 (e-Course)	**Agricultural Research, Research Ethics and Rural Development Programmes**		1	0	0	20	10	**30**	-	-	-	0	**0**	**70**	**100**	1:0:0	1	√		√			√	√	4
GPB 591	**Master's Seminar**		-	-	-	-	-	-	-	-	-	-	-	-	**100**	0:0:1	1			√					4
GPB 599	**Master's Research**		-	-	-	-	-	-	-	-	-	-	-	-	S/US	0:0:5	5$	√		√			√	√	4
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester; *Student can opt any one subject from Minor; $Master's Research credit to be counted in Final Semester examinations; S/US=Satisfactory/Unsatisfactory*

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-II
Course Title: Fundamentals of Quantitative Genetics
Course Code: GPB 503
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Introduction and historical background of quantitative genetics, Multiple factor hypothesis, Qualitative and quantitative characters, Analysis of continuous variation mean, range, SD, CV; Components of variation- Phenotypic, Genotypic, Nature of gene action- additive, dominance and epistatic, linkage effect. Principles of analysis of variance and linear model, Expected variance components, Random and fixed effect model, Comparison of means and variances for significance.

Unit-II
Designs for plant breeding experiments- principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA.

Unit-III
Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysis-Metroglyph and D2, Generation mean analysis, Parent progeny regression analysis.

Unit-IV
Mating designs- classification, Diallel, partial diallel, L × T, NCDs, and TTC; Concept of combining ability and gene action, G × E interaction-Adaptability and stability; Methods and models for stability analysis; Basic models- principles and interpretation, Bi-plot analysis.

Unit-V
QTL mapping, Strategies for QTL mapping- Desired population and statistical methods, QTL mapping in genetic analysis; Markers, Marker assisted selection and factors influencing the MAS, Simultaneous selection based on marker and phenotype.

Practical:
Analysis and interpretation of variability parameters; Analysis and interpretation of Index score and Metroglyph; Clustering and interpretation of D2 analysis; Genotypic and phenotypic correlation analysis and interpretation; Path coefficient analysis and interpretation; Estimation of different types of heterosis, inbreeding depression and interpretation; A, B and C Scaling test; L × T analysis and interpretation, QTL analysis; Use of computer packages; Diallel analysis; G × E interaction and stability analysis.

Suggested readings:

- Bos I and Caligari P. 1995. Selection Methods in Plant Breeding. Chapman & Hall.
- Falconer DS and Mackay J. 1998. Introduction to Quantitative Genetics (3rd Ed.).ELBS/Longman, London.
- Mather K and Jinks JL.1985. Biometrical Genetics (3rd Ed.). Chapman and Hall, London.
- Nandarajan N and Gunasekaran M. 2008. Quantitative Genetics and Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Naryanan SS and Singh P. 2007. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Roy D. 2000. Plant Breeding: Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Sharma JR. 2006. Statistical and Biometrical Techniques in Plant Breeding. New Age International Pvt. Ltd.

- Singh P and Narayanan SS. 1993. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Singh RK and Chaudhary BD. 1987. Biometrical Methods in Quantitative Genetic analysis. Kalyani Publishers, New Delhi.
- Weir DS. 1990. Genetic Data Analysis. Methods for Discrete Population Genetic Data. Sinauer Associates.
- Wricke G and Weber WE. 1986. Quantitative Genetics and Selection in Plant Breeding. Walter de Gruyter.

e-Suggested Reading:

- www.iasri.icar.gov.in
- www.hau.ac.in/OPstat

COURSE OBJECTIVES:

- To impart theoretical knowledge of variation and variances
- To impart the computation skills regarding components of scales, mating designs and gene effects.
- To impart the knowledge of yield and quality characters are controlled by many genes and show the quantitative.
- To study about the various strategies for QTL mapping.

COURSE OUTCOME (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	able to know theoretical knowledge of variation and variances.
CO2	able to components of scales, mating designs and gene effects.
CO3	Students will have the knowledge of yield and quality characters are controlled by many genes and show the quantitative.
CO4	Students know how different strategies for QTL mapping work.

CO-PO-PSO mapping

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	2	2	3	1		2		3	3	3	3	3
CO2	2	3	2	3	2	2		2		2	3	3	2	3
CO3	3	3	3	3	2	1		1		3	3	3	2	3
CO4	3	2	2	3	3	2		2		3	3	2	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-II
Course Title: Molecular Breeding and Bioinformatics
Course Code: GPB 506
w.e.f. Session 2022-2023

3(2+1)

Unit-I

Genotyping; Biochemical and Molecular markers; Morphological, biochemical and DNA-based markers (RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc.), Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); Molecular mapping and tagging of agronomically important traits; Statistical tools in marker analysis.

