Course	Credit					
	Year-I		Year-II		Year-III	
	I	II	III	IV	V	VI
DCC (Other than Subject)	**DCC-1** 6 (4+2)	**DCC-4** 6 (4+2)	**DCC-7** 6 (4+2)	**DCC-10** 6 (4+2)	-	-
DCC	**DCC-2** Microbiology, Mycology and Phytopathology, Algae, Lichens and Bryophytes **(4)** **DCC-2P**Practicals based on DCC-2 **(2)**	**DCC-5**Pteridophytes, Gymnosperms and Palaeobotany, Taxonomy and Developmental Biology of Higher Plants **(4)** **DCC-5P**Practicals based on DCC-5 **(2)**	**DCC-8** Plant Ecology and Utilization of Plants, Cell and Molecular Biology **(4)** **DCC-8P**Practicals based on DCC-8 **(2)**	**DCC-11** Plant Physiology, Biochemistry, Cytogenetics and Biotechnology **(4)** **DCC-11P**Practicals based on DCC-11 **(2)**	-	-
DCC (Other than Subject)	**DCC-3** 6 (4+2)	**DCC-6** 6 (4+2)	**DCC-9** 6 (4+2)	**DCC-12** 6 (4+2)	-	-
DSE Interdiciplinary	-	-	-	-	**DSE-1** 6 (4+2)	**DSE-4** 6 (4+2)
DSE Interdiciplinary	-	-	-	-	**DSE-2a** Plant Breeding **(4+2)** or **DSE-2b** Analytical Techniques in Plant Sciences **(4+2)** **Or** **DSE-2c** PlantStress Biology **(4+2)**	**DSE-5a** Industrial and Environmental Microbiology **(4+2)** or **DSE-5b** Ethnobotany **(4+2)**or **DSE-5c**Agricultural Botany and Weed Science **(4+2)**
DSE Interdiciplinary	-	-	-	-	**DSE-3** 6 (4+2)	**DSE-6** 6 (4+2)
AEC (Hindi/English/ Rajasthani)	2	2	-	-	-	-
SEC	-	-	SEC-1 Nursery techniques, Gardening and Landscape planning (2)	SEC-2 Floriculture (2)	SEC-3 Urban and Social Forestry(2)	SEC-4 Pulp and Paper technology (2)
Total Credit	20	20	20	20	20	20

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B.Sc. 3rd year (Sem-V)

DSE-2a Plant Breeding (4+2)

Course Nomenclature	**Plant Breeding (4)**	
Course Code	**DSE-2a**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	CO 1 Understanding the basic concepts of plant breeding CO 2 Analyze the different selection and breeding methods applied in crop improvement CO 3 Ability to apply the concepts, principles and tools of biotechnology and plant tissue culture techniques on research problems pertinent to crop improvement CO 4 Link the rapid advances in cell and molecular biology to better understanding of contemporary Plant Breeding techniques CO 5 Students would be able to develop Comprehensive, detailed understanding regarding the experimental steps and methods involved in generating new varieties using classical and contemporary breeding practices CO 6 Learn to use the descriptors in various crops for selection of superior genotypes. CO 7 Locate, analyze, evaluate and synthesize information relevant to plant breeding.	
Unit I	**Plant Breeding** Introduction and objectives. Breeding systems; modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.	
Unit II	**Methods of crop improvement** Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross-pollinated and vegetatively propagated plants; Hybridization – Procedure, advantages and limitations. **Quantitative inheritance** Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance.	
Unit III	**Inbreeding depression and heterosis** History, genetic basis of inbreeding depression and heterosis; Applications. **Crop improvement and breeding**	

	Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.
Practicals	1. Introduction to field /controlled pollinations in field and laboratory (temporal details of anthesis, anther dehiscence, stigma receptivity and pollen viability, emasculation, bagging). 2. Analysis of the breeding system of chosen crop species by calculating Pollen:Ovule Ratio 3. Calculation of Index of self-incompatibility (ISI) and Confirmation of Self- Incompatibility. 4. Study of Quantitative and qualitative characters in selected crops. 6. Study of Pollinators. 7. Assessment of genetic diversity by using Molecular Markers.
Textbooks	1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition. 2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition. 3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Or

DSE-2b Analytical Techniques in Plant Sciences (4+2)

Course Nomenclature	**Analytical Techniques in Plant Sciences**	
Course Code	**DSE-2b**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	CO 1 The students have first-hand knowledge of the basic and contemporary techniques in biological sciences and the equipment and instruments thereof, along with an understanding of the application and limitations. CO 2 Will be acquainted with some basic concepts in statistics, acquire the skill of data representation and its elementary analysis along with the analysis pertaining to attributes and to interpret the results. CO 3 . Students will be able to apply fundamental mathematical tools (statistics) and physical principles (physics, chemistry)	

	to the analysis of relevant biological situations.
Unit I	**Imaging and related techniques** Principles of microscopy; Light microscopy; Fluorescence microscopy; Applications of fluorescence microscopy, Chromosome banding, FISH, chromosome painting; Use of fluorochromes; Flow cytometry and FACS, Confocal microscopy; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze-fracture, and freeze etching.
Unit II	**Cell fractionation** Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2gradient, analytical centrifugation, ultracentrifugation, marker enzymes. **Radioisotopes** Use in biological research, auto-radiography, pulse chase experiment. **Spectrophotometry** Principle and its application in biological research. **Chromatography** Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion exchange chromatography; Molecular sieve chromatography; Affinity chromatography.
Unit III	**Characterization of proteins and nucleic acids** Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE **Biostatistics** Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.
Practicals	1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs. 2. Demonstration of ELISA. 3. To separate nitrogenous bases by paper chromatography. 4. To separate sugars by thin layer chromatography. 5. Isolation of chloroplasts by differential centrifugation. 6. To separate chloroplast pigments by column chromatography. 7. To estimate protein concentration through Lowry's methods.

