Semester IV

Course 12: Cell Biology and Genetics

Credits -3

I. Learning Objectives: By the end of this course the learner has:

1. To look into the ultra-structure of plant cell and its organelle
2. To know the morphology and functions of chromosomes
3. To understand the principles of genetics, structure and functions of gene

II. Learning Outcomes: On completion of this course students will be able to:

1. Sketch the ultra-structural aspects of plant cell and its components.
2. Hypothesise the role of chromosomes in inheritance.
3. Justify the role of genes in inheritance of characters by descent.
4. Correlate the functions of the nucleic acid with their structure.
5. Explain the discoveries led to understand the fine structure of a gene.

III. Syllabus of Theory:

Unit-1: Cell and its organelle **8 Hrs.**

1. Cell theory; prokaryotic vs eukaryotic cell; animal vs plant cell; a brief account on ultra-structure of a plant cell.
2. Ultra-structure of cell wall.
3. Ultra-structure of plasma membrane and various theories on its organization.
4. Polymorphic cell organelles (Plastids); ultra structure of chloroplast, plastid DNA.
5. Ultrastructure of mitochondria, mitochondrial DNA.

Unit-2: Chromosomes **8 Hrs.**

1. Prokaryotic vs eukaryotic chromosome; morphology of a eukaryotic chromosome.
2. Euchromatin and Heterochromatin; Karyotype and ideogram.
3. Brief account of chromosomal aberrations - structural and numerical changes
4. Organization of DNA in a chromosome (nucleosome and solenoid models).

Unit-3: Mendelian and non-Mendelian Genetics 10 Hrs.

1. Mendel's laws of inheritance. Incomplete dominance and co-dominance; Multiple allelism.
2. Complementary, supplementary and duplicate gene interactions (plant-based examples are to be dealt).
3. A brief account of linkage and crossing over; Chromosomal mapping - 2 point and 3 point test cross.
4. Concept of maternal inheritance (Corren's experiment on *Mirabilis jalapa*).

Unit-4: Structure and function of DNA 10 Hrs.

1. Watson and Crick model of DNA. Brief account on DNA Replication (Semiconservative method).
2. Brief account on transcription, types and functions of RNA.
3. Genetic code and a brief account of translation.
4. Regulation of gene expression in prokaryotes - Lac Operon.

Unit-5: Gene concept and Sex determination 9 Hrs.

1. Evolution of gene concept: classical vs molecular concepts of gene.
2. Cis–Trans complementation test for functional allelism, gene as unit of function, mutation and recombination.
3. Pattern of sex determination in plants.
4. Allele and genotype frequencies, Hardy-Weinberg law.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi
2. Ghosh, A.K., K.Bhattacharya&G. Hait (2011) A Text Book of Botany, Volume-III, New Central Book Agency Pvt. Ltd., Kolkata
3. A.V.S.S. Sambamurty (2007) Molecular Genetics,Narosa Publishing House,New Delhi
4. S. C. Rastogi (2008) Cell Biology,New Age International (P) Ltd. Publishers, New Delhi

V. Reference Books:

1. P. K. Gupta (2002) Cell and Molecular biology, Rastogi Publications, New Delhi
2. B. D. Singh (2008) Genetics,Kalyani Publishers, Ludhiana
3. Cooper, G.M. & R.E. Hausman (2009) The Cell – A Molecular Approach, A.S.M. Press, Washington
4. Becker, W.M., L.J. Kleinsmith& J. Hardin (2007) The World of Cell, Pearson, Education, Inc., New York
5. De Robertis, E.D.P. & E.M.F. De Robertis Jr. (2002) Cell and Molecular Biology, Lippincott Williams & Wilkins Publ., Philadelphia
6. Robert H. Tamarin (2002) Principles of Genetics, Tata McGraw –Hill Publishing Company Limited, New Delhi.
7. Gardner, E.J., M. J. Simmons & D.P. Snustad (2004) Principles of Genetics, John Wiley & Sons Inc., New York
8. Micklos, D.A., G.A. Freyer & D.A. Cotty (2005) DNA Science: A First Course, I.K.International Pvt. Ltd., New Delhi

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Group discussion on different types of cells and their components.

Evaluation method: Identifying the best group or performer and giving a reward.

Unit-2: Activity: Observation of chromosomal aberrations in *Allium cepa* root cells exposed to industrial effluent/ heavy metals

Evaluation method: Validation of report and assigning a grade based on a rubric.

Unit-3: Activity: Solving the problems on classical genetics.

