GURU KASHI UNIVERSITY

Master of Science in Agriculture
(Genetics & Plant Breeding) (GPB)
Session: 2025-26
Faculty of Agriculture

Graduate Attributes of the Programme: -

Type of learning outcomes	The Learning Outcomes Descriptors
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specific to disciplinary/interdisciplinary areas of learning	To provide knowledge genetic principles can be applied to improve crop productivity, sustainability and resilience in the scenario of global challenges like and techniques molecular and how to apply these in the development a new variety in agricultural and horticultural crops for their economic value suitable under various agro climatic conditions.and food security.
Generic learning outcomes	To acquire in depth knowledge.with practical skill, preparing student for careers in plant breeding, agricultural research, biotechnology and related fields. Students will largely learn technical techniques for improving varieties and genetic stocks, changing the genetic make-up of plants and developing novel breeding strategies to increase food, feed, oil content and fiber production.

Programme Learning outcomes: A Postgraduate Certificate is awarded to students who have demonstrated the achievement of the outcomes located at level 6.0:

Element of theDescriptor	Programme learning outcomes relating to Undergraduate Certificate
The graduates should be able to demonstrate the acquisition of:	
Knowledge and Understanding	Comprehend the principles and methodologies used in Plant Genetics and Breeding.
General, technical and professional skills required to perform and accomplish tasks	Effective plant breeding requires general skills like communication, teamwork, and problem-solving; technical skills such as hybridization, molecular marker use, data analysis, and field trial management; and professional skills including ethical research practices, project planning, and scientific reporting. These skills ensure successful development of improved, high-yielding, and resilient crop varieties.
Application of knowledge and skills	Plant Genetics and Breeding applies knowledge and skills to improve crop traits, enhance yield, ensure disease resistance, and support sustainable agriculture through scientific innovation.

<table>
<tr><td>Generic learning outcomes</td><td>Generic learning outcomes in Genetics and Breeding include critical thinking, effective communication, teamwork, ethical reasoning, problem-solving, and lifelong learning applicable across scientific and professional contexts.</td></tr>
<tr><td>Constitutional, humanistic, ethical, and moral values</td><td>Genetics and Breeding uphold constitutional, humanistic, ethical, and moral values by promoting responsible research, respecting biodiversity, ensuring food security, and safeguarding the rights of all stakeholders.</td></tr>
<tr><td>Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset</td><td>Employability and entrepreneurship through experiential learning, internships, and interdisciplinary projects. Programs may include exposure to industry standards, case studies of agribusiness success stories, and mentorship by professionals. This approach not only prepares students to meet the expectations of employers but also empowers them to become job creators and innovators in the agricultural sector.</td></tr>
<tr><td>Credit requirements</td><td>
<table>
<tr><th></th><th>Masters' Programme</th></tr>
<tr><td>(i) Course work</td><td></td></tr>
<tr><td>Major courses</td><td>20</td></tr>
<tr><td>Minor courses</td><td>08</td></tr>
<tr><td>Supporting courses</td><td>06</td></tr>
<tr><td>Common courses</td><td>05</td></tr>
<tr><td>Seminar</td><td>01</td></tr>
<tr><td>(ii) Thesis Research</td><td>30</td></tr>
<tr><td>Total</td><td>70</td></tr>
</table>
</td></tr>
<tr><td>Entry requirements.</td><td>A student with a Bachelor Degree subject to fulfillment of the eligibility conditions of a programme as specified by the University, shall be eligible for admission to a 2-year PG Programme.</td></tr>
</table>

Program Structure

SEMESTER- I									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
GPB501	Principles of Genetics	Major	2	0	0	2	30	70	100
GPB502	Principles of Genetics Lab	Major	0	0	2	1	30	70	100
GPB503	Principles of Plant Breeding	Major	2	0	0	2	30	70	100
GPB504	Principles of Plant Breeding Lab	Major	0	0	2	1	30	70	100
GPB505	Principles of Biotechnology	Minor	3	0	0	3	30	70	100
STAT501	Agriculture statistics	Supporting	3	0	0	3	30	70	100
STAT502	Agriculture statistics Lab	Supporting	0	0	2	1	30	70	100
PGC501	Library and Information Services Lab	Common	0	0	2	1	30	70	100
PGC502	Agricultural Research, Research Ethics and Rural Development Programmes	Common	1	0	0	1	30	70	100
GPB500	Master Research	Research	-	-	-	5	50	0	50
Total						**20**	**320**	**630**	**950**

SEMESTER-II									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
GPB551	Nano biotechnology	Major	2	0	0	2	30	70	100
GPB552	Fundamentals of Quantitative Genetics	Major	2	1	1	2	30	70	100
GPB553	Fundamentals of Quantitative Genetics Lab	Major	0	0	2	1	30	70	100
GPB554	Fundamental of Molecular Biology	Minor	3	0	0	3	30	70	100
GPB555	Seminar	Seminar	-	-	-	1	30	70	100
CA551	Fundamentals of Computer Applications Lab	Supporting	-	-	4	2	30	70	100
PGC551	Basic Concepts in Laboratory Techniques Lab	Common	0	0	2	1	30	70	100
GPB500	Master Research	Research	-	-	-	7	50	0	50
Total						**19**	**290**	**560**	**850**

