VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY
Jnanasagara campus, Bellary-583105

Department of Studies in Botany

SYLLABUS

Master of Science

(III semester)

With effect from

2021-22

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Department of Botany

Jnana Sagara, Ballari - 583105

Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Programs

III – SEMESTER

With Practical

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
THIRD	DSC9	21 BOT 3C9L	Plant physiology	30	70	100	4	-	-	4	3
	DSC10	21BOT3C10L	Molecular Biology	30	70	100	4	-	-	4	3
	DSE1	21BOT3E1AL	A. Gardening and Landscaping	30	70	100	4	-	-	4	3
		21BOT3E1BL	B. Applied and Industrial Botany								
		21BOT3E1CL	C. Plant Biochemistry								
	DSE2	21BOT3E2AL	A. Medicinal & Aromatic plants	30	70	100	4	-	-	4	3
		21BOT3E2BL	B. Seed Technology								
		21BOT3E2CL	C. Nanobiotechnology								
	GEC1	21BOT3G1AL	A. Forensic Botany	20	30	50	2	-	-	2	1
		21BOT3G1BL	B. Biofertilizers & Biopesticides								
		21BOT3G1CL	C. Aquatic Botany								
	SEC3	21BOT3S3LP	Research Methodology	20	30	50	1	-	2	2	1
	DSC9P7	21BOT3C7P	Plant physiology	20	30	50	-	-	4	2	4
	DSC10P8	21BOT3C8P	Molecular Biology	20	30	50	-	-	4	2	4
Total Marks for III Semester						**600**				**24**	

M.Sc. Botany III Semester

Course: **Plant Physiology**	Course code: **21 BOT 3C9L**
Teaching hours/week (L-T-P): **4-0-0**	No. of credits: **04**
Internal assessment: **30 marks**	Semester End Examination: **70 Marks**
Total contact hours: **55**	

COURSE OUTCOMES:

1. Understand the detailed mechanism of Photosynthesis.
2. Understand role of growth regulators and growth retardants in growth and development of plants.
3. Understand various aspects of photophysiology like Photoperiodism, vernalization, Circadian rhythms etc.
4. Will be able to distinguish between C3 and C4 plants.
5. Understand how plants behave under biotic and abiotic stress.
6. Understand concepts like photoinhibition, photoperiodism, and Nitrogen metabolism.

COURSE CONTENTS

Unit- 1 Plant growth regulators 11 hrs

Auxins, discovery, structure, biosynthesis, mode of action, and function. Gibberellins- discovery, physiological effects, and the response of plants, biosynthesis, and mode of action. Cytokinins- discovery, structure, biosynthesis, physiological effect on seed plants, and mode of action. Synthetic growth retardants: Abscisic acid, physiological effects, biosynthesis. Ethylene, biological effects, and biosynthesis.

Unit-2Role of Growth regulators on modern agriculture and horticulture 11 hrs

A brief account of brassinosteroids, polyamines, Jasmonic acid, salicylic acid, and nitric oxide signalling in plant defense. Hormone mutants. Phytochromes - History and discovery, occurrence, and distribution of phytochromes, cryptochromes, and phototropin, their photochemical and biochemical properties.

Unit-3Photosynthesis 11 hrs

Composition and characterization of photosystems I and II. Photophosphorylation. Path of carbon: Differences between C3 and C4 photosynthesis CAM pathway and its regulation. Photorespiration, biosynthesis of glycolate, and regulation of photorespiration.

Unit-4Photo physiology 11 hrs

Light induced responses cellular localization. A brief account of the molecular mechanism of action of photomorphogenic receptors. Photoperiodism, vernalization, chemical: control of

flowering. Circadian rhythms in plants. Seed germination and dormancy. Juvenility and senescence.

Unit-5Stress physiology **11 hrs** Plant responses to biotic and abiotic stress, plant defense mechanisms against water stress, salinity stress, metal toxicity, freezing and heat stress, and oxidative stress. Photo inhibition and other physiological activities are affected by stress. Role of plant hormones in plant response to stress (ABA and Polyamines).

REFERENCES

1. A Text book of Plant Physiology and Biochemistry S.K. Verma, S.Chand& Comp., New Delhi.
2. Applied radiobiology and radiation protection: Granier R and Gambini D J: Ellis Howard, 1990.
3. Biochemistry and physiology of plant hormones –T.C.Moore, Springer and Verlag, Naw York, USA. 3. Plant physiology–L.Taiz and E.Zeiger, 2nd edition, Sinauer Associates. In. Publisher, Massachusetts, USA.
4. Cell Physiology and Biochemistry: Me Elroy W D: Prentice Hall of India,1995.
5. Electrogenic ion pumps: Spanswick R M: Ann. Rev. Plant Physiol. 32, 267-289,1981.
6. Enzymatic reaction mechanisms: Walsh C T: W H Freeman, New York,1979,
7. Introduction to Plant Physiology - Hopkins, John Wiley and Sons, New York, USA. 10. Plant Physiology. Salisbury and Ross, Wadsworth Publ. Co., California, USA.
8. Introduction to plant physiology –W.G. Hopkins ,John Wiley &Sons,Inc.New York USA.
9. Photorespiration protects C3 plants from photo-oxidation: Kozaki A and Takeba G: Nature, 384,557-560,1996.
10. Photosynthesis: Robinowitch E and Govindjee: Wiley, New York1969.
11. Physiology of ion transport across the tonoplast of higher plants: Birkla B J andPantanjo O: Ann. Rev. Plant Physiology, 47, 159-184,1996.
12. Physiology of Plant Growth and Development Edited M.B. Wilkins McGraw Hill, London.
13. Plant membranes-Endo and plasma membranes of plant cells: Robinson D G:West Germany,1985.
14. Plant metabolism Dennis, Turpin, Lefebure and Layzell, Longman Essex, England. 12. Plant Physiology Taiz and Zeiger, Sinauer Associates, Inc Pub. Massachusetts, USA.
15. Plant Physiology C.P. Malik, Kalyani Publishers, New Delhi.
16. Plant Physiology –F.C.Steward, Academic Press ,New York.
17. Plant Physiology, Devlin. Yan Nostrand Reinhold Comp. New York. Affiliated East West Press Pvt.Ltd., New Delhi.
18. Plant physiology–F.B. Salisbury and C.W.Ross, 4th edition, Wadsworth publishing Co. , California. 5. Photoperodism in plants –B.Thomas and D.Vince pure, 2nd edition Academic press, Sandiego, USA.
19. Plant Physiology—S. Mukharji and A.K.Gosh 7. Plant Physiology –D.Hess, Springer Berlin.
20. The Phytochrome chromophore I. Photomorphogenesis in plants: Rudier Wand Thummlar K: Netherlands 51-69,1994.