Evaluation method: Assessing the accuracy in solving the problems and awarding a grade.

Unit-4: Activity: Making models of nucleic acids.

Evaluation method: Selecting the best and assigning a grade.

Unit-5: Activity: Making a comprehensive report on sex determination in plants by collecting scientific literature.

Evaluation method: Validation of report and assigning a grade based on a specified point scale.

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Semester IV

Course 12: Cell Biology and Genetics

Credits -1

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify the stages of mitotic and meiotic cell divisions.
2. Infer the structure and functions of nucleic acids.
3. Predict the consequences of a particular genetic condition.

II. Laboratory/field exercises:

1. Study of ultra structure of plant cell and its organelles using electron microscopic photographs /models.
2. Demonstration of mitosis in *Allium cepa/Aloe vera* roots using squash technique.
3. Observation of various stages of mitosis in permanent slides.
4. Demonstration of meiosis in P.M.C.s of *Allium cepa* flower buds using squash technique.
5. Observation of various stages of meiosis in permanent slides.
6. Study of structure of DNA and RNA molecules using models.
7. Solving problems on monohybrid, dihybrid, back and test crosses.
8. Solving problems on gene interactions (at least one problem for each of the gene interactions in the syllabus).
9. Chromosomes mapping using problems of 3- point test cross data.

Semester IV

Course13: Plant Physiology and Metabolism

Credits -3

I. Learning Objectives: By the end of this course the learner has:

1. To understand the concept of Soil-Plant-Atmosphere continuum based on plant-water relations.
2. To study the anabolic and catabolic processes in plants.
3. To understand the role of plant growth regulators on growth, development and flowering.

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

1. Comprehend the importance of water in plant life and mechanisms for transport of water and solutes in plants.
2. Explain the role of minerals in plant nutrition and their deficiency symptoms.
3. Interpret the role of enzymes in plant metabolism.
4. Hypothesise the light reactions and carbon assimilation processes responsible for synthesis of food in plants.
5. Analyze the biochemical reactions in relation to Nitrogen and lipid metabolisms.
6. Evaluate the physiological factors that regulate growth, development and flowering in plants.

III. Syllabus of Theory:

Unit – 1: Plant-Water relations **8 Hrs.**

1. Importance of water to plant life, physical properties of water, diffusion, imbibition, osmosis. water potential, osmotic potential, pressure potential.
2. Absorption and lateral transport of water; Ascent of sap
3. Transpiration: stomata structure and mechanism of stomatal movements (K^+ ion flux).
4. Mechanism of phloem transport; source-sink relationships.

Unit – 2: Mineral nutrition, Enzymes and Respiration 10 Hrs.

1. Essential macro and micro mineral nutrients and their role in plants; symptoms of mineral deficiency
2. Absorption of mineral ions; passive and active processes.
3. Characteristics, nomenclature and classification of Enzymes. Mechanism of enzyme action, enzyme kinetics.
4. Respiration: Aerobic and Anaerobic; Glycolysis, Krebs cycle; electron transport system, mechanism of oxidative phosphorylation, Pentose Phosphate Pathway (HMP shunt).

Unit – 3: Photosynthesis and Photorespiration 10 Hrs.

1. Photosynthesis: Photosynthetic pigments, absorption and action spectra; Red drop and Emerson enhancement effect
2. Concept of two photosystems; mechanism of photosynthetic electron transport and evolution of oxygen; photophosphorylation
3. Carbon assimilation pathways (C3, C4 and CAM).
4. Photorespiration - C2 pathway

Unit – 4: Nitrogen and lipid metabolism 9 Hrs.

1. Nitrogen metabolism: Biological nitrogen fixation – asymbiotic and symbiotic nitrogen fixing organisms. Nitrogenase enzyme system.
2. Lipid metabolism: Classification of Plant lipids, saturated and unsaturated fatty acids.
3. Anabolism of triglycerides, β-oxidation of fatty acids, Glyoxylate cycle.

Unit – 5: Plant growth - development 8Hrs.

1. Growth and Development: Definition, phases and kinetics of growth.
2. Physiological effects of Plant Growth Regulators (PGRs) - auxins, gibberellins, cytokinins, ABA, ethylene and brassinosteroids.
3. Physiology of flowering:Photoperiodism, role of phytochrome in flowering.
4. Seed germination and senescence; physiological changes during seed germination.