SEMESTER-III									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
GPB600	Molecular Breeding and Bioinformatics	Major	2	0	0	2	30	70	100
GPB601	Molecular Breeding and Bioinformatics Lab	Major	0	0	2	1	30	70	100
GPB602	Breeding for Stress Resistance and Climate Change	Major	2	0	0	2	30	70	100
GPB603	Breeding for Stress Resistance and Climate Change Lab	Major	0	0	2	1	30	70	100
PGC600	Technical writing and communication skills Lab	Common	0	0	2	1	30	70	100
MBB601	Plant Genetic Engineering	Minor	2	0	0	2	30	70	100
GPB500	Master Research	Research	-	-	-	9	200	0	200
Total						**18**	**380**	**420**	**800**

SEMESTER-IV									
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
GPB651	Principles of Cytogenetics	Major	2	0	0	2	30	70	100
GPB652	Principles of Cytogenetics Lab	Major	0	0	2	1	30	70	100
PGC651	Intellectual Property and its Management in Agriculture	Common	1	0	0	1	30	70	100
GPB500	Master Research	Research	-	-	-	9	200	0	200
Total						**13**	**290**	**210**	**500**
Grand Total						**70**			

Semester-I

Course Title: Principles of Genetics

Course Code: GPB 501

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to

1. Acquire basic knowledge about genes, concept of inheritance
2. Mendel's law and Sex determination and extra chromosomal inheritance, mechanism of sex determination in different organisms.
3. Gene families and clusters and Molecular mechanisms of mutation.
4. Understanding the basic concepts of inheritance of genetictraits.
5. Helping students to develop their analytical, quantitative and problem-solvingskills from classical to molecular genetics.

Course Content (Theory)

Unit-I **8 hours**

Beginning of genetics, early concepts of inheritance, Mendel's laws; Discussion onMendel'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 **6 hours**

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

Unit III **8 hours**

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 **8 hours**

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).Genomics and proteomics; metagenomics; Transgenic bacteria and bioethics; Genesilencing; genetics of mitochondria and chloroplasts. Concepts of Eugenics, Epigenetics, Genetic disorders.

Course Title: Principles of Genetics Lab
Course Code: GPB 502

L	T	P	Credits
0	0	2	2

Total Hours-30

Course Content (Theory)

• 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.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring

Suggested readings:

1. Daniel LH and Maryellen R. 2011. Genetics: "Analysis of Genes and Genomes".
2. Gardner EJ and Snustad DP. 1991. Principles of Genetics. John Wiley and Sons. 8th ed. 2006
3. Klug WS and Cummings MR. 2003. Concepts of Genetics. Peterson Edu. Pearson Education
4. India; Tenth edition
5. Lewin B. 2008. Genes XII. Jones and Bartlett Publ. (International Edition) Paperback, 2018
6. Russell PJ. 1998. Genetics. The Benzamin/ Cummings Publ. Co
7. Singh BD. 2009. Genetics. Kalyani Publishers (2nd Revised Edition)
8. Snustad DP and Simmons MJ. 2006. Genetics. 4th Ed. John Wiley and Sons. 6th Edition
9. International Student Version edition
10. Stansfield WD.1991. Genetics.Schaum Outline Series McGraw Hill
11. Strickberger MW. 2005. Genetics (III Ed). Prentice Hall, New Delhi, India; 3rd ed., 2015
12. Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs., McGraw Hill Education; 7edition
13. Uppal S, Yadav R, Singh S and Saharan RP. 2005. Practical Manual on Basic and Applied genetics. Dept. of Genetics, CCS HAU Hisar.

Course Title: Principles of Plant Breeding

Course Code: GPB 503

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to

1. To understand the various components to structure a plant breeding programme.
2. Know the requirements in breeding for biotic and abiotic stress tolerant varieties.
3. Learn the impact of IPRs including PBR, PVP and PPVFRA
4. Students will acquire independent ability to carry out statistical analysis of data and Interpretation of results in breeding programs.
5. To understand the Mendelian inheritance in plants

Course Content(Theory)

Unit I **6 hours**

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 **7 hours**

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 **7 hours**

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 **10 hours**

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.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.

Course Title: Principles of Plant Breeding
Course Code: GPB 504

L	T	P	Credits
0	0	2	2

Total Hours-30

Course Content(Practical)

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

Course Title: Principles of Biotechnology
Course Code: GPB505

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes:

1. The course will also help student careers in plant related research, government regulatory bodies, education, food industry and other plant-based product development and related businesses.
2. Gain an advanced level of understanding in the comprehensive components of plant biotechnology.
3. The content of the course contributes for food security and human health towards sustainable agriculture.
4. To understand the overview of GM crops in the market and pipeline for their various applications like improved food quality and medicine.
5. To understand the various techniques and phenomenon of molecular biotechnology'

Course Content (Theory)

Unit I **10hours**

History, scope and importance of Biotechnology; Specializations in Agricultural Biotechnology: Genomics,Geneticengineering, Tissue Culture, Bio-fuel, Microbial Biotechnology, Food Biotechnology etc. Basics of Biotechnology, Primarymetabolicpathways,Enzymesanditsactivities.

Unit II

10hours

Structure of DNA, RNA and protein, their physical and chemical properties. DNA function: Expression, exchange ofgenetic material, mutation. DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acidhybridization; DNA/RNA libraries; Applications of gene cloning in basic and applied research, Plant transformation: GenetransfermethodsandapplicationsofGMcrops.