	8. To separate proteins using PAGE. 9. To separation DNA (marker) using AGE. 10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH). 11. Preparation of permanent slides (double staining). 12. Representation of Data (Tabular and Graphical) 13. Analysis and interpretation of data using appropriate statistical method
Textbooks	1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition. 2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A. 3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition. 4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

Or

DSE-2c Plant Stress Biology **(4+2)**

Course Nomenclature	Plant Stress Biology	
Course Code	**DSE-2c**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	At the end of the course student will have to be able to 1. Explain the basic processes and/or traits are affected by each one of the stresses. 2. Explain how the plant tissue responds to biochemical and molecular level to each one of the stress.	

Unit I	**Defining plant stress** Acclimation and adaptation. **Environmental factors** Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis–related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates. **Stress sensing mechanisms in plants** Calcium modulation, Phospholipid signalling
Unit II	Developmental and physiological mechanisms that protect plants against environmental stress Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.
Unit III	**Reactive oxygen species–Production and scavenging mechanisms.** **Practical** 1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress. 2. Superoxide activity in seedlings in the absence and presence of salt stress. 3. Zymographic analysis of peroxidase. 4. Zymographic analysis of superoxide dismutase activity. 5. Quantitative estimation and zymographic analysis of catalase. 6. Quantitative estimation and zymographic analysis of glutathione reductase. 7. Estimation of superoxide anions
Practicals	1. Separation and quantification of chlorophylls 2. Separation and quantification of carotenoids 3. O2 evolution during photosynthesis 4. Anatomical identification of C3 and C4 plants 5. Measurement of gas exchange parameters, conductance, photosynthetic rate, photorespiration 6. Measurement of respiration rates
Textbooks	**1.** Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition. **2.** Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

B.Sc. 3rd year (Sem-VI)

DSE- 5a Industrial and Environmental Microbiology (4+2)

Course Nomenclature	**Industrial and Environmental Microbiology**	
Course Code	**DSE- 5a**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, blended learning, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	CO 1 Understand the main concepts and principles of modern applied microbiology CO 2 Knowledge of Various microbes and the Microbial physiology which may be harnessed for human health and hygiene / industrial and environmental purposes CO 3 Discuss the applications and use of microbial power in industry and for various environmental issues CO 4 Gain hands-on experience of basic culture techniques, water analysis tests, understanding and comprehending the theory and practical aspects and report writing	
Unit I	Scope of microbes in industry and environment **Bioreactors/Fermenters and fermentation processes** Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous fermentations. Components of a typical bioreactor, Types of bioreactors-laboratories, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.	
Unit II	**Microbial production of industrial products** Microorganisms involved, media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands-on on microbial fermentations for the production and estimation (qualitative and quantitative) of Enzyme: amylase or lipase activity, Organic acid (citric acid or glutamic acid), alcohol (Ethanol) and antibiotic (Penicillin) **Microbial enzymes of industrial interest and enzyme immobilization** Microorganisms for industrial applications and hands-on screening microorganisms for casein hydrolysis; starch hydrolysis; cellulose hydrolysis. Methods of immobilization, advantages and applications of immobilization, large-scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).	

Unit III	**Microbes and quality of environment** Distribution of microbes in air; Isolation of microorganisms from soil, air and water. **Microbial flora of water** Water pollution, role of microbes in sewage and domestic waste water treatment systems. Determination of BOD, COD, TDS and TOC of water samples; Microorganisms as indicators of water quality, check coliform and fecal coliform in water samples. **Microbes in agriculture and remediation of contaminated soils** Biological fixation; Mycorrhizae; Bioremediation of contaminated soils. Isolation of root nodulating bacteria, arbuscular mycorrhizal colonization in plant roots.
Practicals	1.Principles and functioning of instruments in microbiology laboratory 2.Hands on sterilization techniques and preparation of culture media. 3. Isolation of root nodulating bacteria 4. Isolation and culture of microorganisms from soil, air and water 5. Determination of BOD, COD,TDS and TOC of water sample 6. Types and functioning of different bioreactors (Using photographs/ Diagrams and flowcharts) 7. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations and writing a report of the visit.
Textbooks	1. Pelzar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi. 2. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition

Or

DSE- 5b Ethnobotany (4+2)

Course Nomenclature	Ethnobotany	
Course Code	**DSE- 5b**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**