IV. Text Books:

1. Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi
2. Ghosh, A. K., K. Bhattacharya &G. Hait (2011) A Text Book of Botany, VolumeIII, New Central Book Agency Pvt. Ltd., Kolkata

V. Reference Books:

1. Aravind Kumar & S.S. Purohit (1998) Plant Physiology – Fundamentals and Applications, Agro Botanica, Bikaner
2. Datta, S.C. (2007) Plant Physiology, New Age International (P) Ltd., Publishers,New Delhi
3. Hans Mohr & P. Schopfer (2006) Plant Physiology, Springer (India) Pvt. Ltd.,New Delhi
4. Hans-Walter heldt (2005) Plant Biochemistry,Academic Press, U.S.A.
5. Hopkins, W.G. & N.P.A. Huner (2014) Introduction to Plant Physiology, Wiley India Pvt. Ltd., New Delhi
6. Noggle Ray & J. Fritz (2013) Introductory Plant Physiology, Prentice Hall (India),New Delhi
7. Pandey, S.M. &B.K.Sinha (2006)Plant Physiology, Vikas Publishing House, New Delhi
8. Salisbury, Frank B. & Cleon W. Ross (2007) Plant Physiology, Thomsen & Wadsworth, Austalia&U.S.A
9. Sinha, R.K. (2014) Modern Plant Physiology, Narosa Publishing House,New Delhi
10. Taiz, L.&E. Zeiger (2003) Plant Physiology, Panima Publishers, New Delhi.
11. Verma, V. (2007) Text Book of Plant Physiology,Ane Books India, New Delhi.

VI. Suggested activities and evaluation method

Unit-1: Activity: Observe and tabulate the water content of different plant parts and justify the importance of the water based on the morphological nature.

Evaluation method: Assess the report and assign the grade points based on a rubric.

Unit-2 Activity: Survey report on various inorganic and organic fertilizers available in the local markets.

Evaluation method: Assess the record and award the grades on a specified point scale.

Unit-3 Activity: Identify the C4 plants from their locality and make a report.

Evaluation method: Assessing the clarity, organization, and effectiveness of the report's presentation and communication based on a rubric**.**

Unit-4 Activity: Group discussion on various Nitrogen fixing microbes.

Evaluation method: Assessing the group members' ability to think critically and analyze the topic being discussed.

Unit-5 Activity: A critical assignment on photoperiodic responses in plants in their locality.

Evaluation method: Evaluating the logical coherence and reasoning in the assignment.

V Semester

Course 13: Plant Physiology and Metabolism

Credits -1

I. Course outcomes: On successful completion of this practical course, students shall be able to:

1. Conduct lab and field experiments pertaining to plant physiology.
2. Estimate the quantities and qualitative expressions using experimental results and calculations
3. Interpret the factors responsible for growth and development in plants.

II. Laboratory/field exercises:

1. Determination of osmotic potential of plant cell sap by plasmolytic method using *Rhoeo*/ *Tradescantia* leaves.
3. Calculation of stomatal index and stomatal frequency of a mesophyte, a hydrophyte and a xerophyte.
3. Determination of rate of transpiration using Cobalt chloride method / Ganong's potometer (at least for a dicot and a monocot).
4. Effect of temperature on membrane permeability by colorimetric method.
5. Study of mineral deficiency symptoms using plant material/photographs.
6. Demonstration of amylase enzyme activity and study the effect of substrate and Enzyme concentration.
7. Separation of chloroplast pigments using paper chromatography technique.
8. Demonstration of Polyphenol oxidase enzyme activity (Potato tuber or Apple fruit)
9. Anatomy of C3, C4 and CAM leaves.
10. Estimation of protein by biuret method/Lowry method.
11. Minor experiments – Osmosis, Arc-auxonometer, ascent of sap through xylem, cytoplasmic streaming

V Semester

Course 14 A: Organic Farming

Credits -3

I. I. Learning Objectives: By the end of this course the learner has:

1. To know the beneficial aspects of organic farming against chemical farming.
2. To gain knowledge about soil fertility, organic pest and disease management strategies.
3. To understand the organic certification process, including the standards and regulations that govern organic farming practices.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Compare and contrast the advantages and disadvantages of conventional and organic farming.
2. Acquire skills on different composting methods.
3. Acquaint with cultural and crop protection practices related to organic farming.
4. Acquire knowledge on various management practices in organic farming.
5. Discuss about the certification and marketing of organic foods.
6. Explain the initiatives of government in promoting organic farming

III. Syllabus of Theory:

UNIT-1: Basic concepts of organic farming 8 Hrs.