Unit III **13hours**

Molecular analysis of nucleic acids -PCR and its application in agriculture and industry, Introduction to Molecularmarkers: RFLP, RAPD, SSR, SNP etc, and their applications; DNA sequencing, different methods; Plant cell and tissue culturetechniques and theirapplications. Introductionto genomics, transcriptomics, ionomics, metabolomics and proteomics.Plantcellandtissueculturetechniquesandtheirapplications.

Unit IV **12hours**

Introduction to Emerging topics: Genome editing, gene silencing, Plant microbial interactions, Success stories inBiotechnology, Careers and employment in biotechnology. Public perception of biotechnology; Bio-safety and bioethics issues;Intellectualpropertyrightsinbiotechnology.

Transaction Mode

Lecture, Seminar, Peer Group Discussion, Self-Learning, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. Watson,J.D.,Baker,T.A.,Bell,S.P.,Gann,A.,Levine,M&LosickR(2014)MolecularBiologyoftheGene,7the

dition,ColdSpringHarborLaboratoryPress,NewYork

2. Brown,T.A.(2010)GeneCloningandDNAanalysisanIntroduction6thedition,WileyBlackwell
3. Primrose,S.B.andTwyman,R.(2006)PrinciplesofgeneManipulation7thedition,WileyBlackwell
4. Singh,B.D,Biotechnology:ExpandingHorizons(2012)4thedition,Kalyanipublisher,NewDelhi,India

Course Title: Agriculture statistics

Course Code: STAT501

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes: On successful completion of this course, the students will be able to:

1 Enumerate statistical principles apply in all the areas of experimental work
2 Recognize the requirement at the national level and farm level for agriculture policy making,
3 Get familiarize with decision making, agriculture development and estimates agriculture and national income
4 Discover the importance of statistics in agriculture, helps to ascertain the volume of crop that needs to be produced based on output and demand of previous year
5 Compile knowledge about land utilization and irrigation including the net area sown gross cultivated area, current follow, cultivable waste

Course Content (Theory)

Unit I **10 hours**

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Hypothesis testing.

Unit II **15 hours**

Concept of p-value.Tests of significance-t, F and chi-square (X^2); Data transformation and missing plot techniques.

Unit III **15 hours**

Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs.

Unit IV **5 hours**

Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Course Title: Agriculture statistics Lab

Course Code: STAT502

L	T	P	Credits
0	0	2	1

Course Content (Practical)

Total 30 hours

- Correlation analysis. Regression analysis (exponential, power function, quadratic, multi-variate, selection of variables, validation of models, ANOVA and testing of hypothesis).
- Tests of significance (Z-test, t-test, F-test and Chi-square test). Analysis of variance.
- Completely randomized design.
- Randomized block and latin square designs.
- Missing plot and analysis of covariance.
- 23, 24 and 33 simple and confounded experiments.
- Split plot designs. Factorial in split plot designs.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring

Suggested readings:

1. *Panse, V.G. and Sukhatme, P.V. 1954. Statistical methods for agricultural workers. Pp. 361.*
2. *Gupta, S.C. and Kapoor, V.K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.pp. 230.*
3. *Snecdecor, G.W. and Cochran, W.G. 1989. Statistical Methods, 8th Edition. Wiley-Blackwell. Pp.524.*
4. *Rangaswamy, R. 2016. Textbook of Agricultural Statistics.New Age International (P) Ltd. New Delhi. pp. 531.*

Course Title: Lab-Library and Information services
Course Code: PGC501

L	T	P	Credits
0	0	2	1

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Identify library services and availability of resources in order to develop a realistic overall plan for research
2. Use general information resources to increase familiarity with the topic and disciplinary vocabulary.
3. Learn about the research topic, question or thesis to achieve a manageable focus appropriate to the assignment criteria, available resources, and evidence needed to support thesis
4. Identify keywords, synonyms and related terms in order to flexibly
5. Effectively search information resources

Course Content

- Introduction to Library and its services; five laws of library science; type of documents;
- Classification and cataloguing; organization of documents;
- Sources of information primary, secondary and tertiary;
- Current awareness and SDI services; tracing information from reference sources;
- Library survey; preparation of bibliography; use of Online Public Access Catalogue;
- Use of CD-ROM databases and other computerized library services, CeRA,
- J-Gate; use of Internet including search engines and its resources; e-resources.

Transaction Mode

- Lecture, Seminar, e-Team Teaching, e-Tutoring

Suggested readings:

1. *Gita, S. 2012. Library and Information Services. LAP Lambert Academic Publishing.USA. pp. 76.*
2. *Kishore, A. 2021. A Conceptual approach to library and information science A complete self study guide.2nd edition. AKB Publication. Jaipur. pp. 250.*

Course Title: AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	**L**	**T**	**P**	**Credits**
Course Code:PGC502	2	0	0	2

Total Hours-30

Learning Outcomes:

On successful completion of this course, the students will able to**:**

1. Identify library services and availability of resources in order to develop a realistic overall plan for research
2. Use general information resources to increase familiarity with the topic and disciplinary vocabulary
3. Learn about the research topic, question or thesis to achieve a manageable focus appropriate to the assignment criteria, available resources, and evidence needed to support thesis
4. Identify keywords, synonyms and related terms in order to flexibly

UNIT I **9 hours**

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 Centres (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.