M.Sc. Botany III Semester

Course: **MolecularBiology**	Course code: **21BOT3C10L**
L-T-P per week **4-0.0**	No of credits – **04**
Internal Assessment: **30 marks**	Semester end Examination: **70 marks**
Total contact hours: **55**	

COURSE OBJECTIVES

- To know the origin of DNA science and related major discoveries which paved the beginning of molecular biology.
- Learn the detailed molecular processes of DNA replication, Transcription, and translation processes in prokaryotes and eukaryote organisms
- Familiarize with the regulation of cell cycle and molecular processes of DNA Replication, Transcription, and Translation and its implication on cellular function
- Application of molecular biology principle in every life science approaches
- To get introduced to the basic concepts of genetic engineering
- Understand the basics of gene cloning, role of enzymes and vectors for genetic engineering, gene transfer methods and gene therapy

COURSE CONTENTS

Unit-1 Nucleic acids 11 hrs

Molecular biology of the central dogma. Historical perspective, DNA is the carrier of genetic information (Griffith's, Hershey and Chase, Avery, McLeod & McCarty experiments). The structures of DNA and RNA as genetic material: Salient features and types of DNA and RNA. Organization of DNA in prokaryotes, viruses, and eukaryotes. Organelle DNA- mitochondria and Chloroplast DNA. DNA replication. Fine structure of prokaryotic and eukaryotic genes. Genetic code, pseudo genes, cryptic genes.

Unit-2 Regulation of gene expression in prokaryotes and eukaryotes 11 hrs

General mechanism of transcription and translation in prokaryotes and eukaryotes-initiation, elongation, and termination. Processing and modification of RNA -split genes-concept of introns and exons, removal of introns, spliceosome machinery, alternative splicing eukaryotic mRNA processing (5' cap, 3' polyA tail). Ribozymes, exon shuffling, RNA editing, and mRNA transport. Ribosome structure and assembly, mRNA. Charging of tRNA, aminoacyl tRNA

synthetases. Regulation of lactose metabolism and tryptophan synthesis in E. coli. Eukaryotes: transcription factors. DNA methylation

Unit-3 Transposable elements **11 hrs**

Eukaryotic transposons – Ac-Ds system in Maize, P-elements in Drosophila and Retro-elements. Transposable elements in man. Prokaryotic transposons- Insertion, composite and non-composite sequences. Applications of transposons in research and health care system.

Unit-4 Genes and Immunity **11 hrs**

Natural and acquired immunity, immune responses-humoral and cell-mediated immunity, antibody structure, antibody genes, immune system, and malfunctions. Genes and Cancer: Genetic control of cell cycle, the molecular basis of cancer, tumor suppressor genes, oncogenes, prevention, detection, and treatment of cancer

Unit-5 Mutation, DNA damage, and repair **11 hrs**

Definition of mutation, a gain of function and loss of function mutation, forward and reverse mutation, point mutation (transitions, transversions, missense mutation, nonsense mutation, silent mutation, frameshift mutation), spontaneous mutation and induced mutation, Mutagen -physical (ionizing and UV radiation), chemical (base analogs, nitrous acid, acridine dyes, alkylating agents), Ames test. Causes and types of DNA damage, DNA repair – Photo reactivation, mismatch repair, base excision, nucleotide excision repair, SOS repair.

REFERENCES:

1. Watson JD., Baker TA., Bell SP., Gann A., Levine M., Losick R (2007) Molecular Biology of the Gene, Pearson Benjamin Cummings
2. Snustad DP and Simmons MJ (2010) Principles of Genetics. John Wiley and Sons Inc., U.S>A. 5th edition.
3. Klug WS., Cummings MR., Spencer CA (2009) Concepts of Genetics. Benjamin Cummings U.S.A. 9th edition.
4. Russell P.J. (2010) Genetics – A molecular approach. Benjamin Cummings. U.S.A. 3rd edition
5. Griffiths AIF., Wessler SR., Carroll SB., Doebley J (2010) Introduction to genetic analysis W.H. Freeman and Co., U.S.A. 10th edition.
6. Cell and Molecular Biology – Concept and Experiments. 2nd Edition: Gerald Karp
7. Cell and Molecular Biology (1999) Gupta P. K. Rastogi Publication Meerut, India
8. Concept of Genetics 4th Edition: William S Klung and M.R. Cummings.
9. De Robertis, EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia

10. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., WH Freeman and Company
11. Voet D and Voet JG (2004) Biochemistry 3rd edition, John Wiley and Son
12. Sharma VK (1991) Techniques in microscopy and Cell Biology. Tata McGraw Hill
13. Reimer L and Kohl H (2008) Transmission electron microscopy. Springer.

COURSE OUTCOMES

On successful completion of this course the student will be able to;

1. Gain detailed know-how of chemical and molecular processes that occur in and between living cells.
2. Understand insight into the most significant molecular and cell-based experimental methods used in molecular biology to expand our understanding of the functioning of biology.
3. Develop precise knowledge and understanding of physical and chemical mutations and the various repair mechanisms that rectify the damage in cellular processes.
4. Develop proficiency in isolation, estimation, and determination of biomolecules to understand cellular mechanisms of operon and RNA interference.
5. To use genetic engineering tools in crop improvement

M.Sc. Botany III Semester

Course: **A. Gardening and Landscaping**	Course code: **21BOT3E1AL**
Teaching hours/week (L-T-P): **4-0-0**	No. of credits:**04**
Internal assessment: **30 marks**	Semester End Examination: **70 Marks**
Total contact hours: **55**	

COURSE OBJECTIVE

- To understand the principles of plant nomenclature and taxonomy and apply this knowledge to the proper communication about landscape plants. Students will clearly distinguish between the hierarchical categories of plants (especially Order, Family, Genus and Species) and will be able to place individual landscape plants in the corresponding category. Students will also master the necessary details of herbaceous and woody plant morphology that will aid in identification.