1. Organic farming: Definition, ecological social and economic benefits.
2. Organic farming and its components; concepts and principles.
3. Biodynamic and natural farming approaches; permaculture and LEISA farming approaches.
4. Sustainable agriculture, key indicators of sustainable agriculture.
5. Living soil and healthy plant concepts.

UNIT-2: Organic inputs for soil 8 Hrs.

1. Vermicompost production technology.
2. Organic manures: Farmyard Manure (FYM), enrichment of FYM.
3. Compost, methods of composting (Bangalore, Indore, Coimbatore, NADEP methods).
4. Green manuring, classification of green manures.
5. Classification of organic residues; recycling of organic residues.

UNIT-3: Organic crop management **10 Hrs.**

1. Introduction to organic crop management – land preparation, planting technic, nutrient management.
2. Factors considered for nutrient management; recommended nutrient quantity –blanket, major problems; balance sheet method.
3. Nutrient composition of some organic resources, right timing of nutrient application.
4. Right method of nutrient application, nutrient use efficiency.

UNIT-4: Cultural and crop protection practices **10 Hrs.**

1. Pre-sowing irrigation; crop rotation, intercropping and mixed cropping.
2. Use of tolerant and resistant varieties; manipulation in sowing dates, irrigation/flooding, destruction of volunteer plants.
3. Pest and disease management – preventive, physical and mechanical methods.
4. Organic crop management – rice, red gram, groundnut, and tomato.
5. Government interventions to promote organic farming: NPOF, NPMSHF, NHM, RKVY, KVK and APEDA.

UNIT-5: Certification and Marketing of Organics **9 Hrs.**

1. Organic certification process – definition, need, aim and scope, requirements to maintain certification.
2. Organic certification process – labelling of products, NPOP, organic quality control, standards,
   accreditation, inspection, and certification.
3. Operational structure of organic certification.
4. Marketing of organic products.

IV. Text Books:

1. Vandana Shiva, Poonam Pande and Jitendra Singh, (2004). Principles of Organic Farming - Renewing the Earth's Harvest, Navdanya, New Delhi.
2. Sujit Chakrabarty, Sumati Narayan, Farooq Ahmad Khan, (2019). Arts and Science of Organic Farming, Purna Organics
3. Thapa, U., and P. Tripathi, (2016). Organic Farming in India, Agrotech Publications, Udaipur
4. Peter, V. Fossel, (2007). Organic Farming (Everything You Need to Know), Voyageur Press, USA

V. Reference Books:

1. Richard Wiswall (2009), The Organic Farmer's Business Handbook Chelsea Green Publishing, White River Junction, VT, USA.
2. William Lockeretz (2007), Organic Farming: An International History CABI Publishing, Wallingford, UK.
3. Ann Larkin Hansen (2010), The Organic Farmer's Manual: A Comprehensive Guide to Starting and Running a Certified Organic Farm Storey Publishing, North Adams, MA, USA. Masanobu Fukuoka (1978), The One-Straw Revolution: An Introduction to Natural Farming Rodale Press, Emmaus, PA, USA.
4. Gary Zimmer (2000), The Biological Farmer: A Complete Guide to the Sustainable & Profitable Biological System of Farming Acres U.S.A., Austin, TX, USA
5. Albert Howard (1947), The Soil and Health: A Study of Organic Agriculture University Press of Kentucky, Lexington, KY, USA.
6. Terri Paajanen (2014), The Complete Guide to Organic Livestock Farming Atlantic Publishing Group, Inc., Ocala, FL, USA.

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Group discussion on advantages and disadvantages of organic and in-inorganic farming methods.

Evaluation method: Analyzing the quality and depth of the content discussed, identifying key ideas, arguments, and supporting evidences.

Unit-2: Activity: Internship on preparation of composts and other organic inputs.

Evaluation method: Performance evaluations, team feedback and competition results.

Unit-3: Activity: Case study report on management practices in organic farming.

Evaluation method: Evaluating the clarity, coherence, and logical structure of the case study report.

Unit-4: Activity: Critical written assignment on support from government agencies to promote organic farming.

Evaluation method: Evaluating the application of critical thinking skills, such as analysis, evaluation, and interpretation of information or ideas presented in the assignment.

Unit-5: Activity: A survey report on marketing of organic food products.

Evaluation method: Evaluating the appropriateness and effectiveness of the survey design, including the clarity of questions, survey structure, and response options.

V Semester

Course 14 A: Organic Farming

Credits -1

I. Course outcomes: On successful completion of this practical course, students shall be able to:

1. Prepare different organic formulations for organic farming.
2. Design a vermicompost unit and prepare the compost.
3. Identify various manures for organic farming.