UNI.II **7 hours**

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

UNIT.III **7 hours**

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

UNIT.IV **7 hours**

Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations.Critical evaluation of rural development policies and programmes.Constraints in implementation of rural policies and programmes.

Transaction Mode

Lecture, Seminar, e-Team Teaching, e-Tutoring, Dialogue, Peer Group Discussion, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

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

Course Title: Master Research

Course Code: GPB500

L	T	P	Credits
-	-	-	5NC

Learning Outcomes: After completion of this course, the learner will be able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of plant pathology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.

Semester II

Course Title: Nanobiotechnology
Course Code: GPB 551

L	T	P	Credits
2	0	0	2

Total Hours-30

Course Contents (Theory)

6hours

UNIT I: Introduction to biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

6hours

UNIT II: Cellular engineering: signal transduction in biological systems, feedback control signalling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

10hours

UNIT III: Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins, DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems,

8hours

UNIT IV: Preparation and characterization of nanoparticles; Nanoparticular carrier systems; Micro- and nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nanoimaging, Metabolic engineering and Gene therapy

Course Title: Fundamentals of Quantitative Genetics
Course Code: GPB 551

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes:

1. The knowledge of this course will enable the student to know breeding methods.
2. To understand the different hybridization techniques for genomic reshuffling.
3. The course will also acquaint the student with importance of floral biology, mutation breeding and participatory plant breeding, etc.
4. To understand various designs for crop experimentation

Course Contents (Theory)

Unit I **8hours**

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 **8hours**

Designs for plant breeding experiments- principles and applications; Variability parameters, concept of selection, simultaneous selection modes and selection of parents, MANOVA.
Association analysis- Genotypic and phenotypic correlation, Path analysis Discriminate function and principal component analysis, Genetic divergence analysisMetroglyph and D2, Generation mean analysis, Parent progeny regression analysis

Unit III **7hours**

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 IV **7hours**

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.

Course Title: Fundamentals of Quantitative Genetics Lab

Course Code: GPB 552

L	T	P	Credits
0	0	2	1

Total Hours-30

Course Contents (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

Transaction Mode

Lecture, Seminar, Peer Group Discussion, Self-Learning, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. Allard RW. 1981. Principles of Plant Breeding. John Wiley & Sons.
2. 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.

3. George A. 2012. Principles of Plant Genetics and Breeding. John Wiley & Sons.

Gupta SK. 2005. Practical Plant Breeding.Agribios.

4. Jain HK and Kharakwal MC. 2004. Plant Breeding and–Mendelian to Molecular

Approach, Narosa Publications, New Delhi

5. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publ. House.
6. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
7. Sharma JP. 2010. Principles of Vegetable Breeding. KalyaniPubl, New Delhi.
8. Simmonds NW.1990. Principles of Crop Improvement. English Language Book Society.
9. Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.

Singh S and Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.

Course Title: Fundamentals of Molecular biology
Course Code: GPB 555

L	T	P	Credits
3	0	0	3

Total Hours-45

Learning Outcomes: After completion of this course, the learner will be able to:

1. To understand the concept of gene, pseudogene, cryptic gene and split gene.
2. DNA replication and regulation in prokaryotes and eukaryotes.
3. Transcription and translation process in prokaryotes and eukaryotes.
4. To study Post translation and transcriptional mechanism and gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon.

Course Contents (Theory)

Unit I **10 hours**

Historical developments of molecular biology, Nucleic acids as genetic material, Chemistry and Nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, Forms of DNA: A,B, Z and their function; Structure and Types of RNA Genome organization in prokaryotes and eukaryotes; DNA Topology; DNA re-association kinetics, Types of repeat sequences.

Unit II **15hours**

Central dogma of Molecular Biology; DNA replication- Classical experiments, Models of DNA replication; DNA replication, Origin and Steps in DNA replication - initiation, elongation and termination; Enzymes and accessory proteins and its mechanisms; Eukaryotic DNA replication in brief. Types of DNA damages and mutations; DNA repair mechanisms, Recombination: Homologous and non-homologous, Genetic consequences.Prokaryotic transcription, initiation, elongation and termination, promoters, Structure and function of eukaryotic RNAs and ribosomal proteins. Eukaryotic transcription – RNA polymerase I, II and III, Elongation and Termination, Eukaryotic promoters and enhancers, Transcription factors, Post transcriptional processing, Splicing: Catalytic RNAs , RNA stability and transport, RNA editing.

Unit. III **10hours**

Genetic code and its characteristics, Universal and modified genetic code and its characteristics, Wobble hypothesis; Translational machinery; Ribosomes in prokaryotes and Eukaryotes. Initiation complex formation, Cap dependent and Cap independent initiation in eukaryotes, Elongation: translocation, transpeptidation and termination of translation; Co- and Post- translational modifications of proteins; Translational control; Protein stability -Protein turnover and degradation.