Unit-II

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assisted backcross breeding for rapid introgression; Genomics- assisted breeding; Generation of EDVs; Gene pyramiding.

Unit-III

Introduction to Comparative Genomics; Large scale genome sequencing strategies; Human genome project; Arabidopsis genome project; Rice genome project; Comparative genomics tools; Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; Nanotechnology and its applications in crop improvement.

Unit-IV

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformation techniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases; Biotechnology applications in male sterility/hybrid breeding, molecular farming; Application of Tissue culture in molecular breeding; MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights; Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.

Practical:

Requirements for plant tissue culture laboratory; Techniques in plant tissue culture; Media components and media preparation; Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretations; Inoculation of explants, callus induction and plant regeneration; Standardizing the protocols for regeneration; Hardening of regenerated plants; Establishing a greenhouse and hardening procedures; Visit to commercial micropropagation unit; Transformation using *Agrobacterium* strains; GUS assay in transformed cells/ tissues; DNA isolation, DNA purity and quantification tests; Gel electrophoresis of proteins and isozymes, PCR-based DNA markers, gel scoring and data analysis for tagging and phylogenetic relationship; Construction of genetic linkage maps using computer software; NCBI Genomic Resources, GBFF, Swiss Prot, Blast n/ Blast p, Gene Prediction Tool, Expasy Resources, PUBMED and PMC, OMIM and OMIA, ORF finder; Comparative Genomic Resources: - Map Viewer (UCSC Browser and Ensembl); Primer designing- Primer 3/ Primer BLAST.

Suggested Readings:

- Azuaje F and Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley and Sons.
- Brown TA. 1991. Essential Molecular Biology: a practical Approach. Oxford university press, 2002, 2nd edition

- Chawala HS. 2000. Introduction to Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd.
- Chopra VL and Nasim A. 1990. Genetic Engineering and Biotechnology: Concepts, Methods and Applications. Oxford & IBH.
- Gupta PK. 1997. Elements of Biotechnology. Rastogi Publ.
- Hackett PB, Fuchs JA and Messing JW. 1988. An Introduction to Recombinant DNA Technology Basic Experiments in Gene Manipulation. 2nd Ed. Benjamin Publ. Co.
- Jollès P and Jörnvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis. Birkhäuser.
- Lewin B. 2017. Genes XII. Jones & Bartlett learning, 2017.
- Robert NT and Dennis JG. 2010. Plant Tissue Culture, Development, and Biotechnology. CRC Press.
- Sambrook J and Russel D. 2001. Molecular Cloning - a Laboratory Manual. 3rd Ed. Cold Spring Harbor Lab. Press.
- Singh BD. 2005. Biotechnology, Expanding Horizons. Kalyani Publishers,

COURSE OBJECTIVES:

- The course will provide deep knowledge on genotyping.
- The course will impart knowledge of different kinds of markers including biochemical and molecular, mapping populations, allele mining.
- This will also add ways to perform marker-assisted selection and gene pyramiding to evolve superior varieties.

Course Outcome (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	able to know what are the concepts of genotyping.
CO2	able to be familiar with different kinds of markers including biochemical and molecular, mapping populations, allele mining.
CO3	Students learned about the comparative genomics of different organisms.
CO4	Students know how to perform marker-assisted selection and gene pyramiding to evolve superior varieties
CO5	Learned about the computational tools used to study genetics and plant breeding.

CO-PO-PSO mapping

	PO										PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	1	1	2	3	1	2	2	1	3	3	3	3	3
CO2	3	3	2	3	2	1	3	2	2	2	3	3	2	3
CO3	3	2	1	3	2	1	1	1	3	3	3	3	2	3
CO4	3	2	2	3	3	2	2	2	1	3	3	2	3	3
CO5	3	1	2	3	3	1	1	2	1	3	3	3	2	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.) Genetics and Plant Breeding
SEMESTER-II
Course Title: Crop Breeding-I (Kharif Crops)
Course Code: GPB 511
w.e.f. Session 2022-2023

3(2+1)

Unit-I

Rice: Origin, evolution, mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding.

Maize: Origin, evolution, mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, releasedvarieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications.