II. Laboratory/field exercises:

1. Preparation of Jeevamrutham (liquid and solid) and Beejamrutham.
2. Preparation of Neemastram and Brahmastram.
3. Preparation of Agniastram and Dashaparni Kashayam.
4. Study of intercropping method.
5. Study of water management in Organic Farming.
6. Study of livestock component in Organic Farming.
7. Hands on training on vermicompost preparation.
8. Study of different organic and green manures.

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V Semester

Course 14 B: Seed Technology

Credits -3

I. Learning Objectives: By the end of this course the learner has:

1. To understand the factors responsible for seed dormancy and procedures for break-down.
2. To learn the aspects of seed processing and storage.
3. To acquaint with various practices in seed testing and diagnosis of seed borne diseases.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Explain the causes for seed dormancy and methods to break dormancy.
2. Understand critical concepts of seed processing and seed storage procedures.
3. Acquire skills related to various seed testing methods.
4. Identify seed borne pathogens and prescribe methods to control them.
5. Understand the legislations on seed production and procedure of seed certification.

III. Syllabus of Theory:

Unit - 1: Seed dormancy **8 Hrs.**

1. Seed and grain: Definitions, importance of seed; structure of Dicot and Monocot seed.
2. Role and goals of seed technology; characteristics of quality seed material.
3. Dormancy: Definition, causes for seed dormancy; methods to break seed dormancy.

Unit – 2: Seed processing and storage **10 Hrs.**

1. Principles of seed processing: seed pre-cleaning, precuring, drying, seed extraction; cleaning, grading, pre-storage treatments; bagging and labelling, safety precautions during processing.
2. Seed storage; orthodox and recalcitrant seeds, natural longevity of seeds.
3. Factors affecting longevity in storage; storage conditions, methods and containers.

Unit – 3: Seed testing **10 Hrs.**

1. Definition of seed vigour, viability and longevity; seed sampling and equipment; physical purity analysis.
2. Seed moisture – importance – methods of moisture determination.
3. Seed germination tests using paper, sand or soil – standard germination test; TZ test to determine seed viability; seed health testing.

Unit – 4: Seed borne diseases **10 Hrs.**

1. A brief account of different seed borne diseases and their transmission.
2. Different seed health testing methods for detecting microorganisms.
3. Management of seed borne diseases; seed treatment methods: spraying and dusting.

Unit – 5: Seed certification **7 Hrs.**

1. Objectives - Indian seed Act; seed rules and seed order; new seed policy (1988).
2. Seed Inspector: Duties and responsibilities; classes of seeds, phases of certification standards (i.e., Land requirement, isolation distance) etc.
2. Issue of certificates, tags and sealing; pre and post control check: Genetic purity verification, certification, records and reporting.

IV. Text Books:

1. Sharma G. K. (2012) Seed Science and Technology, Daya Publishing House, New Delhi, India
2. Reddy, M. V. and K. V. Krishna Reddy (2009) Seed Science and Technology: A Comprehensive Manual, BS Publications, Hyderabad, India
3. Lawrence O. Copeland and Miller B. McDonald (2014) Principles of Seed Science and Technology, Springer, New York, USA
4. Agrawal, (2005) Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi

V. Reference Books:

1. Umarani R, Jerlin R, Natarajan N, Masilamani P, Ponnuswamy AS (2006) Experimental Seed Science and Technology, Agrobios, Jodhpur
2. Desai B D 2004. Seeds Hand Book: Processing and Storage, CRC Press
3. Agarwal V K and J B Sinclair 1996, Principles of Seed Pathology, CRC Press
4. Tunwar NS and Singh SN. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.
5. McDonald, M.B. and L.O. Copland. 1999. Seed Science and Technology Laboratory Manual, Scientific Publishers, Jodhpur
6. Jagdish Lal and R. C. Saxena (2011) Seed Technology and Seed Pathology, Agrobios (India), Jodhpur, India

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collection of scientific literature and writing a report on causes for seed dormancy and methods to break down.

Evaluation method: Assessing the overall structure and organization of the report based a pre-determined rubric.

Unit-2: Activity: A critical assignment on factors affecting seeds under storage conditions.

Evaluation method: Assessing the depth of analysis and the originality of ideas presented in the assignment.

Unit-3: Activity: Laboratory experimentation and report preparation on seed germination and viability in some plant species.