4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	After studying this course, the student will gain knowledge about: CO 1 The student will gain knowledge about The Traditional Knowledge Systems and the interdisciplinary nature of ethnobotany. CO 2 Students will have an understanding of the treasure, value and usefulness of natural products and their efficient use by the local communities as food and medicine and their conservation practices. CO 3 The course will broaden the vision of scholars regarding The culturally specific ways humans see and identify various plants and the way humans utilize plant species, CO 4 will Gain Hands-on learning experience of the various methodologies of procuring ethnobotanical data from primary and secondary sources and its analysis in modern perspective	
Unit I	**Introduction to Ethnobotany and Basic Taxonomy** Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science, databases and knowledge resource (Traditional Knowledge Digital Library), The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their lifestyles, Plants used by the indigenous societies: a) Food plants b) Medicinal plants c) intoxicants and beverages d) Resins and oils and miscellaneous uses.	
Unit II	**Applied Ethnobotany** Role of ethnobotany in Modern Medicine, Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology): a) *Azadiractha indica,* b) Ocimum sanctum, c) *Vitex negundo,* d) *Gloriosa superba,* e) *Tribulus terrestris,* f) *Pongamia pinnata,* g) *Cassia auriculata,* h) *Indigofera tinctoria.* **The Ecology of Ethnobotany** Ethnobotany—Spirits, Lore, Material Cultures, Folk Magic, Narcotics, Stimulants; Nutritional Ethnobotany – Agriculture, foraging and wild foods; Linguistic Ethnobotany—Botanical Classification and Ethics; Medicinal Ethnobotany and Ethnopharmacology; Ethnoveterinary knowledge	
Unit III	**Research Methods in Ethnobotany** Etic and Emic Perspectives: a) Fieldwork; b) Herbarium; c) Ancient Literature and oral traditions; d) Archaeological finding inferences; e) Religious and sacred places. Protecting Knowledge Ethnobotany and legal aspects, Ethnobotany as a tool to protect interests of ethnic groups, Sharing of wealth concept with few examples from India, Biopiracy, Intellectual Property Rights and Traditional Knowledge; Case studies of traditional medicines leading to development of modern pharmaceutical products (use of *Trichopuszeylanicus*by kanhi tribe and	

	Artemesia sp. for malaria cure)
Practicals	1. Collection, identification and preparation of herbarium of three ethno-botanically important plants with appropriate references 2. Preparation of crude extract of ethno-botanically important plants with appropriate references (any method to be used) 3. Project work-documentation, literature survey, and collection of information on ethno-botanically useful plants from traditional healers and local communities)
Textbooks	1. Jain, S.K. (2010). Manual of Ethnobotany. Rajasthan: Scientific Publishers. 2. Martin, G.J. (1995). Ethnobotany: A Methods Manual. Chapman Hall 3. Cunningham, A.B. (2001). Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan, London. 4. Young, K.J. (2007). Ethnobotany. Infobase Publishing, New York. 5. Schmidt, B.M., Cheng, D.M.K. (Eds.) (2017). Ethnobotany: A Phytochemical Perspective. John Wiley & Sons Ltd. Chichester, UK.

Or

DSE- 5c Agricultural Botany and Weed Science**(4+2)**

Course Nomenclature	Agricultural Botany and Weed Science	
Course Code	**DSE- 5c**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4+2	**4 Hours+ 4Hours**	**56 + 56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	After completion of this course the students would be able to understand: 1 How is the quality of seeds judged and how are the suitable conditions for the seed germination created? 2. How are the growth, flowering and fruiting in plants managed through the applications of hormones? 3. How are weeds managed in commercial crops?	

Unit I	**Seed Physiology** Seed dormancy types, factors, mechanism and methods for breaking dormancy, seed viability, seed vigour and seed germination. **Physiology of Crop Growth and Yield** Growth, methods of growth analysis, factors affecting growth, concept of phytotronics and Fertilizers (Nitrogen, Phosphorus, biofertilizers).
Unit II	**Regulation of Growth and Development** Role of hormones in plant growth and development, growth retardant. **Reproductive Physiology and Senescence** Physiology of flowering, Photoperiodism, vernalization, physiology of fruit ripening, senescence and regulation of senescence.
Unit III	**Biology of Weeds** Ecology of weeds, competition, reproduction of weeds. Allelopathy and Invasive Plants. **Crop Management Practices** Mechanical, Cultural, Biological and Chemical Weed control. Some abnoxious weeds and their management, Integrated pest management (IPM).
Practicals	1. To study the effect of ethylene on shelf life of cut flowers. / To study the effect of cytokinin on leaf senescence. 2. To test the viability of weed seeds. 3. To study the allelopathic effects of weeds on germination of crop seeds. 4. To study the effect of herbicides on seed germination and seedling growth of weeds. 5. Determination of pH and analysis of a soil sample for carbonates, chlorides, sulphates, organic matter and base deficiency by rapid field tests. 6. To perform the qualitative test for Nitrogen (NH4+, NO3-, urea) in a fertilizer and the soil sample. 7. Demonstration / photographs for the mechanisms used in herbicide application. 8. Field trip to a crop land to study weeds. 9. Submission of any two properly dried and mounted weed specimens with the herbarium label.