Small millets: Evolution and distribution of species and forms - wild relatives and germplasm; Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc.

Unit-II

Pigeon pea: evolution, mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes.

Groundnut: Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.

Other pulses: Urdbean, mungbean, cowpea: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.

Unit-III

Soybean: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Castor and Sesame: Origin, evolution mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement; Hybrid breeding in castor – opportunities, constraints and achievements.

Unit-IV

Cotton: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton.

Jute: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.

Unit-V

Sugarcane: Evolution and distribution of species and forms, wild relatives and germplasm; Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc.

Forage crops: Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship; Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance, etc.

Seed spices: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship; Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops.

Practical:

Floral biology, emasculation, pollination techniques in rice, maize, pigeon pea, soybean, sesame, cotton; Study of range of variation for yield and yield components; Study of segregating populations in cereal, pulses and oilseed crops; Learning on the crosses between different species; attempting crosses between black gram and green gram; Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton; Visit to Cotton Technology Laboratory and Spinning Mills; Learning on the Standard Evaluation System (SES) and descriptors; Use of software for database management and retrieval; Practical learning on the cultivation of fodder crop species on sewage water, analysing them for yield components and palatability; Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes; Visit to animal feed producing factories; Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.

Suggested Readings:

- Agarwal RL. 1996. Identifying Characteristics of Crop Varieties. Oxford & IBH.
- Bahl PN and Salimath PM. 1996. Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds. Oxford & IBH.
- Chandraratna MF. 1964. Genetics and Breeding of Rice. Longmans.
- Chopra VL and Prakash S. 2002. Evolution and Adaptation of Cereal Crops. Oxford & IBH. Gill KS. 1991. Pearl Millet and its Improvement. ICAR.
- IRRI. 1964. Rice Genetics and Cytogenetics. Elsevier.
- IRRI. 1986. Rice Genetics. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 1991. Rice Genetics II. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 1996. Rice Genetics III. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- IRRI. 2000. Rice Genetics IV. Proc. International Rice Genetics Symposium. IRRI, Los Banos, Manila, Philippines.
- Jennings PR, Coffman WR and Kauffman HE. 1979. Rice Improvement. IRRI, Los Banos, Manila,
- Philippines.
- Kannaiyan S, Uthamasamy S, Theodore RK and Palaniswamy S. 2002. New Dimensions and Approaches for Sustainable Agriculture. Directorate of Extension Education, TNAU, Coimbatore.
- Murty DS, Tabo R and Ajayi O. 1994. Sorghum Hybrid Seed Production and Management. ICRISAT, Patancheru, India.
- Nanda JS. 1997. Manual on Rice Breeding. Kalyani Publishers.
- Parthasarathy VA. 2017. Spices and Plantation Crops Vol.1 (Part A) Breeding of Horticultural Crops Vol.1 (Part-B), Today and Tomorrow Printers and Publishers
- Poehlman, JM. 1987. Breeding of Field Crops. AVI Publishing Co. Inc. East Post Connecticut, USA.
- Ram HH and Singh HG. 1993. Crop Breeding and Genetics. Kalyani.

- Sharma, AK. 2005. Breeding Technology of Crop Plant. Yesh Publishing House, Bikaner
- Slafer GA. (Ed.). 1994. Genetic Improvement of Field Crops. Marcel Dekker.
- Singh HG, Mishra SN, Singh TB, Ram HH and Singh DP. (Eds.). 1994. Crop Breeding in India. International Book Distributing Co.
- Walden DB. 1978. Maize Breeding and Genetics. John Wiley & Sons.

COURSE OBJECTIVES:

- Botanical features, reproductive systems, genetics involved in Kharif Crop.
- Important breeding techniques are essential to undertake any crop improvement programme.
- This course is designed for important/ major Kharif crops.
- The student will know about plant breeding research in different Kharif crops.

COURSE OUTCOME (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	learned the insight into recent advances in improvement of kharif crops using conventional and modern biotechnological approaches.
CO2	The students will be able to know the origin, evolution mode of reproduction and breeding objectives of different Kharif crops.
CO3	Students will be able to use the knowledge of genetics of different crops.
CO4	The student will understand about plant breeding research in different Kharif crops.