Unit IV **10hours**

Gene regulation in prokaryotes, Constitutive and Inducible expression, small molecule regulators; Operon concept: lac and trp operons, attenuation, anti-termination, stringent control. Gene regulation in eukaryotes– regulatory RNA and RNA interference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation; Families of DNA binding transcription factors: Helix-turn-helix, helix-loop-helix etc. Epigenetic regulations

Transaction Mode

Lecture, Seminar, Peer Group Discussion, Self-Learning, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. Nelson,D.L.andCox,M.M.(2017)Lehinger'sPrinciplesofBiochemistry,7thedition,WHFreemanPublicationNewYork.
2. Krebs,J.E.,Goldstein,E.S.,Kilpatrick,S.T.,(2017)Lewin'sGenesXII12thedition,Jones&BartlettLearningpublisher,Inc.
3. Watson,J.D.,Baker,T.A.,Bell,S.P.,Gann,A.,Levine,M&LosickR(2014)MolecularBiologyoftheGene,7thedition,ColdSpringHarborLaboratoryPress,NewYork.
4. Alberts,B.,(2017)MolecularBiologyoftheCell5thedition,WWNorton&Co,Inc.

Allison,L.A.2011.FundamentalsofMolecularBiology.(2ndEdition)JohnWileyandSons

Course Title: Credit Seminar
Course Code: GPB556

L	T	P	Credits
-	-	-	1

Learning Outcomes: After completion of this course, the learner will be able to:

1 Show competence in identifying relevant information, defining and explaining topics under discussion
2 Present the classical and innovative work related to plant pathology subject.
3 Reach across diverse disciplines to apply theories, methods and knowledge bases from multiple fields to a single question or problem
4 Judge when to speak and how much to say, speak clearly and audibly in a manner appropriate to the subject
5 To ask appropriate questions, use evidence to support claims, respond to a range of questions

Course Title: Fundamentals of Computer Applications Lab
Course Code: CA551

L	T	P	Credits
0	0	4	2

Total Hours-60

Learning Outcomes: After completion of this course, the learner will be able to:

1. Learn and understand about basics of MS-Word, Excel, preparation of Graphs
2. Read, understand, and interpret material on technology. They will have an appreciation for some of the ideas, issues, and problems involved in writing about technology and in workplace writing.
3. Recognize the operating systems, peripheral devices, networking, multimedia and internet
4. Familiarize with basic sources and methods of research and documentation on topics in technology, including on-line research.
5. Synthesize and integrate material from primary and secondary sources with their own ideas in research papers.

Course Content (Practical)

60 Hours

- Ms-word: creating a document, saving and editing, use of options from tool bars, format, insert and tools(spelling and grammar),
- alignment of text, creating a table, merging cells, column and row width. Ms-excel:
- entering expressions through the formula tool bar and use of inbuilt functions, sum, average, max, min.
- Creating graphs and saving with and without data in Ms-excel.
- Ms-access: creating database, structuring with different types of fields.
- Ms-power point: preparation of slides on power point.
- Internet Browsing: browsing a web page and creating of E-Mail ID. Agri. net (ARIS).

Suggested Readings:

1. *Salaria, R.S. 2017. Computer Fundamentals.Daryaganj, New Delhi. pp. 486.*
2. *Manish, S. and Bhatt, A. 2016. Computers in Agriculture: Fundamentals and Applications. New India Publishing Agency.New Delhi. pp. 190.*

Manjunath, B.E. 2010.Computer Basics.Vasan Publications, Bengaluru, Karnataka. pp. 356.

Course Title: BASIC CONCEPTS IN LABORATORY TECHNIQUES
Course Code:PGC551

L	T	P	Credits
0	0	2	1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

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;
• Neutralisation 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

1. Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions.

Chemical Publ. Co.

Course Title: Master Research
Course Code: GPB500

L	T	P	Credits
-	-	-	7NC

Learning Outcomes: After completion of this course, the learner will be able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of plant pathology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.

Semester III

Course Title: Molecular Breeding and Bioinformatic
Course Code: GPB600

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:

1. Provide deep knowledge to the students on genotyping and kinds of markers including biochemicaland molecular, mapping populations, allele mining.
2. This will also add ways to perform marker-assisted selection and genepyramidingtoevolvesuperiorvarieties.knowledge and awareness of the basic principles and concepts of biology.
3. To understand the computer science and mathematicsexisting software effectively to extract information from large databases and to use this information in computer modeling.

Course Contents (Theory)

Unit I **5hours**

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); Molecularmappingandtaggingofagronomicallyimportanttraits;Statisticaltoolsinmarkeranalysis.

Unit II

5 hours

Allele mining; Marker-assisted selection for qualitative and quantitative traits; QTLs analysis in crop plants; Marker-assistedbackcrossbreedingforrapidintrogression;Genomics-assistedbreeding;GenerationofEDVs;Genepyramiding.

Unit III **8hours**

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 gelelectrophoresis;chromatography&sequencingbyEdmandegradation&massspectrometry; Endopeptidases;Nanotechnologyanditsapplicationsincropimprovement.

Unit IV **12hours**

Recombinant DNA technology, transgenes, method of transformation, selectable markers and clean transformationtechniques, vector-mediated gene transfer, physical methods of gene transfer; Production of transgenic plants in various fieldcrops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc and commercial releases; Biotechnology applications inmale 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 countriesincluding India, ethical, legal and social issues;

Intellectual property rights ; Introduction to bioinformatics: bioinformatics tools,biologicaldatabases(primary&secondary),implicationsincropimprovement.

Course Title: Molecular Breeding and Bioinformatic lab	**L**	**T**	**P**	**Credits**
Course Code: GPB 601	2	0	0	2

Total Hours-30

Course Contents (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.