Textbooks	1. Ashton, F. M., Monaco, T. J. (2002). Weed Science: Principles and Practices. New Jersey, U.S.: John Wiley and Sons. Inc. 2. Hopkins, W. G., Huner, N. P. A. (2009). Introduction to Plant Physiology, 4th edition. New Delhi, Delhi: Wiley India Pvt. Ltd. 3. Taiz, L., Zeiger, E., Moller, I. M., Murphy, A. (2018). Plant Physiology and Development International 6th edition. New York, NY: Oxford University Press, Sinauer Associates. 4. Mandal, R.C. (1990). Weeds, weedicides and weed control: Principle and Practice. New Delhi, Delhi: Agro Botanical Publishers. 5. Rao, V. S. (1999). Principles of Weed Science. Oxford and IBH Publishers, New Delhi. 6. Subramanian, S. (2017). All about weed control. New Delhi, Delhi: Kalayani publishers.

3rd Year

Sem-V

SEC-3 Urban and Social Forestry (2)

Course Nomenclature	**Urban and Social Forestry**	
Course Code	**SEC-3**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**2 Hours**	**28**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	1. Develop an understanding of the benefits and costs of street trees and urban forests to municipal regions/cities/towns 2. Acquire a working knowledge of urban tree biology and street tree planting and maintenance strategies 3. Develop skills in street tree and urban forest inventory and analysis 4. Engage in a practical urban forest case study project, culminating in a team presentation.	
Unit I	Introduction, objective and scope of urban forestry, History of Urban Forestry/Distribution and Ownership of the Urban Forest	

Unit II	Functions and Values of the Urban Forest Urban Forest Environment Tree Hazard Assessment and Management Street, roads and parks tree inventories and Valuation
Unit III	The Urban Wildland Interface, Species selection for Street Tree and Park Management: Planting, Tree Maintenance, Removals Urban Forestry Ordinances, biomass estimation for carbon stock assessment and mitigation of carbon footprint calculation.
Practicals	1. Identification of various types of forest tree species found in urban environment. 2. Tree hazards assessment through different methods. 3. Species selection for plantation and establishment of nursery. 4. Biomass estimation for carbon stock in different species.
Textbooks	1. Malcom Fisher (1999). Urban forestry: planning and management. Syrawood publication house. 2. V.K. Prabhakar (2000). Forestry and forest resources. Anmol Publication, New Delhi. 3. SS Negi (1989), Urban and recreational forestry. International book distributors, Dehradun. 4. S S Negi (2003). Manual of forestry, Bishen singh. Mahendra pal singh, Dehradun,

Sem-VI

SEC-4 Pulp and Paper technology (2)

Course Nomenclature	**Pulp and Paper technology**	
Course Code	**SEC-4**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**2 Hours**	**28**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	To acquaint the students with the resources and processes for making pulp and paper.	

Unit I	Raw material used in pulp and paper industries, characteristics and handling. Pulping process, mechanical, chemical, semi-chemical and biopulping. Pulp bleaching, pulp treatment, defibering, de-knotting, brown stock washing, screening, cleaning, thickening, etc.
Unit II	Recycled fibers, supplementary pulp treatment and additives. Paper making, paper drying, reeling, external sizing, coating, calendaring, etc.
Unit III	Structure of paper, its characterization and measuring strength method, optional and structural properties of paper, Type of paper: coated paper, corrugated containers, printing quality of paper, ageing of paper. Rayon industry.
Practicals	Visit to pulp and paper industry; Study of raw materials, techniques and pulp yield, making of paper and its quality determination.
Textbooks	Engineers, N. B. C. (2004). *The Complete Technology Book on Pulp & Paper Industries: How paper is made, Pulp and Paper Making Process, pulping process for making paper, what is pulp and paper?, pulp and paper manufacturing process, making of pulp, paper making process, pulp and paper manufacturing, pulp and paper industry process, manufacturing process of paper, Pulp & Paper Plant Process, Processes for Pulp and Paper, How the paper is manufactured*. NIIR Project Consultancy Services. https://books.google.co.in/books?id=YwmsDAAAQBAJ *Volume 1-4 Wood Chemistry and Wood Biotechnology*, Berlin, New York: De Gruyter, 2009.

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Botany

Course	Credit					
	Year-I		Year-II		Year-III	
	I	II	III	IV	V	VI
DCC (Other than Subject)	**DCC-1** 6 (4+2)	**DCC-4** 6 (4+2)	**DCC-7** 6 (4+2)	**DCC-10** 6 (4+2)	-	-
DCC	**DCC-2** Microbiology, Mycology and Phytopathology, Algae, Lichens and Bryophytes **(4)** **DCC-2P**Practicals based on DCC-2 **(2)**	**DCC-5**Pteridophytes, Gymnosperms and Palaeobotany, Taxonomy and Developmental Biology of Higher Plants **(4)** **DCC-5P**Practicals based on DCC-5 **(2)**	**DCC-8** Plant Ecology and Utilization of Plants, Cell and Molecular Biology **(4)** **DCC-8P**Practicals based on DCC-8 **(2)**	**DCC-11** Plant Physiology, Biochemistry, Cytogenetics and Biotechnology **(4)** **DCC-11P**Practicals based on DCC-5 a & b **(2)**	-	-
DCC (Other than Subject)	**DCC-3** 6 (4+2)	**DCC-6** 6 (4+2)	**DCC-9** 6 (4+2)	**DCC-12** 6 (4+2)	-	-
DSE Interdiciplinary	-	-	-	-	**DSE-1** 6 (4+2)	**DSE-4** 6 (4+2)
DSE Interdiciplinary	-	-	-	-	**DSE-2a** Plant Breeding **(4+2)** or **DSE-2b** Analytical Techniques in Plant Sciences **(4+2)** **Or** **DSE-2c Plant** Stress Biology **(4+2)**	**DSE-5a** Industrial and Environmental Microbiology **(4+2)** or **DSE-5b** Ethnobotany **(4+2)**or **DSE-5c**Agricultural Botany and Weed Science **(4+2)**
DSE Interdiciplinary	-	-	-	-	**DSE-3** 6 (4+2)	**DSE-6** 6 (4+2)
AEC (Hindi/English/ Rajasthani)	2	2	-	-	-	-
SEC	-	-	SEC-1 Nursery techniques, Gardening and Landscape planning (2)	SEC-2 Floriculture (2)	SEC-3 Urban and Social forestry (2)	SEC-4 Pulp and Paper technology (2)
Total Credit	20	20	20	20	20	20