CO-PO-PSO mapping

	PO										PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	3	1	3	3	3	2	1	2	3	2	2	2	2
CO2	3	2	3	2	2	2	2	3	1	3	2	2	2	2
CO3	3	2	2	1	3	1	1	2	1	3	3	2	2	3
CO4	3	2	3	2	1	3	1	3	1	3	3	2	3	3
CO5	3	1	3	3	2	2	2	3	2	3	3	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.)
SEMESTER-II
Course Title: Techniques in Molecular Biology I
Course Code: MBB 504
w.e.f. Session 2022-2023

3(0+3)

Practicals:
Good lab practices, preparation of buffers and reagents; Principle of centrifugation and spectrophotometry; Growth of bacterial culture and preparation of growth curve; Isolation of Genomic DNA from bacteria, Isolation of plasmid DNA from bacteria; Growth of lambda phage and isolation of phage DNA; Isolation and restriction of plant DNA (e.g. Rice / Moong / Mango / Marigold); Quantification of DNA by (a) Agarose Gel electrophoresis and (b) Spectrophotometry; PCR using isolated DNA; PAGE Gel electrophoresis; Restriction digestion of plasmid and phage DNA, ligation, Recombinant DNA construction; Transformation of *E. coli* and selection of transformants; Chromatographic techniques a. TLC b. Gel Filtration Chromatography, c. Ion exchange Chromatography, d. Affinity Chromatography; Dot blot analysis, Southern hybridization, Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

Suggested Readings:

- Sambrook, J., and Russell, R.W. 2001. Molecular Cloning: A Laboratory Manual 3rd Edition, Cold spring harbor laboratory press, New York.
- Wilson, K., and Walker, J., 2018. Principles and Techniques of Biochemistry and Molecular Biology 8th edition, Cambridge University Press.
- Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA and Struhl K. 2002. Short Protocols in Molecular Biology 5th edition, Current Protocols publication.

COURSE OBJECTIVES:
- To get a basic overview of molecular biology techniques, good lab practices and recombinant DNA technology.
- To get a hands on training in chromatography, protein analysis, nucleic acid analysis, bacterial and phage genetics.

COURSE OUTCOME (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	able to know what are the concepts of GLPs .
CO2	able to have an overview of molecular biology techniques and recombinant DNA technology.
CO3	Students learned about in chromatography, protein analysis, nucleic acid analysis, bacterial and phage genetics.

CO-PO-PSO mapping

	PO										PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	3	2	1	1	2	2	1	3	3	3	3	3
CO2	2	1	2	3	3	2	3	2	1	2	3	3	2	3
CO3	3	2	1	3	2	1	2	1	2	3	3	3	2	3
3: Strong contribution, 2: average contribution, 1: Low contribution														

M. Sc. (Ag.)
SEMESTER-II
Course Title: Plant Tissue culture
Course Code: MBB 509
w.e.f. Session 2022-2023

3(2+1)

Unit-I

History of plant tissue culture, principle of Totipotency; Tissue culture media; Plant hormones and morphogenesis; Direct and indirect organogenesis; Direct and indirect somatic embryogenesis; Applications of plant tissue culture; National certification and Quality management of TC plants; Genetic Fidelity testing and Virus indexing methods – PCR, ELISA

Unit-II

Micropropagation of field and ornamental crops; Virus elimination by meristem culture, meristemtip culture and micrografting; Androgenesis and gynogenesis - production of androgenic and gynogenic haploids - diploidization; Protoplast culture - isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization - Production of Somatic hybrids and Cybrids;, Wide hybridization - embryo culture and embryo rescue techniques; Ovule, ovary culture and endosperm culture.

Unit-III

Large-scalecell suspension culture - Production of alkaloids and other secondary metabolites- techniques to enhance secondary metabolite production, Somaclonal and gametoclonal variations – causes and applications; Callus culture and *in vitro* screening for stress tolerance; Artificial seeds, *In vitro* germplasm storage and cryo-preservation. Commercial Tissue Culture: Case studies and success stories, Market assessment; project planning and preparation, economics, government policies

Practicals:

Preparation of stocks - macronutrients, micronutrients, vitamins and hormones, filter sterilization of hormones and antibiotics; Preparation of Murashige and Skoog medium; Micro-propagation of plants by nodal and shoot tip culture; Embryo culture to overcome incompatibility, Anther culture for haploid production; Callus induction in tobacco leaf discs, regeneration of shoots, root induction, role of hormones in morphogenesis; Acclimatization of tissue culture plants and establishment in greenhouse; Virus indexing in tissue culture plants. (Using PCR and ELISA); Plan of a commercial tissue culture unit.