Transaction Mode

Lecture, Seminar, Peer Group Discussion, Self-Learning, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. LewinB.2017.GenesXII.Jones&Bartlettlearning,2017
2. RobertNTandDennisJG.2010.PlantTissueCulture,Development,andBiotechnology.CRCPress

3. ambrookJ&RusselD.2001.MolecularCloning-aLaboratoryManual.3rdEd.ColdSpringHarborLab.Press.
4. SinghBD.2005.Biotechnology,ExpandingHorizons.KalyaniPubl.
5. WatsonJ.2006.RecombinantDNA.ColdSpringharborlaboratorypress

Course Title: Breeding for Stress Resistance and ClimateChange

Course Code: GPB 602

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes:

1. To gain the knowledge of different types of stresses in plants
2. To understand the mechanism of different stresses in plants
3. To know the different methods of developing the resistant varieties against the biotic and abiotic stresses
4. To understand the process and method of screening the plants for different kinds of stresses in plants

Course Contents (Theory)

Unit I **3 hours**

Concept and impact of climatic change; Importance of plant breeding with special reference to biotic and abiotic stress resistance; Classification of biotic stresses – major pests and diseases of economically important crops.

Unit II **10 hours**

Concepts of resistance to insect and pathogen resistance; Analysis and inheritance of resistance variation; Host defence responses to pathogen invasions- Biochemical and molecular mechanisms; Acquired and induced immunity and systemic acquired resistance (SAR); Host-pathogen interaction, gene-for-gene hypothesis, molecular evidence for its operation and exceptions; Concept of signal transduction and other host-defence mechanisms against viruses and bacteria. Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops; Transgenics in management of biotic and abiotic stresses, use of toxins, protease inhibitors, lectins, chitinases and Bt for diseases and insect pest management.

Unit III **12 hours**

Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants; Quantitative resistance/ adult plant resistance and slow rusting resistance; Classical and molecular breeding methods - Measuring plant resistance using plant fitness; Behavioural, physiological and insect gain studies; Phenotypic screening methods for major pests and diseases; Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence; Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc.; Stress due to soil factors and mineral toxicity; Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.

Unit IV **5 hours**

Genetics of abiotic stress resistance; Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures;

Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum, wheat, cotton, etc.; Breeding for resistance to stresses caused by toxicity, deficiency and pollutants/ contaminants in soil, water and environment.

Course Title: Breeding for Stress Resistance and Climate Change Lab
Course Code: GPB 603

L	T	P	Credits
0	0	2	1

Total Hours-30

Course Contents (Practical)

- Understanding the climatological parameters and predisposal of biotic and abiotic stress factors- ways of combating them for diseases caused by fungi and bacteria;
- Symptoms and data recording; use of MAS procedures;
- Phenotypic screening techniques for sucking pests and chewing pests – Traits to be observed at plant and insect level;
- Phenotypic screening techniques for nematodes and borers; Ways of combating them;
- Evaluating the available populations like RIL, NIL, etc. for pest resistance;
- Use of standard MAS procedures. Breeding strategies - Weeds – ecological, environmental impacts on the crops;
- Breeding for herbicide resistance;
- Screening crops for drought and flood resistance; factors to be considered and breeding strategies;
- Screening varieties of major crops for acidity and alkalinity- their effects and breeding strategies;
- Screening forage crops for resistance to sewage water and tannery effluents; Quality parameters evaluation.

Transaction Mode
Lecture, Seminar, e-Team Teaching, e-Tutoring, Assignments, quiz.

Suggested Readings

1. Blum A. 1988. Plant Breeding for Stress Environments. CRC Press.
2. Christiansen MN and Lewis CF. 1982. Breeding Plants for Less Favourable Environments. Wiley International.
3. Fritz RS and Simms EL. (Eds.). 1992. Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics. The University of Chicago Press.
4. Li PH and Sakai A. 1987. Plant Cold Hardiness. Liss, New York Springer

5. Luginpill P. 1969. Developing Resistant Plants - The Ideal Method of Controlling Insects. USDA, ARS, Washington DC.
6. Maxwell FG and Jennings PR. (Eds.). 1980. Breeding Plants Resistant to Insects. John Wiley & Sons. Wiley-Blackwell.
7. Roberto F. 2018. Plant Breeding for Biotic and Abiotic Stress Tolerance. Springer. Russel GE. 1978. Plant Breeding for Pest and Disease Resistance. Butterworths.
8. Sakai A and Larcher W. 1987. Frost Survival in Plants. Springer-Verlag.
9. Singh BD. 2006. Plant Breeding. Kalyani Publishers, New Delhi.
10. Turener NC and Kramer PJ. 1980. Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.
11. Van der Plank JE. 1982. Host-Pathogen Interactions in Plant Disease. Academic Press.

Course Title: Lab- Technical writing and communication skills

L	T	P	Credits

Course Code: PGC600

0	0	4	2

60 hours

Learning Outcomes: After completion of this course, the learner will be able to:

1. Understand and know how to follow the stages of the writing process (prewriting/writing/rewriting) and
2. Apply them to technical and workplace writing tasks
3. Produce a set of documents related to technology and writing in the workplace and will have improved their ability to write clearly and accurately
4. Understand the basic components of definitions, descriptions, process explanations, and other common forms of technical writing
5. Familiarise with basic technical writing concepts and terms, such as audience analysis, jargon, format, visuals, and presentation

Course Content

Various forms of scientific writings: theses, technical papers, review, 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, precis, citations etc. commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; paginations, numbering of tables and illustrations; writing of numbers and dates in scientific write-ups; editing and proof reading; writing a review article, access methods.