Unit-1Principles of gardening **11 hrs**

Principles of gardening, garden components, adornments, lawn making, methods of designing rockery, water garden, etc. Landscaping, basic principles and basic components. Computer applications in landscaping

Unit-2 Garden types, features and components **11 hrs**

Special types of gardens, their walk-paths, bridges, constructed features. Greenhouse. Special types of gardens, trees, their design, values in landscaping, propagation, planting shrubs and herbaceous perennials. Importance, design values, propagation, potting, climbers and creepers, palms, ferns, grasses and cacti succulents.

Unit-3 Ornamental Plants **11 hrs**

Flowering annuals; Herbaceous perennials; Shrubs, Climbers; Ornamental trees; Ornamental bulbous plants; Palms and Cycads; Potted plants and indoor gardening. Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolus, Marigold, Rose, Lilium, Orchids); Bonsai & Terrariums.

Unit-4 Propagation of Garden Plants **11 hrs**

Sexual and vegetative methods of propagation; Role of plant growth regulators. Floral arrangement and bonsai Importance, production details and cultural operations, constraints, post-harvest practices. Culture of bonsai, art of making bonsai.

Unit-5 Gardening operations **11 hrs**

Soil laying, Manuring, Watering, Management of pests and diseases; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Mulching; Pruning, Topiary making.

REFERENCES

1. Dirr, Michael A. (2009) Manual of Woody Landscape Plants. Their Identification, Ornamental Characteristics, Culture, Propagation and Uses. 6th Edition. Stipes Publishing, Champaign, Illinois.
2. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
3. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
4. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
5. Hartmann and Kester, 2010. Plant Propagation: Principles and Practices. Pearson Publisher.
6. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
7. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
8. Thakur, A.K., Kashyap, B., Bassi, S.K. and Sharma, M. 2018. Floriculture. S. Dinesh & Co., Jalandhar
9. SaidaiahPidigam, Sindhuja S., Geetha Amarapalli. (2018)Text Book of Nursery, Gardening and Floriculture, Kalyani Publishers, New Delhi.

COURSE OUTCOMES:

1. Students will be accustomed to the contents and details of gardening and landscaping.
2. Students will be acquainted with the features of different types of gardens.
3. They could categorize annuals, perennials, and flowering trees required for landscaping and gardening.
4. Develop skills in roof/terrace/vertical gardening
5. Understand the role and importance of indoor and outdoor plants as aesthetics.
6. Students will understand the propagation techniques of garden plants.
7. Students will be familiar with various hedges and edge plants.

M.Sc. Botany III Semester

Course: **B. Applied and Industrial Botany**	Course code: **21BOT3E1BL**
Teaching hours/week (L-T-P): 4-0-0	No. of credits:**04**
Internal assessment: **30 marks**	Semester End Examination: **70 Marks**
Total contact hours: **55**	

COURSE OBJECTIVE

- Understand various processes of commercial production, extraction, manufacture, and utility of wood, paper, sugar and sugarcane, rubber, essential oils, and vegetable oils, gums, resins, and dyes. Pharmaceutical products like nutraceuticals, and medicines like quinine. Packing of milk and milk products, pickles, jams, jellies, juices, pastes, sauces etc.

Unit-1Extraction of sugar from sugar cane **11 hrs**

Flow diagram of the process with a critical study of the steps involved, and problems faced by the sugar industry in India. Bye-products of the sugar industry, the distillation of alcohol and other products

Unit- 2 Commercial Wood **11 hrs**

Physical characteristics of Indian woods, methods of seasoning, and chemical treatment of specialized use fireproofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywood according to their use. Some important commercial woods: Dalbergia spp., *Shorearobusta, Tectona grandis, Cedrus deodara*, Bamboo-the 'green gold' of India

UNIT 3 **11 hrs**

Paper and Rubber industry: Manufacturing of paper and board from raw plant material. Manufacturing of crude and high-quality paper and recycled paper. The rubber plants of India, extraction of raw rubber and its chemical processing for the manufacturing of finished rubber.

UNIT 4 **11 hrs**

Sources and methods of extraction of essential oils, vegetable oils, and fats and their utilization. Fibers: Classification of fibers, physical and chemical processes involved in the

manufacturing of fibers from different types of fiber-yielding plants. Gums and Resin: Classification and extraction and uses. Dyes: sources and extraction methods.

UNIT 5 **11 hrs**

Pharmaceutical and Agro industries- Production of Plant medicines: An introduction to the pharmaceutical industry in India, extraction of antibiotics from higher plants, Industrial manufacturing of quinine. Nutraceuticals: source, utility. Agro industries in India with particular reference to Karnataka.

REFERENCES

1. Brown H P (1989). An Elementary Manual on Indian Wood Technology (Reprinted). International Book Distributors, Dehra Dun, India.
2. Kochhar S. L. (1998). Economic Botany in the Tropics. MacMillan India Limited, Delhi.
3. Pandey B P (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd. New Delhi.
4. Shankar Gopal Joshi (2000). Medicinal Plants. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi. 6. Ambasta S P (1994). The Useful Plants of India. (3rd Ed.). Publications & Information Directorate, New Delhi.
5. Trotter H (1982). The Common Commercial Timbers of India and their Uses. The Controller of Publications, Delhi.