Suggested Readings:

- Razdan, M.K. 2003. Introduction to plant tissue culture, 2nd edition, Oxford publications group
- Butenko, R.G. 2000. Plant Cell Culture University Press of Pacific
- Herman, E.B. 2008. Media and Techniques for Growth, Regeneration and Storage, Agritech Publications, New York, USA.
- Bhojwani, S.S and Dantu P. 2013. Plant Tissue Culture – An Introductory Text. Springer Publications.
- Gamborg, O.L and G.C. Philips (eds.). 2013. Plant Cell, Tissue and Organ culture-Lab Manual. Springer Science & Business media.

COURSE OBJECTIVES:

- To provide insight into principles of plant cell culture and genetic transformation.
- To get a hands on training in basic plant tissue culture techniques, callusing, micropropagation and analysis.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION

CO1	Learn different forms of plant tissue culture techniques.
CO2	Learn the insight into principles of plant cell culture and genetic transformations.
CO3	Students will get a hands on training in basic plant tissue culture techniques, callusing, micropropagation and analysis.
CO4	Students will learn the commercial tissue culture: case studies and success stories.

CO-PO-PSO MAPPING:

	PO												**PSO**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	2	2	3	1	1	3	3	2	2	1
CO2	3	1	2	3	2	3	2	2	1	2	3	2	2	2	2
CO3	2	2	1	1	1	1	2	1	2	2	3	3	2	2	2
CO4	3	3	3	3	2	2	2	1	1	1	3	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Technical Writing and Communications Skills
Course Code: PGS502
w.e.f. Session 2018-19

1(1+0)

Practical: Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article. **Communication Skills -** Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings:

- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.
- Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
- Mohan K. 2005. Speaking English Effectively. MacMillan India.
- Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
- Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- Collins' Cobuild English Dictionary. 1995. Harper Collins.
- James HS. 1994. Handbook for Technical Writing. NTC Business Books.
- Gordon HM & Walter JA. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Richard WS. 1969. Technical Writing. Barnes & Noble.

COURSE OBJECTIVES:

- To give knowledge about the various forms of scientific writings
- To give knowledge about the various parts of thesis, research communications
- To give knowledge about writing of abstracts, summaries, citations etc
- To give knowledge about research communications, illustrations, photograph, drawings
- To give knowledge about pagination, scientific write ups, editing and proof reading, and writing of review article

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Learn that what are the various forms of scientific writings
CO2	Learn how to write the various parts of thesis, research communications
CO3	Learn how to do writing of abstracts, summaries and what are citations etc
CO4	Learn research communications, illustrations, photograph, drawings

CO5	Learn pagination, scientific write ups, editing and proof reading, and writing of review article

CO-PO-PSO MAPPING:

	PO												**PSO**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	0	0	2	0	1	1	3	3	2	2	1
CO2	3	3	1	2	0	3	2	0	0	0	3	2	2	2	2
CO3	3	3	1	0	0	1	2	0	0	0	3	3	2	2	2
CO4	3	3	2	3	0	2	2	0	0	0	3	3	2	2	2
CO5	3	3	2	3	0	3	2	1	0	0	3	3	2	2	1
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Agricultural Research, Research Ethics and Rural Development Programmes
Course Code: PGS505 (e-Course)
w.e.f. Session 2018-19

1(0+1)

Unit-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit-II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit-III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:

- Bhalla GS & Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
- Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
- Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ..

COURSE OBJECTIVES:

- To know the objective and principle of extension education
- To obtain idea on various development programmes in agriculture and allied area to help farmers.
- To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students capable, efficient, and self-reliant in character.
CO2	They gain knowledge to help rural families in better appreciation of SWOT in the village.
CO3	They know about to open new opportunities for developing talents and leadership of rural people.

CO4	To provide knowledge and help for better management of farms and increase incomes.
CO5	To promote better social, natural recreational intellectual and spiritual file among the people.

CO-PO-PSO MAPPING:

	PO												**PSO**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1	1	3	3	3	2	3	1	1	1	1	1
CO2	3	3	3	1	1	3	3	3	2	3	3	2	2	2	2
CO3	3	2	1	1	1	2	3	3	2	1	2	1	1	1	2
CO4	3	2	2	2	1	3	3	3	2	2	3	1	2	2	2
CO5	3	1	1	1	1	2	3	3	2	2	3	3	1	1	1
3: Strong contribution, 2: average contribution, 1: Low contribution															