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

1. *Day, R.A. and Gastel, B. 2011. How to Write and Publish a Scientific Paper, 7th Edition.GreenwoodPress,United States. pp. 300.*
2. *Laplante, P.A. 2011. Technical Writing: A Practical Guide for Engineers and Scientists.CRC Press, London. pp. 250.*
3. *Greenlaw,R. 2012. Technical Writing, Presentational Skills and Online Communication: Professional Tools and Insights. Idea Group,U.S. pp. 247.*

Course Title: Plant Genetic Engineering

L	T	P	Credits

Course Code: GPB605

2	0	0	2

Total Hours-30

Learning Outcomes: After completion of this course, the learner will be able to:To learn about transgene and transgenic crops. To understand the process and mechanism of gene cloning and manipulating the gene in plants for produce transgenics. To get a basic overview of molecular cloning, vectors and genomic library construction.To get anoverview of PCR and its applications, sequencing, gene knockouts, transgenics*etc*.

Course Contents (Theory)

Unit I **8hours**

Historical developments of molecular biology, Nucleic acids as genetic material, Chemistry and Nomenclature ofnucleic acids;Structureof DNA:primary structure; secondary structure, Forms of DNA:A,B, Z andtheir function; StructureandTypesofRNAGenomeorganizationinprokaryotesandeukaryotes;DNATopology;DNAre-associationkinetics,Typesofrepeatsequences.

Unit II **10hours**

Central dogma of Molecular Biology; DNA replication- Classical experiments, Models of DNA replication; DNAreplication,OriginandStepsinDNAreplication-initiation,elongationandtermination;Enzymesandaccessoryproteinsandits mechanisms; Eukaryotic DNA replication in brief. Types of DNA damages and mutations; DNA repair mechanisms,Recombination:Homologousandnon-homologous,Geneticconsequences.Prokaryotic transcription, initiation, elongation and termination, promoters, Structure and function of eukaryotic RNAsand ribosomal proteins. Eukaryotic transcription – RNA polymerase I, II and III, Elongation and Termination, Eukaryoticpromoters and enhancers, Transcription factors, Post transcriptional processing, Splicing: Catalytic RNAs , RNA stability andtransport,RNAediting.

Unit III **6hours**

Genetic code and its characteristics, Universal and modified genetic code and its characteristics, Wobble hypothesis;Translational machinery; Ribosomes in prokaryotes and Eukaryotes. Initiation complex formation, Cap dependent and Capindependent initiation in eukaryotes, Elongation: translocation, transpeptidation and termination of translation; Co- and Post-translationalmodificationsofproteins;Translationalcontrol;Proteinstability-Proteinturnoveranddegradation.

Unit IV **8hours**

Gene regulationinprokaryotes, Constitutive andInducible expression,small molecule regulators; Operon concept:lac and trp operons, attenuation, anti-termination, stringent control. Gene regulation in eukaryotes– regulatory RNA and RNAinterference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation; Families of DNA bindingtranscriptionfactors:Helix-turn-helix,helix-loop-helixetc.Epigeneticregulations

Transaction Mode

Lecture, Seminar, Peer Group Discussion, Self-Learning, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. Vasil, I. K. (2008) A short history of plant biotechnology. Phytochem 7: 387-394.
2. Vasil, I. K. (2008) A history of plant biotechnology: from the Cell Theory of Shleiden and Schwann to biotech crops. Plant Cell Rep 27: 1423-1440.

Course Title: Master Research
Course Code: GPB500

L	T	P	Credits
-	-	-	9NC

Learning Outcomes: After completion of this course, the learner will be able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of plant pathology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.

Semester IV

Course Title: Principles of Cytogenetics

Course Code: GPB 651

L	T	P	Credits
2	0	0	2

Total Hours-30

Learning Outcomes:

1. The course will provide full knowledge to the student on the various procedures linked with cell development and chromosome structure and function.
2. This course will also enable student how to tailor and utilize the variation in chromosome number and structures in the development and synthesis of new species and varieties.
3. To understand the different cell cycles and their use in plant breeding

Course Contents (Theory)

Unit I **9 hours**

Cell cycle and architecture of chromosome in prokaryotes and eukaryotes; Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere; artificial chromosome construction and its uses; Special types of chromosomes.Variation in chromosome structure: Evolutionary significance; Introduction to techniques for karyotyping; Chromosome banding and painting -In situ hybridization and various applications.

Unit II **8 hours**

Structural and numerical variations of chromosomes and their implications; Symbols and terminologies for chromosome numbers, euploidy, haploids, diploids and polyploids; Utilization of aneuploids in gene location; Variation in chromosome behaviour, somatic segregation and chimeras, endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal and chromosome complexes; Inter-varietal

chromosome substitutions.

Unit III **8 hours**

Fertilization barriers in crop plants at pre-and postfertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy. Genetic consequences of polyploidization and role of polyploids in crop breeding; Evolutionary advantages of autopolyploid vs allopolyploids; Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer; Alien addition and substitution lines, creation and utilization; Apomixis, evolutionary and genetic problems in crops with apomixes.