Evaluation method: Presentation of report with results, including clear and concise summaries, appropriate visuals (tables, graphs), and effective communication of key findings.

Unit-4: Activity: Collection of diseased seeds, identification of pathogens and presenting a report.

Evaluation method: Judging the appropriateness and effectiveness of the experimental design, selection of variables, and control of confounding factors.

Unit-5: Activity: Group discussion on seed certification process.

Evaluation method: Judging the quality and depth of the content discussed, identifying key ideas, arguments, and supporting evidence.

V Semester

Course 14 B: Seed Technology

Credits -1

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Break the seed dormancy using various techniques.
2. Determine seed moisture, seed germination percentage, seed viability and vigour.
3. Identify the seed borne pathogens and prescribe methods to prevent or control them.

II. Laboratory/field exercises:

1. Determination of physical properties of seeds of 3 select local crops (1each from cereals, millets, pulses and oil seeds).
2. Breaking seed dormancy in 3 select local crops.
3. Measurement of seed moisture content by O S W A or moisture meter or oven drying method.
4. Seed germination tests and evaluation.
5. Seed vigour - conductivity test.
6. Accelerated ageing tests.
7. Tetrazolium test.
8. Priming and invigoration treatments for improving germination and vigour.

V Semester

Course 15 A: Mushroom Culture Technology

Credits -3

I. Learning Objectives: By the end of this course the learner has:

1. To learn about the morphology and nutritional value of some edible mushrooms.
2. To gain knowledge on basic requirements for establishing a mushroom culture unit.
3. To learn the cultivation methods and management practices specific to certain edible mushrooms.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Understand the structure and life of a mushroom and discriminate edible and poisonous mushrooms.
2. Identify the basic infrastructure to establish a mushroom culture unit.
3. Demonstrate skills preparation of compost and spawn.
4. Acquire a critical knowledge on cultivation of some edible mushrooms.
5. Explain the methods of storage, preparation of value-added products and marketing.

III. Syllabus of Theory:

Unit – 1: Introduction and value of mushrooms 8 Hrs.

1. Mushrooms: Definition, structure of a mushroom and a brief account of life cycle; historical account and scope of mushroom cultivation; difference between edible and poisonous mushrooms.
3. Morphological features of edible mushrooms - Button mushroom (*Agaricus bisporus*), Milky mushroom (*Calocybe indica*), Oyster mushroom (*Pleurotus sajor-caju*) and Paddy straw mushroom (*Volvariella volvacea*).
4. Nutraceutical value of mushrooms; medicinal mushrooms in South India (*Ganoderma lucidum, Phellinus rimosus, Pleurotus florida and Pleurotus pulmonaris*) and their therapeutic value; Poisonous mushrooms - harmful effects.

Unit – 2: Basic requirements of cultivation system **9 Hrs.**

1. Small village unit and larger commercial unit; layout of a mushroom farm - location of building plot, design of farm, bulk chamber, composting, equipment and facilities, pasteurization room and growing rooms.
2. Compost and composting: Definition, machinery required for compost making, materials for compost preparation.
3. Methods of composting- long method of composting and short method of composting.

Unit – 3: Spawning and casing **10 Hrs.**

1. Spawn and spawning: Definition, facilities required for spawn preparation; preparation of spawn substrate.
2. Preparation of pure culture, media used in raising pure culture; culture maintenance, storage of spawn.
3. Casing: Definition, Importance of casing mixture, Quality parameters of casing soil, different types of casing mixtures, commonly used materials.

Unit – 4: Mushroom cultivation **10 Hrs.**

Raw material, compost, spawning, casing, cropping, and problems in cultivation (diseases, pests and nematodes, weed molds and their management strategies), picking and packing of the following mushrooms:

(a) Button mushroom (b) Oyster mushroom (c) Milky mushroom and (d) Paddy straw mushroom

Unit – 5: Post harvest technology **8 Hrs.**

1. Shelf life of mushrooms; preservation of mushrooms - freezing, dry freezing, drying and canning.
2. Quality assurance and entrepreneurship - economics of different types of mushrooms; value added products of mushrooms.
3. Management of spent substrates and waste disposal of various mushrooms.

IV. Text Books:

1. Tavis Lynch (2020) Mushroom Cultivation: An Illustrated Guide to Growing Your Own Mushrooms at Home, Rockridge Press, Emeryville, California, USA
2. Chang, P. and C. P. Bhatnagar (2003) Mushrooms: Cultivation, Nutritional Value, Medicinal Effect, and Environmental Impact, CRC Press, Boca Raton, Florida, USA
3. Tripathi, D.P. (2005) Mushroom Cultivation, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
4. Pathak, V. N. and Yadav, N. (1998). Mushroom Production and Processing Technology. Agrobios, Jodhpur.