5.3.24

B.Sc. 2nd year (Sem-III)

DCC-8 Plant Ecology and Utilization of Plants, Cell and Molecular Biology **(4)**

Course Nomenclature	Plant Ecology and Utilization of Plants, Cell and Molecular Biology	
Course Code	**DCC-8**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4	**4 Hours**	**56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, &fieldwork etc.,**	
Course Outcomes	After studying this course, a student will able to – CO1. The students will be learning tounderstand the concept, types, development and functions of various ecosystems and their communication application of these concepts to solve environmental problems. The various environmental factors governing these ecosystems are also clearly understood. CO2. Students will acquire understanding of the Basic principles and modern-age applications of recombinant DNA technology. Learn molecular and technical skills along with applications of the instrumentation. Designing/conducting experiments to showchromosomesat metaphysic stage.	
Unit I	Plants and environment: Atmosphere (gaseous composition), water (properties of water cycle), light (global radiation, photosynthetically active radiation), temperature, soil (development, soil profiles, physico-chemical properties), and biota. Population ecology: Growth curves; ecotypes: ecads. Community ecology: Community characteristics. frequency, density, cover, life forms. biological spectrum; ecological succession. Ecosystems: Structure; abiotic and biotic components; food chain, food web. ecological pyramids, energy flow, biogeochemical cycles of carbon, nitrogen and phosphorus.	

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Unit II	Biogeographical regions of India. Vegetation types of India: Forests and grasslands Morphological, anatomical and physiological responses of plants to water (hydrophytes and xerophytes), temperature (thermoperiodicity and vernalization). light (photoperiodism, heliophytes and sciophyles) and salinity. **Plant Resources and their Utilization** Food Plants: Rice, wheat, maize, potato, sugarcane. Fibers: Cotton and jute Vegetable oils: Groundnut. mustard and coconut General account of sources of firewood, timber and bamboos,Spices, Medicinal plants, Beverages: Tea and coffee Rubber.
Unit III	**Cell and Molecular Biology** Structure and function of cell envelopes; cell wall & Plasma membrane: Structure and functions of cell organelles; Golgi body, endoplasmic reticulum, peroxisomes, vacuoles, chloroplast, mitochondria, centrioles, microtubules & microfilaments. Ultrastructure of Nucleus, nucleolus and nuclear membrane. Ultrastructure and function of chromosomes, centromere, telomere, chromosomal alteration; in structure and in number, genome, DNA structure and replication; the concept of Recombinant DNA, Types of DNA & RNA, extranuclear genome and their significance. Cell cycle: Mitosis and Meiosis and their significance. Nucleic acids: Carriers of genetic information, The Structures of DNA and RNA / Genetic Material, The replication of DNA, Central dogma and genetic code
Textbooks	1. Odum, E.P. 1983. Basic Ecology. Saunders. Philadelphia 2. Kormondy. E.J. 1996, Concepts of Ecology. Prentice-Hall of India Pvt. Lid, New Delhi. 3. Mackenzie, A et. al. 1909. Instant Notes in Ecology Viva books PvI. Lid. New Delhi. 4. Kocchar. S.L. 1998. Economic Botany in Tropics. 2nd edition. Macmillan 5. India Ltd., New Delhi. 6. Sambamurthy, A.V.S.S. and Subramanyam. N.S. 1989. A Textbook of Economic Botany. Wiley Easter Delhi.

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	7. Sharma, O.P. 1996. Hill's Economic Botany (Late Dr A.F. Hill, adapted by O.P. Shurna). Tata McGraw Hill, New Delhi. 8. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany - Plants in Our World. McGraw Hill, New Delhi. 9. Alberts, B. Bray, D., Lewis J. Raft, M., Roberts-K. and Watson I. D. 1999.Molecular Biology of cell. Garland Pub. Co., Inc., New York. USA. 10. Gupta P. K. 1999 A text book of cell and Molecular Biology RastogiPublications. Meerut India. 11. Kleinsmith. L. J. and Kish. V.M. 1995. Principles of Cell and Molecular Biology (2nd edition) Harper Collins College Publishers. New York USA. 12. Wolfe.S.L. 1993. Molecular and Cellular Biology: Wadsworth Publishing Co. California USA

DCC-8P Practicals based on DCC-8 (2)

Course Nomenclature	**Practicals based on DCC-8**	
Course Code	**DCC-8P**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**4 Hours**	**56**
Teaching Pedagogy	**Laboratory and field work**	
Course Outcomes	After studying this course, a student will able to – CO1. The students will be learning tounderstand the concept, types, development and functions of various ecosystems and their communication application of these concepts to solve environmental problems. The various environmental factors governing these ecosystems are also clearly understood. CO2. Students will acquire understanding of the Basic principles and modern age applications of recombinant DNA technology. Learn molecular and technical skills along with applications of the instrumentation. Designing/conducting experiments to show chromosomes at metaphysic stage.	