Unit IV **5 hours**

Reversion of autopolyploid to diploids; Genome mapping in polyploids; Interspecific hybridization and allopolyploids; Synthesis of new crops (wheat, Triticale, Brassica, and cotton); Hybrids between species with same chromosome number, alien translocations; Hybrids between species with different chromosome number; Gene transfer using amphidiploids, bridge species. Chromosome manipulations in wide hybridization; case studies; Production and use of haploids, dihaploids and doubled haploids in genetics and breeding.

Course Title: Principles of Cytogenetics Lab

Course Code: GPB 652

L	T	P	Credits
0	0	2	1

Total Hours 30

Course Contents (Practical)

- Learning the cytogenetical laboratory techniques, various chemicals to be used for fixation, dehydration, embedding, staining, cleaning, etc.;
- Microscopy: various types of microscopes;
- Preparing specimen for observation;
- Fixative preparation and fixing specimen for light microscopy studies in cereals;
- Studies on mitosis and meiosis in crop plants;
- Using micrometres and studying the pollen grain size in various crops. Pollen germination in vivo and in-vitro;
- Demonstration of polyploidy.

Transaction Mode

e-Team Teaching, e-Tutoring, Lecture, Seminar, Peer Group Discussion, CollaborativeLearning and Cooperative Learning

Suggested Readings

1. Becker K and Hardin J. 2004. World of the Cell. 5th Ed. Pearson Edu. 9th edition.
2. Carroll M. 1989. Organelles. The Guilford Press.
3. Charles B. 1993. Discussions in Cytogenetics. Prentice Hall Publications.
4. Darlington CD and La Cour LF. 1969. The Handling of Chromosomes. George Allen &Unwin Ltd.
5. Elgin SCR. 1995. Chromatin Structure and Gene Expression. IRLPress,Oxford.
6. Gupta PK and Tsuchiya T. 1991. Chromosome Engineering in Plants: Genetics, Breeding and Evolution. Part A.
7. Gupta PK. 2010. Cytogenetics. RastogiPubishers.
8. Johannson DA. 1975. Plant Micro technique. McGraw Hill.
9. Karp G. 1996. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Khush GS. 1973. Cytogenetics of aneuploids. Elsevier. 1 edition.
10. Roy D.2009. Cytogenetics. Alpha Science Intl Ltd.
11. Schulz SJ.1980. Cytogenetics- Plant, animals and Humans. Springer.
12. Sharma AK and Sharma A. 1988. Chromosome Techniques: Theory and Practice. ButterworthHeinemann publisher 2014.3rd edition
13. Singh RJ. 2016. Plant Cytogenetics 3rd Edition. CRC Press.
14. Sumner AT. 1982. Chromosome Banding. Unwin Hyman Publ. 1 edition, Springer pub.
15. Swanson CP. 1960. Cytology and Cytogenetics. Macmillan & Co.

Course Title: Intellectual Property and its Management in Agriculture
Course Code: PGC651

L	T	P	Credits
1	0	0	1

Total Hours-15

Learning Outcomes: After completion of this course, the learner will be able to:

1. Equip students and stakeholders with
2. Distinguish about Intellectual Property Rights (IPR) related protection systems
3. Make use of IPR as a tool for wealth and value creation in a knowledge-based economy.
4. Prioritize about Protection of plant varieties and farmers' rights.
5. Hypothesize NationalBiodiversity protection initiatives.

Course Content

Unit-I **4 hours**

Historical perspectives and need for the introduction of Intellectual Property

Rightregime; TRIPs and various provisions in TRIPS Agreement; Intellectual Propertyand Intellectual Property Rights (IPR), benefits of securing IPRs.

Unit-I **4 hours**

Indian Legislationsfor the protection of various types of Intellectual Properties; Fundamentals ofpatents, copyrights, geographical indications, designs and layout, trade secrets andtraditional knowledge, trademarks.

Unit-I **3 hours**

Protection of plant varieties and farmers' rightsand biodiversity protection; Protectable subject matters, protection in biotechnology,protection of other biological materials, ownership and period of protection.

Unit-I **4 hours**

NationalBiodiversity protection initiatives; Convention on Biological Diversity; InternationalTreaty on Plant Genetic Resources for Food and Agriculture; Licensing oftechnologies, Material transfer agreements, Research collaboration Agreement,License Agreement.

Transaction Mode

Lecture, Mobile Teaching, Self-Learning, Collaborative Learning and Cooperative Learning

Suggested readings:

1. *Erbisch FH and Maredia K.1998.Intellectual Property Rights in AgriculturalBiotechnology.CABI.*

2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy.McGraw-Hill.

3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC andAesthetic Technologies

Course Title: Master Research
Course Code: GPB500

L	T	P	Credits
-	-	-	9NC

Learning Outcomes: On successful completion of this course, the students

will be able to:

1 Conduct an investigation and solve scientific problems using a range of methods, and apply appropriate and/or theoretical techniques
2 Negotiate, plan, design and execute a research-based project,
3 Analyse data and provide a written report or thesis on the methodology and outcomes in an appropriate format
4 Learn the methodology of planning, layout, data recording, analysis, interpretation and report writing of plant pathology experiments
5 Familiarize with indexing databases, citation databases: web of science, scopus, etc.