COURSE OUTCOMES

1. Understand various processes of commercial production of wood, paper, essential and vegetable oils.
2. Able to distinguish between commercial and noncommercial plants.
3. Understand procedures and methodology of extraction and manufacture of medicines like quinine.
4. The role of nutraceuticals in human health is well understood.
5. Industrial packing of milk and milk products, pickles, jams, jellies, pastes etc. arouse interest and understood the processes.

M.Sc. Botany III Semester

Course: **C.Plant Biochemistry**	Course code**: 21BOT3E1CL**
Teaching hours/week (L-T-P): **4-0-0**	No. of credits: **04**
Internal assessment: **30 marks**	Semester End Examination: **70 Marks**
Total contact hours: **55**	

COURSE OBJECTIVE

- Will be able to understand biochemistry fundamentals and will learn about important metabolic processes taking place in plants. Acquire detailed knowledge about photosynthesis, metabolism of saccharides, metabolism of nitrogen compounds, and about molecular mechanisms of signalization and regulation.

COURSE CONTENTS

Unit-1 Carbohydrate **11 hrs**

Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Polysaccharides. Glycoproteins, glycolipids, proteoglycans, mutarotation, isomerization epimerization, stability of polysaccharides.

Unit-2 **11 hrs**

Glycolytic pathway; regulation of the hexokinase, phosphofructokinases, Kreb'scycle amphibolic nature of TCA cycle, glyoxylate cycle, glycogen breakdown, glycogen synthesis, regulation of glycogen metabolism.

Unit-3 **11 hrs**

Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body, oxidation of fatty acids (beta & alpha), oxidation of long chain fatty acids, Synthesis of lipids.

Unit-4 **11 hrs**

Structure, composition and properties of nucleic acids, De-Novo synthesis of purine and pyrimidine nucleotides and its regulation. Hydrodynamic methods of separation of biomolecules such as viscosity and sedimentation- their principles, variants, and applications.

Unit-5 **11 hrs**

Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids, and general reactions of amino acid metabolism. Structure and properties of vitamins, co-enzymes, biochemical action of vitamins and water-soluble vitamins, Biosynthesis of vitamins, and role of vitamins in the metabolism.

REFERENCES

1. Berg J.M., Tymoczko J.L. and Stryer L., Biochemistry. 7th edition, W.H. Freeman and Co. New York, 2011.Lenninger, Albert L., David L. Nelson, and Michael M. Cox. 2000. Lehninger principles of biochemistry. New York: Worth Publishers.
2. Biochemistry & Molecular Biology of Plants, 2nd edition, edited by Bob. B. Buchanan, Wilhelm Gruissem, and Russell L. Jones. ASBP and Wiley Blackwell.
3. Biochemistry, 5th edition, by Berg, Tymoczko and Stryer, New York: WH Freeman, 2002, http://www.ncbi.nlm.nih.gov/books/NBK21154.
4. Nelson, D. C. andCox, M.M., Lehninger Principles of Biochemistry, 5thEdition,W. H. Freeman, 2010.
5. Principles of Biochemistry, 2nd edition, by Lehninger, Nelson, and Cox, New York: Worth, 1992 http://www.bioinfo.org.cn/book/biochemistry.
6. Voet D., Voet J.G, Biochemistry 4 th Edition., John Wiley and Sons, 2011.

COURSE OUTCOMES

1. Students will extend their knowledge of biochemistry fundamentals and will learn about the significance of biochemistry and important metabolic processes taking place in plants.
2. Students will be able to contrast the different mechanisms of carbon fixation in the plant kingdom.
3. Students will be able to characterize the main biosynthetic pathways of natural products.
4. Acquire a detailed knowledge about the chemistry of carbohydrates, lipids, proteins and amino acids and their classification, structural organization of proteins, metabolism of saccharides, lipids.
5. Learn amino acid structures and relate their chemical properties to the synthesis and unction of proteins and enzymes.
6. Understand protein structural hierarchy and relate structure to function.

M.Sc. Botany III Semester

Course:**A. Medicinal and Aromatic Plants**	Course code: **21BOT3E2AL**
L-T-P per week **4-0.0**	No of credits **– 04**
Internal Assessment: **30 marks**	Semester end Examination: **70 marks**
Total contact hours: **55**	

COURSE OBJECTIVES

1. To educate the student on the basic concepts of herbal medicine
2. To provide knowledge of the traditional system of medicine and their vast richness
3. To disseminate the knowledge on the classification of plants based on biological sources and drugs of plants
4. To provide an understanding of the usage of herbal medicine based on important chronic and non-chronic diseases
5. To gain knowledge of medicinal plants and awareness of the conservation of plants

COURSE CONTENTS

Unit-1 Medicinal and aromatic plants 11 hrs

: Definition, history, importance, and future prospects. Medicinal plants-past and present status in the world and India. MAPs as industrial crops – constraints and remedial measures. Medicinal plant diversity & local healthcare. Medicinal plant conservation – Issues and approaches. Medicinal plant conservation areas (MPCA), non-timber forest products (NTFP).

Unit-2 Herbal drugs 11 hrs

Method and preparation of herbal drugs for the treatment of heart and blood disorders, nervous disorders, respiratory and intestinal disorders, jaundice, urinary, skin, hair, diabetes, cancer, gynecological disorders, and infertility. Plants are used as general tonics. Medicinal food plants: Cereals, pulses, spices, fruits, vegetables, and wild food plants. Medicinal and nutritive value of mushrooms

Unit-3 Oil yielding plants, cultivation of medicinal and aromatic plants 11 hrs

Regional distribution of aromatic and non-aromatic oil-yielding plants. Use of vegetable oil in food, medicine, and industry. Cultivation practices, diseases, and methods of pest control, harvesting, and storage of medicinal plants. Post-harvest care, deterioration, and disintegration of the active compound during storage (*Rauwolfia*, *Costus*, *Withania*, *Mentha*, *Cymbopogon*). Controversial drugs

Unit-4 Pharmacognosy, Phytochemistry, and Intellectual Property Rights 11 hrs

Raw drug analysis, microscopic, macroscopic characteristics, and preliminary chemical analysis (*Senna*, *Withania*, *Rauwolfia*). Classification of alkaloids, steroids, terpenoids, lectins, and non-protein amino acids. Principles and applications of MS, UV, IR, NMR spectral analysis, and crystallography. IPR is related to medicinal and aromatic plants.