V. Reference Books:

1. Tewari Pankaj Kapoor, S. C. (1988). Mushroom Cultivation. Mittal Publication, New Delhi.
2. Pandey R.K, S. K Ghosh, (1996). A Hand Book on Mushroom Cultivation. Emkey Publications
3. Nita Bhal. (2000). Handbook on Mushrooms (Vol. I and II). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
4. Pathak V.N., Nagendra Yadav and Maneesha Gaur (2000), Mushroom Production and Processing Technology Vedams Ebooks Pvt. Ltd., New Delhi
5. Rattan, S.S. and R.C. Upadhyay (2006) Mushroom Production Technology: Recent Advances, Daya Publishing House, Delhi, India

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Collection of data on various types of mushrooms and making a report.

Evaluation method: Judging the written report, providing feedback on the overall quality, strengths, and areas for improvement.

Unit-2: Activity: Group discussion of mushroom cultivation units and layout.

Evaluation method: Members of the group provide evaluations of their peers' contributions and participation.

Unit-3: Activity: Internship on spawning and casing in mushroom culture.

Evaluation method: A viva-voce at the end of internship based on specific performance metrics and knowledge gained.

Unit-4: Activity: Case study on production techniques for different edible mushrooms.

Evaluation method: Clarity, coherence, and logical structure of the case study report based on identification of key issues, analysis, and synthesis of information.

Unit-5: Activity: A survey report on market demand and consumer preferences for mushrooms and their value-added products.

Evaluation method: Assessing the quality of data analysis, including the use of appropriate statistical techniques, interpretation of results, and meaningful conclusions.

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V Semester

Course 15 A: Mushroom Culture Technology

Credits -1

I. Course Outcomes: On successful completion of this practical course, student shall be able to:

1. Identify and discriminate different mushrooms based on morphology.
2. Understand facilities required for mushroom cultivation.
3. Demonstrate skills on preparation of spawn, compost and casing material.
4. Exhibit skills on various cultivation practices for an edible mushroom.

II. Laboratory/field exercises:

1. Identification of different types of mushrooms.
2. Preparation of pure culture of an edible mushroom.
3. Preparation of mother spawn.
4. Production of planting spawn and storage.
5. Preparation of compost and casing mixture.
6. Demonstration of spawning and casing.
7. Hands on experience on cropping and harvesting.
8. Demonstration of storage methods.
9. Preparation of value-added products.

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V Semester

Course 15 B: Plant Propagation Techniques

Credits -3

I. Learning Objectives: By the end of this course the learner has:

1. To gain knowledge on asexual propagation methods in plants.
2. To understand the principles pertaining to various vegetative propagation methods.
3. To know the specific propagation method that is applied to a particular species.

II. Learning Outcomes: Students at the successful completion of the course will be able to:

1. Explain various plant propagation structures and their utilization.
2. Understand advantages and disadvantages of vegetative, asexual and sexual plant propagation methods.
3. Assess the benefits of asexual propagation of certain economically valuable plants using apomictics and adventive polyembryony.
4. Demonstrate skills related to vegetative plant propagation techniques such as cuttings, layering,
   grafting and budding.
5. Apply a specific macro-propagation technique for a given plant species.

III. Syllabus of Thoey:

Unit – 1: Basic concepts of propagation **8 Hrs.**

1. Propagation: Definition, need and potentialities for plant multiplication; asexual and sexual methods of propagation - advantages and disadvantages.
   3. Propagation facilities: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery - tools and implements.
   4. Identification and propagation by division and separation: Bulbs, pseudobulbs, corms, tubers and rhizomes; runners, stolons, suckers and offsets.

Unit – 2: Apomictics in plant propagation **8 Hrs.**

1. Apomixis: Definition, facultative and obligate; types – recurrent, non-recurrent, adventitious and vegetative; advantages and disadvantages.
2. Polyembryony: Definition, classification, horticultural significance; chimera and bud sport.
3. Propagation of mango, *Citrus* and *Allium* using apomictic embryos.

Unit – 3: Propagation by cuttings **10 Hrs.**

1. Cuttings: Definition, different methods of cuttings; root and leaf cuttings.
2. Stem cuttings: Definition of stem tip and section cuttings; plant propagation by herbaceous, soft wood, semi hard wood, hard wood and coniferous stem cuttings.
4. Physiological and bio chemical basis of rooting; factors influencing rooting of cuttings; use of plant growth regulators in rooting of cuttings.