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Exercises	1. To determine the minimum size of quadrats required for phytosociological studies. 2. To determinethe frequency of the herbaceous species by quadrate method. 3. To determine the density of the herbaceous flora by quadrate method. 4. To measure the above-ground plant biomass in a grassland. Soil analysis/Field test: (a) Soil Texture (b) Soil moisture (c) Soil pH 5. To estimate bulk density and porosity of grassland and wood land soil. 6. To determine water holding capacity of grassland and wood land soil. Water analysis: 7. To estimate pH, temperature and transparency of different water bodies. 8. To demonstrate the presence of carbonate and chloride in different water samples. 9. Ecological instruments and their working: oven, maximum and minimum thermometer 10. Plant adaptive modifications, specimen/ slides: Opuntia, Euphorbia, Capparis, Casuarina, Hydrilla, Typha, Eichhornia 1L. To estimate thedust-holding capacity of the leaves of different plant species 12. Utilization of Plants (Economic botany) (a) Food plants - Rice. wheat, maize. potato and sugarcane (b) Fibres - Cotton & Jute (c) Vegetable oils - Groundnut, mustard and coconut (d) A general account of the Firewood trees, timber-yielding plants and bamboos (e) Spices - Black pepper. cloves, cinnamon and cardamom (0) Study of at least 10 medicinal plants used in indigenous systems of medicine (allopathy, ayurveda &Homoeopathy etc.) (g) Beverages - Tea & Coffee (h) Rubber 13. study cell structure from onion leaf peels; demonstration of staining and mounting methods. 14. Comparative study of cell structure in onion cells.*Hydrilla* and *Spirogyra*. 15. Study of cyclosis in *Tradescantia* staminal cells.

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	16. Study of plastids to examine pigment distribution in plants (Q.g. *Cassia*, *Lycopersicon* and *Capsicum*) 17. Examination of electron micrographs of eukaryotic cells with special reference lo Organelles 18. Examination of electron micrographs of viruses, bacteria cyanobacteriaand eukaryotic cells for comparative cellular organization. 19. Examination of various stages of mitosis and meiosis using appropriate plant material root tips and flower buds of onion. Cytological examination of special types of chromosomes: bar body lampbrush and polytene chromosomes.

B.Sc. 2nd year (Sem-IV)

DCC-11 Plant Physiology, Biochemistry, Cytogenetics, and Biotechnology (4)

Course Nomenclature	Plant Physiology, Biochemistry, Cytogenetics, and Biotechnology	
Course Code	**DCC-11**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
4	**4 Hours**	**56**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, &fieldwork etc.,**	
Course Outcomes	After studying this course, a student will able to – CO1. The students will be able to understand the various physiological life processes occurring in plants. They will also gain knowledge about the various uptake and transport mechanisms. They understand the role of various hormones, signalling compounds, thermodynamics and enzyme kinetics. During the course, students will enrich themselves with the phenomenon	

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	of metabolism of primary and secondary metabolites and their role in plants. CO2. To understand the pattern of inheritance in various life forms. To develop strong fundaments basics for further molecular studies. CO3. The students will learn about the Concepts, tools and techniques related to in vitro propagation of plants. Different methods used for genetic transformation of plants, use of Agrobacterium as a vector for plant transformation, components of a binary vector system. Various case studies related to basic and applied research in plant sciences using transgenic technology.
Unit I	Plant-water relations: Importance of water to plant life: physical properties of water: diffusion and osmosis; absorption, transport of water and transpiration: physiology of stomata. Transport of organic substances: Mechanism of phloem transport:source-sink relationship; factors affecting translocation. Mineral nutrition: Essential macro- and micro-elements and their role; mineral uptake: deficiency and toxicity symptoms. Basics of enzymology: Discovery and nomenclature; characteristics of enzymes: concept of holoenzyme, apoenzyme, coenzyme and cofactors; regulation of enzyme activity, mechanism of action. Photosynthesis: Significance: historical aspects; photosynthetic pigments; action spectra and enhancement effects; concept of two photosystems; Z-scheme; photophosphorylation; Calvin cycle; C4 pathway, CAM plants; photorespiration.
Unit II	Respiration: ATP - the biological energy currency; aerobic and anaerobic respiration: Kreb's cycle; electron transport mechanism (chemiosmotic theory); redox potential; oxidative phosphorylation; pentose phosphate pathway. Nitrogen and lipid metabolism: Biology of nitrogen fixation; the importance of nitrate reductase and its regulation; ammonium assimilation; structure and function of lipids; fatty acid biosynthesis; β-oxidation; saturated and unsaturated fatty acids; storage and mobilization of fatty acids. Growth and Development: Definitions: phases of growth and development; kinetics of growth; seed dormancy, seed germination and factors of their regulation; plant movements; the concept of photoperiodism; physiology of flowering; florigen concept; Vernalization, biological clocks; physiology of senescence, fruit ripening. Plant hormones-auxins,