Unit-5 Important aromatic plants of India 11 hrs

Introduction and background of aromatic plants and cosmetic products. Raw material for perfumes etc. Cosmetic industries. Taxonomic descriptions and uses of important aromatic plants -Citronella, Dhavana, Geranium, Cardamom, Lavender, Lemon grass, Mentha, Holy basil, Rosemary, Eucalyptus, Celery, Tamarind, Saffron, Artemisia, Oreganum, and Curry leaf

REFERENCES:

1. Kirtikar KR and Basu BD (1932) Indian Medicinal Plants
2. Nadkarni AK (1954) Indian Materia medica Vol-I and II
3. Sivarajan VV and Indira B (1994) Ayurvedic drugs and their plant sources. Oxford and IBH Publishing Co., New Delhi
4. Trease GE and Evans WL (1983) Pharmacognosy 12th Ed. Bailliere Tindall, London
5. Vaidya B (1982) Some controversial drugs in Indian medicine. Chaukamba Orientalia, Varanasi
6. Harborne J (1984) Phytochemical methods. Ed. Chapman & Hall, London
7. Mann J., Davidson RS Hobbs JB., Benthorpe DV and Harborne Natural Products, Longman Scientific and Technical Co, Essex
8. Smith PM (1976) The chemotaxonomy of plants Edward Arnold, London
9. Prajapati, Purohit, Sharma and Kumar (2007) Hand Book of Medicinal Plants: A complete source book, Agrobios India
10. Maheshwari JK (2000) Ethnobotany and medicinal plants of Indian Subcontinent, Scientific Publishers, India
11. Rastogi RP and Meharotra BN (1991) Compedium of Medicinal Plants. Vol I and II CDIR Lucknow and Publication and information directorate New Delhi, India.
12. Prajapati et al., (2003) A Hand Book of Medicinal Plants – A complete source book. Agrobios, Jodhpur, India.

COURSE OUTCOMES

After successful completion of this course graduates will be able to:

1. Analyze literature on traditional knowledge of the role of plants and related alternate medicine practices for the treatment of chronic diseases and improvement of health conditions in view of the new evidence provided by modern science and technologies.
2. Identify different medicinal and aromatic plants available in different parts of the country
3. Carryout processing of MAPs for value addition

4. Develop different products from MAPs
5. Become self-employed in related sectors

M.Sc. Botany III Semester

Course: **B.Seed Technology**	Course code: **21BOT3E2BL**
Teaching hours/week (L-T-P): **4-0-0**	No. of credits: **04**
Internal assessment: **30 marks**	Semester End Examination: **70 Marks**
Total contact hours: **55**	

COURSE OBJECTIVE

To familiarize the importance and need of seed technology and seed certification. To properly select healthy seeds and methods of seed treatment pre and post-harvest. To understand seed act and seed control order.

Unit-1 Seed and Seed technology **11 hrs**

Introduction, definition, and importance. difference between seed and grain. Role of seed technology. Goas of seed technology. Causes of deterioration of crop varieties and their control & maintenance of genetic purity during seed production. Seed quality, characters of good quality seed.

Unit-2 Classes of seed **11 hrs**

Definition and classes of seeds- nuclear seeds, foundation seeds, registered seeds, certified seeds. Certified seed production of important cereals (Sorghum, Wheat, Maize, Rice & Bajra). Foundation and certified seed production of important pulses (Pigeon pea, green gram, etc.). Foundation and certified seed production of important vegetable crops.

Unit-3 Seed storage **11 hrs**

Objective, purpose, and importance of seed storage. Stages of seed storage- (i) storage of seed on plants (physiological maturity until harvest) (ii) storage from harvest until processing (iii) storage of seed in the warehouse, cryopreservation. Requirement and types of seed storage. Factors affecting seed storage and role of moisture, temperature, pH, and moisture equilibrium. Viability nomographs, Seed drying- forced air seed drying, heated air drying, management of seed drying. Processing and their steps

Unit-4 Seed health **11 hrs**

Seed health testing- Direct examination (inspection), incubation tests, blotter tests /seedling symptom tests. Agar plate, examination of the embryo, immunoassay, molecular methods. Significance of seed health. Procedures for seed health test and rules. Seed-borne pathogens-

externally and internally borne diseases. Important diseases of cereals, pulses, and vegetables. Use of pesticides, botanicals, and mycotoxins for seed treatments.

Unit-5 Quarantine and International procedures of phytosanitary certificates 11 hrs

Phytosanitary certificate (PSC), International plant protection convention (IPPC) 1951. Procedure for inspection and issue of phytosanitary process. Seed Act and Seed Act enforcement Duty and powers of seed inspector, offenses and penalties. Seed control order 1983.

REFERENCES

1. Anonymous, 1992. Legislation on Seeds. NSC Ltd., Department of Agriculture and Cooperation, Ministry of Agriculture, New Delhi.
2. Dhirendra Khare and Mohan Bhale. 2921. Seed technology SuccintEdn. (PB). Scientific
3. Nema, N.P. 1986. Principles of Seed Certification and Testing. Allied Publishers, NewDelhi.
4. Nempal Singh, DK Singh, YK Singh, and Virendra Kumar. 2006. Vegetable seed
5. Phundan Singh. 2013. Principles of seed technology. Kalyani Publications, New Delhi Production. International Book, Distribution company. Lucknow publishers, Jodhpur.
6. R L Agarwal. 2017. Seed technology. Oxford and IBH, publishing company, New Delhi.
7. Subirsen N Ghosh. 2014. Seed Science and Technology. Kalyani Publications, New Delhi
8. Tunwar, N.S. & Singh, S.N. 1988. Indian Minimum Seed Certification Standards. CSCB, Ministry of Agriculture, New Delhi.