Unit – 4: Propagation by layering **10 Hrs.**

1. Layering: Definition, principle and factors influencing layering.
2. Plant propagation by layering: Ground layering – tip layering, simple layering, trench layering, mound (stool) layering and compound (serpentine layering).
3. Air layering technique – application in woody trees.

Unit – 5: Propagation by grafting and budding **9 Hrs.**

1. Grafting: Definition, principle, types, graft incompatibility, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification; micrografting.
2. Propagation by veneer, whip, cleft, side and bark grafting techniques.
3. Budding: Definition; techniques of 'T', inverted 'T', patch and chip budding.

IV. Text Books:

1. Sharma RR and Manish Srivastav.2004. Plant Propagation and Nursery Management International Book Distributing Co. Lucknow.
2. Sadhu, M.K. 1996. Plant Propagation. New Age International Publishers, New Delhi.

V. Reference Books:

1. Alan Toogood (2003) Plant Propagation, DK Publishing, London, UK
2. Hudson T. Hartmann, Dale E. Kester, Fred T. Davies Jr., and Robert L. Geneve (2010) Plant Propagation: Principles and Practices, Prentice Hall, Upper Saddle River, NJ, USA
3. John Mason (2006) Plant Propagation, Landlinks Press, Collingwood, VIC, Australia
4. Peter Thompson (2006) The Basics of Plant Propagation, Timber Press, Portland, OR, USA

VI. Suggested activities and evaluation methods:

Unit-1: Activity: Preparation of a report on vegetative propagation organs in different plant species of economic importance.

Evaluation method: Assessing the correctness and quality of report prepared using a determined rubric.

Unit-2: Activity: Critical written assignment on polyembryony in various plant species.

Evaluation method: Assessing the depth of analysis and the originality of ideas presented in the assignment.

Unit-3: Activity: Field trip to a horticulture research station to learn propagation of plants by cuttings.

Evaluation method: Participation, observing the student's active involvement, curiosity, and interaction with the experts in the field.

Unit-4: Activity: A case study report on propagation of plants using layering technique.

Evaluation method: Assessing the integration of relevant principles and concepts from the course into the case study analysis.

Unit-5: Activity: Group discussion on grafting techniques in plants.

Evaluation method: Assessing individual participation and contributions during the discussion.

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V Semester

Course 15 B: Plant Propagation Techniques

Credits -1

I. Course Outcomes: On successful completion of this practical course, student will be able to:

1. Make use of different plant propagation structures for plant multiplication.
2. Explore the specialized organs or asexual propagules in some plants for their proliferation.
3. Demonstrate skills on micropropagation of plants through vegetative propagation techniques.
4. Evaluate and use a suitable propagation technique for a given plant species.

II. Laboratory/field exercises:

1. Preparation of nursery beds – flat, raised and sunken beds.
2. Propagation through apomictic.
3. Propagation by separation and division technique.
4. Propagation by cuttings.
5. Propagation by layering
6. Propagation by grafting.
7. Propagation by budding.
8. Preparation of potting mixture, potting and repotting.

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Suggested Model Paper for Theory Question Papers

Common pattern for Question Paper for Theory Examination(s) at Semester end
Max. Time: 3 Hrs. **Max. Marks: 75 M**

Section – A

Answer all the following questions. **5 x 2 = 10 M**

- ✓ One question should be given from each Unit in the syllabus.

Section – B

Answer any three of the following questions. Draw a labelled diagram wherever necessary.
3 x 5 = 15 M

- ✓ One question should be given from each Unit in the syllabus.

Section – C

Answer any five of the following questions. Draw a labelled diagram wherever necessary.
5 x 10 = 50 M

- ✓ Two questions (a & b) are to be given from each Unit in the syllabus (internal choice in each unit). Student has to answer 5 questions by choosing one from a set of questions given from a Unit.

Note: Questions should be framed in such a way to test the understanding, analytical and creative skills of the students. All the questions should be given within the frame work of the syllabus prescribed.

Suggested Model Paper for Practical Examination

Common pattern for Question Paper for Practical Examination(s) at Semester end
Max Time: 3 Hrs. **Max. Marks: 50**

1. Experiment-1 (Major Experiment)	15 M
2. Experiment-2 (Minor Experiment)	10 M
3. Spotters	3 x 5 = 15 M
4. Record + Viva-voce	7 + 3 = 10 M