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	gibberellins, cytokinins, abscisic acid and ethylene, discovery, structure, Bioassay, physiological role and application; photomorphogenesis. phytochromes, their discovery. physiological role, mechanism of action and HIR (High Irradiance Response).
Unit III	Genetic inheritance: Mendelism; laws of segregation and independent assortment: linkage analysis; allelic and non-allelic interactions. Gene expression: Structure of gene; transfer of genetic information; transcription, translation, protein synthesis: regulation of gene expression in prokaryotes and eukaryotes; proteins structure. Genetic variations: Mutations: spontaneous and induced, Transposable genetic elements; DNA damage and repair. Green revolution to Gene revolution with special reference to transgenic plants. Genetic engineering: Tools and techniques of recombinant DNA technology; cloning vectors: genomic and cDNA library: transposable elements: techniques of gene mapping and chromosome waking. Biotechnology: Functional definition, basic aspects of plant tissue culture: cellular totipotency, differentiation and morphogenesis; biology of Agrobacterium, vectors for gene delivery and vectorless gene transfer; marker and reporter genes; salient achievements in crop biotechnology.
Textbooks	1. Hopkins, W.G. 1995, Introduction to Plant Physiology. John Wiley & Sons.Inc., New York. USA. 2. Lea, P.J. and Leegood. R.C. 1999 Plant Biochemistry and Molecular Biology, John Wiley & Sons. Chicheste. England. 3. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th Edition).Wadsworth Publishing Co.. California, USA. 4. Taiz. L. and Zeiger, E. 1998. Plant Physiology (2"' Edition). Sinauer Associates, Inc., Publishers. Massachusetts, USA 5. Bhojwani. S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers. New York. USA 6. Vasil, 1. K. and Thorpe. T. A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands 7. Alberts, B. Bray, D., Lewis J. Raft, M., Roberts.K. and Watson I. D. 1999. Molecular Biology of Cell. Garland Pub.

Co., Inc., New York. USA.
8. Gupta P. K. 1999 A textbook of cell and Molecular Biology Rastogi Publications. Meerut India.
9. Kleinsmith. L. J. and Kish. V.M. 1995. Principles of Cell and Molecular Biology (2nd edition) Harper Collins College Publishers. New York USA.
10. Wolfe. S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co. California USA

DCC-11P Practicals based on DCC-11 (2)

Course Nomenclature	Practicals based on DCC-11	
Course Code	**DCC-11P**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**4 Hours**	**56**
Teaching Pedagogy	**Laboratory & field work etc.,**	
Course Outcomes	After studying this course, a student will able to – CO1. The students will be able to understand the various physiological life processes occurring in plants. They will also gain knowledge about the various uptake and transport mechanisms. They understand the role of various hormones, signalling compounds, thermodynamics and enzyme kinetics. During the course, students will enrich themselves with the phenomenon of metabolism of primary and secondary metabolites and their role in plants. CO2. To understand the pattern of inheritance in various life forms. To develop strong fundaments basics for further molecular studies. CO3. The students will learn about the Concepts, tools and techniques related to in vitro propagation of plants. Different methods used for genetic transformation of plants, use of Agrobacterium as a vector for plant transformation, components of a binary vector system. Various case studies related to basic and applied research in plant sciences using transgenic technology.	

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Excercise 6	1. To study the permeability of plasma membrane using different concentrations of organic solvents. 2. To study the effect of temperature on permeability of plasma membrane. 3. Separation of chlorophyll pigments by paper chromatography. 4. To study the phenomenon of plasmolysis using *Tradecantia/Rhoeodiscolor* leaves. 5. To demonstrate unequal transpiration in dorsiventral leaves using cobaltchloride paper 6. To observe the effect of different wavelengths of light on photosynthesis using Wilmott's bubbler: 7. To demonstrate osmosis using potato osmoscope. 8. To study the enzyme activity of catalase and peroxidase as influenced by pH and temperature. 9. Introduction and demonstration of instruments, pH meter, colourimeter,centrifuge etc. 10. Phytochemical tests for starch: cellulose, protein, fats. Lignin, Anthocyanin. 11. Comparison of the rate of respiration of various plant parts. 12. Separation of amino acids in a mixture by paper chromatography. 13. Introduction of Instruments/Techniques. Laminar air flow/ sterile bench, autoclave. 14. Preparation of nutrient media for tissue culture- M.S. media, Nutrient agar, 15. Demonstration of Inoculation technique, aseptic transfer of explant and microbial transfer technique 16. Demonstration of the technique of micro-propagation by using different explants e.g. axillary buds, shoot meristem. 17. Demonstration of the techniques of anther culture. 18.Numerical problems based on genetics.