COURSE OUTCOMES

1. To believe in the role of good quality seed in agriculture
2. To grasp the significance of basic principles of seed production in crop plants
3. To understand legal procedures related to seed quality control
4. To grasp the importance of Indian minimum seed certification standards
5. To know the systems involved in seed production
6. Students will get knowledge on seed storage methods and seed treatment procedures.
7. To really understand the procedure for seed certification.

M.Sc. Botany III Semester

Course: C. Nanobiotechnology	Course code: **21BOT3E2CL**
L-T-P per week **4-0.0**	No of credits – **04**
Internal Assessment: **30 marks**	Semester end Examination: **70 marks**
Total contact hours:**55 hrs**	

COURSE OBJECTIVES

1. To introduce students to the exciting and emerging field of bio-nanotechnology.
2. It provides an understanding of biophysics, modern biomaterials, bio-nanomachines, biomolecular design, and functional principles of nanotechnology
3. To make the students acquire an understanding the Nanoscience and applications
4. To help them understand in broad outline of Nanoscience and Nanotechnology

COURSE CONTENTS

Unit-1 Introduction **11 hrs**

The nanoscale dimension and paradigm. Definitions and historical evolution (colloids etc.) and current practice. Types of nanomaterials and their classifications (1D, 2D, and 3D, etc. Nanocrystal, Nanoparticle, Quantum dot, Quantum wire, Quantum well, etc.). Polymer, carbon, inorganic, organic, and biomaterials – structures and characteristics.

Unit-2 Physical, chemical, and biological fundamentals of nanomaterials **11 hrs**

Overview of synthetic methods, surfactants, polymers, and emulsions. micelles / reverse micelles and colloids. Top-down and bottom-up approaches. Biological methods (plants, microbes, and biomimetics). Growth and stabilization. Self-assembly. DNA-protein nanostructures, DNA-based metallic nanowires, and networks. DNA-gold nanoparticles conjugates

Unit-3 Properties and Characterizations of Nanomaterials **11 hrs**

Optical (UV-Vis/ Fluorescence), X-ray diffraction, Imaging and size (Electron microscopy, light scattering, Zeta potential, surface composition (ECSA, EDAX, AFM/STM etc). Vibrational (FT-IR and Raman spectroscopy. Magnetic, electrical, and electrochemical methods.

Unit -4 Nanomaterials and diagnostics/drug delivery and therapeutics **11 hrs**

MRI, imaging, surface modified nanoparticles. MEMS/ NEMS based nanomaterials/ Peptide / DNA coupled nanoparticles. Lipid nanoparticles for drug delivery. Inorganic nanoparticles for drug delivery, metal/ metal-oxide nanoparticles (antibacterial/ antifungal / antiviral), anisotropic and magnetic particles (hyperthermia)

Unit-5 Current Application of Nanoparticles in food and medicine **11 hrs**

Nanoparticle-based drug delivery systems – ultra sound triggered nano/ microbubbles- regenerative medicine – nanoimmuno conjugates- Biosensors-Optical biosensors based on nanoplasmonics. Cyclodextrin in nanomedicine foods and cosmetics- Bioavailability and delivery of nutraceuticals and functional foods using nanotechnology. Nanocomposite for food packaging. Nanoparticles in cancer, infectious disease, auto-immune disease, cardiovascular disease, neurodegenerative, ocular disease, pulmonary disease, and regenerative therapies

REFERENCES

1. Jain KK (2012) The handbook of nanomedicine, Springer
2. Bhushan Bharat (Ed) 2012. Encyclopedia of Nanotechnology. Springer
3. Sharon M and Sharon M (2012) Bio-Nanotechnology -concepts and applications, CRC Press
4. Cao G Nanostructures and Nanomaterials – Synthesis, properties and applications. Imperial College Press 2006
5. Nanostructured materials: Processing, properties and potential applications. Edited by Carl C. Koch, Noyes Publications, 2002.
6. David E Reisner (2011) Bionanotechnology II-Global Prospects, CRC Press, Nano/Micro Biotechnology, Springer
7. Niemeyer CM (2006) Nanobiotechnology: Concepts Applications and Perspectives, Wiley -VCH, 2006
8. David S GoodsellBionanotechnology, John Wiley & Sons, 2004
9. Buddy D Ratner, Allan S Hoffman, Federick J Schoen Jack E Lemons "Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2012.
10. DebasisBagchi, ManashiBagchi, Hiroyoshi Moriyama, Fereidoon Shahidi – "Bio-Nanotechnology" A Revolution in food, Biomedical and Health sciences" Wiley – Blackwell, 2013.

COURSE OUTCOMES

Upon completion of this course, students should be able to

1. Gain knowledge and understanding about harnessing biological systems to further nanotechnological endeavor
2. Gain knowledge of structure and function of biological systems and cellular systems to construct the functional devices within nanotechnology
3. Apply their learned knowledge to develop Nanomaterials
4. Learn current applications and state of the art within bio nanotechnology.

M.Sc. Botany III Semester

Course: **A.Forensic Botany**	Course code: **21BOT3G1AL**
Teaching hours/week (L-T-P): **2-0-0**	No. of credits: **02**
Internal assessment: **20 marks**	Semester End Examination: **30 Marks**
Total contact hours – **35 hrs**	

COURSE OBJECTIVES:

1. To understand the critical role of basic botanical science for a range of forensic botanical methods and how this science can influence society;
2. Able to articulate ways in which underlying biological variability and similarity can be exploited in a forensic context
3. Capable of reading and understanding primary literature (case studies) in forensic botany;
4. Achieve awareness of the primary literature in basic science that serves as the foundation for forensic literature and field application.

COURSE CONTENTS

Unit-1Plants as evidence **07 hrs**

Plant classification schemes, sub-specialization of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology, limnology, plant architecture roots, stems, flowers, leaves. Various types of woods, timbers, seeds, and leaves and their forensic importance, Identification and matching of various types of wood, timber varieties, seeds, and leaves.

Unit-2Algae in forensic investigations **07 hrs**

Algal diversity, Application of algal evidence in forensic investigations- Linking suspects to specific aquatic crime scenes or physical evidence, Diagnosis and placing of death by drowning. Linking suspects to specific aquatic crime scenes or physical evidence. Case studies. Diagnosis and placing of death by drowning. Diagnosis of algal toxins poisonings. Collection and processing of algal evidence in forensic investigations.

Unit-3 Plant DNA analyses in forensics and poisonous plants **07 hrs**

Types of samples and collection for DNA analyses, Plant species identification. Genotyping methods, DNA extraction, microsatellites, random/anonymous markers. Genetic interpretation. Case studies. Poisonous plants: *Abrusprecatorius*, *Anacardium occidentale*, *Argemone mexicana*, *Calotropis*, *Cannabis sativa*, *Atropa belladonna*, *Gloriosa superba*, *Jatropha curcas*, *Nerium indicum*, *Nicotiana tobacco*, *Plumbago*, *Ricinus communis*, *Strychnosnuxvomica*, *Thevetianerifolia*.

Unit-4Collection and preservation of botanical evidence 07 hrs

Botanical samples, outdoor crime scene consideration, Analysis of samples, DNA analysis, plant DNA typing, classic forensic botany cases: Case histories by using plant anatomy and systematic, Palynology, Plant ecology, Limnology, Plant Molecular Biology, and Drug enforcement.

Unit-5 Forensic palynology 07 hrs

Pollens and spores. Chemical and Physical resistance. Mode of pollen transmission and pollination. Pollen structure and anatomy. Use of pollens in the forensic and non-forensic setting. Plants growing in the relevant locations. Collection and storage of pollen samples. Collection tools and accidental contamination. Case examples- murder and genocide.

REFERENCES

1. Coyle H.M. (2004) Forensic Botany: Principles and applications to criminal casework. CRC Press
2. James SH., Nordby JJ., Bell S (2015). Forensic Science: An Introduction to Scientific and Investigative Techniques. CRC Press; 4 edition
3. Hall DW and Byrd J (2012) Forensic Botany: a practical guide. Wiley -Blackwell, I edition
4. Bock JH and Nirris DO (2016) Forensic plant Science, Academic Press.
5. David W Hall and Jason H Byrd (2012) Forensic Botany, a practical guide. Wiley-Blackwell. A John Wiley and Sons Ltd., Publication.

COURSE OUTCOMES

After completing this course, the learner will be able to:

1. Conceptualize the classification of plants from a forensic point of view
2. Understand the forensic importance of different parts of plants
3. Provide the basic knowledge about the application of Botany to Forensic investigations

M.Sc. Botany III Semester

Course: **B.Biofertilizers and Biopesticides**	Course code: **21BOT3G1BL**
Teaching hours/week (L-T-P): **2-0-0**	No. of credits: **02**
Internal assessment: **20 marks**	Semester End Examination: **30 Marks**
Total contact hours – **35 hrs**	

COURSE OBJECTIVE

- To conceptualize applications of biofertilizers and biopesticides in human welfare and familiarize with the production technology of biopesticides. Get well acquainted with methods of application of biofertilizers, biopesticides, and bioagents.

COURSE CONTENTS

Unit-1 History and concept of Biopesticides ***07 hrs***

Definitions, concepts, and classification of biopesticides: Classes of biopesticides. Microbial pesticides, biochemical pesticides, and plant-incorporatedprotectants (PIPs). Advantages of using biopesticidesand Biorationals'. Biocontrol agents: Importance of Trichoderma spp., Pseudomonas spp. and Bacillus spp. as a biocontrol agents

Unit-2 Production technology of Biopesticides ***07 hrs***

The basic requirement for establishing t of biopesticide unit. Biopesticide registration. Major types of bioagents are available for commercial production. Isolation, selection of strain, preparation of mother culture, starter culture, mass culturing of Rhizobium, Azotobacter, Azospirillum, Anabaena.

Unit-3 Biofertilizers ***07 hrs***

History advantages of biofertilizers over chemical fertilizer. Types of biofertilizers- Fungal biofertilizers. Organic farming - Definition, classification, advantages, and constraints. Bacterial biofertilizers. Culturing of microorganisms: Fermentation Method-Bioreactor and protocol. Mycorrhizae as biofertilizers.

Unit-4 Application of biofertilizers, biopesticides and bioagents ***07 hrs***

Plant growth promoting Rhizobacteria (PGPR). Bacterial endophytes and endosymbionts. Application Methods of Carrier Based Biofertilizers, Application Methods of Liquid Biofertilizer- seed treatment, seedling treatment, soil application, soil pelleting, foliar spray, drip irrigation.

Unit-5 Role of microorganisms in decomposition of organic form waste 07 hrs

Stages in the breakdown of organic matter. Mineralisation of organic matter. Immobilisation of mineral nutrients. Method of decomposition of organic wastes like Cellulose, hemicellulose, Lignin. Decomposition of soil organic matter.

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REFERENCES

1. Agrios, G. N. Plant Pathology, Fourth Edition 1997, AcademicPress.
2. Dubey, R. C. (2008): A Textbook of Biotechnology. S. Chand & Co., NewDelhi.
3. Ilanchet (Ed.). Innovative Approaches to plant disease Control. Wiley InterScience Publication, Ihon Wiley and Sons New York(1987).
4. Kannaiyan, S., 2003. Biotechnology of Biofertilizers, CHIPS, Texas.
5. Mahendra K. Rai, 2005. Handbook of Microbial biofertilizers, The Haworth Press, Inc. New York. Reddy, S.M. et. al., 2002. Bioinoculants for sustainable agriculture and forestry, Scientific Publishers, Jodhpur.
6. Newton, W. E. et al. (1977): Recent Developments in Nitrogen Fixation.Academic Press, NewPlants. Academic Press Inc., San Die go, USA.
7. Saleem, F.and A.R. Shakoori, 2012. Development of Bioinsecticide, Lambert Academic Publishing, Latvia, European Union.
8. Schwintzer, C. R. and Tjepkema, J. D. (1990): The Biology of Frankia andActinorhizal
9. Stewart W. D. P. and Gallon J. R. 1980): Nitrogen Fixation. Academic Press, NewYork.
10. Subba Rao, N. S. (1982): Advances in Agricultural Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., NewDelhi.
11. Subba Rao, N. S. (2002): Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., NewDelhi.
12. Subba Rao, N. S. and Dommergues, Y. R. (1998): Microbial Interactions in Agriculture and Forestry. Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd., NewDelhi.
13. SubbaRao N.S., 1995 Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. New Delhi
14. Verma, A. (1999): Mycorrhiza. Springer Verlag,Berlin.
15. Wallanda, T. et a*l*. (1997). Mycorrhizae. Backley's Publishers, TheNetherlands. NewYork.