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2nd Year

Sem-III

SEC-1 Nursery techniques, Gardening and Landscape planning (2)

Course Nomenclature	**Nursery techniques, Gardening and Landscape planning**	
Course Code	**SEC-1**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**2 Hours**	**28**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	On successful completion of this course, the students will be able to perform soil and plant nutrients management activities, make compost, perform nursery planning and management activities, perform plant protection activities, be familiar with various gardens, perform garden development activities, maintain garden and garden plants, propagate the plant, arrange and decorate house plants, prepare and maintain the lawn, market plants, perform communication and professionalism development activities, and perform entrepreneurship development activities.	
Unit I	Nursery: Definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities- planting, direct seedling and transplants. Seed: Structure and types- Seed dormancy: Causes and methods of breaking dormancy-Seed storage: Seed banks, factors affecting seed viability, genetic erosion- Seed production technology- seed testing and certification. Vegetative Propagation: air- layering, cutting, selection of cutting, collection, season, treatment of cutting, rooting medium and planning of cuttings- hardening of plants- greenhouse- mist chamber, shed root, shade house, and glasshouse.	
Unit II	Soilless media- Vermiculite, Soilrite, Cocopeat, Peat moss Composting and composts- Vermicompost, Vermiwash, Leaf-Mold, Organic and chemical fertilizers, Integrated Fern management. Grafting and its types- Agrochemicals and PGRs in horticulture.	

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Unit III	Gardening: Definition, objectives and scope- a different type of gardening - landscape and home gardening- parks and its components- plant materials and designing- computer application in landscaping- Gardening operation: soil, laying. manuring, watering, management of pests and diseases and harvesting.
Practicals	1. Practice of grafting, budding, cutting, and layering, anatomical studies of rooting of cuttings and grafting union, planning and layout for commercial nursery. 2. Sample seed testing, use of bioregulators in propagation, sterilization of equipments and laboratory. 3. Media preparation, selection and preparation of explants, meristem culture and micrografting, planning and layout of experiments on various aspects of propagation. 4. Visit to tissue culture labs and nurseries.
Textbooks	1. Bose T.K. and Mukherjee, D. 1972 Gardening in India, Oxford & IBH Publishing Co. New Delhi. 2. Sandhu, M.K. 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras. 3. Kumar, N., 1997, Introduction to Horticulture, Rajlaxmi Publications, Nagercoil. 4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co. New Delhi. 5. Agrawal, P.K. 1993 Handbook of seed technology. Deptt. of Agriculture and Co-operation, National Seed Corporation Ltd., New Delhi. 6. Janick Jules. 1979 Horticultural Science (3rd Ed.), W.H. Freeman and Co. San Francisco.

Sem-IV

SEC-2 Floriculture (2)

Course Nomenclature	**Floriculture**	
Course Code	**SEC-2**	
Course Credit	**No. of Hours per Week**	**Total No. of Teaching Hours**
2	**2 Hours**	**28**
Teaching Pedagogy	**Classroom lectures, tutorials, Group discussions, Seminar, & fieldwork etc.,**	
Course Outcomes	Students at the successful completion of the course will be able to: 1. Understand the significance of flowers in human life. 2. Acquire skills related to production techniques in floriculture. 3. Explain the breeding techniques of some flowering plants. 4. Demonstrate skills of protected cultivation in floriculture. 5. Perform skills in post-harvest operations in floriculture.	
Unit I	Basic concepts of floriculture- 1. Aesthetic, cultural and industrial importance of flowers; domestic and export marketing of flowers. 2. Floriculture - Importance, area and production in Rajasthan and India. 3. Scope and importance of commercial floriculture in Rajasthan, and India.	
Unit II	Plant breeding of flowering ornamentals- 1. Objectives and techniques in ornamental plant breeding. 2. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of following ornamental and flower crops. (a) Carnation (b) Petunia (c) Geranium (d) Cosmos (e) Hibiscus (f) Snapdragon	
Unit III	Post-harvest practices in floriculture- 1. Growing of flowering plants under protected environments such as glasshouses, plastic houses, net houses, etc. 2. Importance of flower arrangement; Ikebana - techniques, types, suitable flowers and cut foliage. 3. post-harvest technology of cut and loose flowers in respect of commercial flower crops. 4. Dehydration techniques for drying of flowers, scope importance and status 6. Packaging materials, transportation and marketing of cut flowers.	
Practicals	1. Identification of commercially important floricultural crops. 2. Propagation technique in Hibiscus/Rose/Chrysanthemum/tuberose. 3. Propagation technique in Gladiolus/carnation/Petunia 4. Sowing of seeds and raising of seedlings of a flowering plant.	

	5. Training and pruning of rose/Jasminum. 6. Drying and preservation of flowers. 7. Use of chemicals and other compounds for prolonging the vase life of cut flowers. 8. Flower arrangement practices. 9. Preparation of bouquets, garland, veni and gajara
Textbooks	1. T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003. Commercial flowers. Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata 2. S.K. Bhattacharjee and L.C. De. 2003. Advanced Commercial Floriculture. Aavishkar Publishers, Distributors, Jaipur, India. 3. V.L. Sheela, 2008. Flower for trade. New India Publishing Agency, New Delhi 4. Dewasish Choudhary and Amal Mehta. 2010. Flower crops cultivation and management. Oxford Book Company, Jaipur, India.