COURSE OUTCOMES

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

1. Realize the importance of eco-friendly fertilizers and pesticides.
2. Demonstrate skills in culture and mass production of biofertilizers and biopesticides.
3. Acquire sound knowledge on application of the biofertilizers and biopesticides for various crops. Study the efficacy of biofertilizers and biopesticides in organic farming.

M.Sc. Botany III Semester

Course: C. Aquatic Botany	Course code: **21BOT3G1CL**
Teaching hours/week (L-T-P): **2-0-0**	No. of credits: **02**
Internal assessment: **20 marks**	Semester End Examination: **30 Marks**
Total contact hours – **35 hrs**	

COURSE OBJECTIVES

1. Comprehend the marine diversity of lower Cryptogams and Angiosperms
2. Understand the morphology, anatomy, physiology, reproduction, and life cycle pattern
3. Their diversification and familiarity with various ecological niche
4. Economic benefits of marine seaweeds
5. To understand the ecological functions and economic uses of aquatic plants with special emphasis on Taxonomy, physiology, ecology, and economic importance of marine and freshwater plants.
6. Other special topics such as biofuel generation from aquatic plants

COURSE CONTENTS

Unit -1 Diversity of Aquatic plants and economic uses 07 hrs

Distribution, morphology, reproduction, and growth physiology of seaweeds. Important cultivable species of aquatic plants, seaweeds, and microalgae. Biodiversity of seaweeds along the coast of India. Seaweed polysaccharides, chemical structure, properties, and extraction of agar, carrageenan, and alginic acid. Important marine algal research centers in India and their work.

Unit -2 Phytoplankton 07 hrs

Diversity of plankton – cyanobacteria, chlorophytes, heterokontophytes, pymnesiophytes, dinophytes, cryptophytes, raphidophytes and rhodophytes. Role of phytoplanktons in geochemical cycles – nutrient requirements, marine food webs, distribution and abundance, biological carbon pump. Phytoplankton physiology and ecology- light acclimatization, bloom formation.

Unit -3 Freshwater higher vascular plants **07 hrs**

Biodiversity of freshwater higher vascular plants in India. Taxonomy of economically important freshwater higher vascular plants of higher vascular plants. Distribution, morphology, reproduction, life-cycle, growth physiology, and culture techniques of freshwater higher vascular plants- Typha, Trapa. Products of higher vascular plants

Unit-4 Diversity of Mangrove plants **07 hrs**

Definition of Mangrove, distribution – biogeography of Indian Mangroves, east and west coast mangroves, Mangrove forests. Salient features of important mangrove families- Rhizophoraceae, Avivenniaceae, Sonneratiaceae, Myrsinaceae, and Acanthaceae. Salt marshes, seagrasses, and sand dune vegetation. Anatomical, physiological, morphological adaptations, vivipary and its role. Fossil mangroves.

Unit-5 Hydroponics **07 hrs**

Hydroponics: Introduction, scope, and importance of hydroponics technology. Plant growth requirements: light, temperature, and humidity. Nutritional requirements, deficiencies, and toxicities. Types of hydroponics: Deep water culture, Ebb, and Flow. Wick systems, drip, and aeroponics.

REFERENCES

1. Chapman VJ (1976) Coastal vegetation. 2nd edition. Pergamon Press. New York
2. Desikachary TV (1975) Marine Plants. NCERT. New Delhi
3. Kumar HD. Introduction to Phycology
4. McConnaughey BH (1974) Introduction to Marine Biology
5. Ranade DR and Gadre RV (1988) Microbial aspects of anaerobic digestion. Laboratory Manual M.A.C.S. Pune
6. Sambamurthy AVSS (2005) A text book of Algae
7. Santhanam R, Ramnathan N, Venkataramanjan K and Jegathanam G (1987) Phytoplankton of Indian Seas and Aspects of Marine Botany. Daya Publication Home, Delhi
8. Sharma OP (1986) A Text Book of Algae. Tata McGraw Hill Publication Publications
9. Stein JR (1973) Handbook of Phycological methods. Cambridge University Press.

COURSE OUTCOMES

At the end of the course, the student should be able to understand

1. The biology and diversity of marine phytoplankton
2. The role of phytoplankton plays in the biological carbon pump as well as in the cycles of other important elements
3. Ecology of harmful algal bloom formation and toxin production
4. Commercial products derived from algae

M.Sc. Botany III Semester

Course: **Research Methodology**	Course code: **21BOT3S3LP**
Teaching hours/week (L-T-P): **2-0-0**	No. of credits: **02**
Internal assessment: **20 marks**	Semester End Examination: 3**0 Marks**
Total contact hours: **28 hrs**	

COURSE OBJECTIVES

1. To provide the students with the information, knowledge, and skills to identify academic journals of various quality
2. To teach students how to choose journals based on their quality and submit research articles independently.
3. To understand the advantages, disadvantages, responsibilities, and ethics of collaborative publishing

COURSE CONTENTS

Unit-1 Introduction to Research 6 hrs

Nature and importance of research- Aims, Objectives, and principles: Fundamental research versus applied research with examples. Qualitative versus quantitative research. Theoretical research versus experimental research with examples. Selection of a research problem and sources of literature – Journals, Conferences, Books. Types of sources. Literature survey engines - Scopus, Web of Science, Google Scholar, PubMed, NCBI, Scihub etc. Science citation index. Citations, h-index, i10 index, impact factor.

Unit-2 Methods of Data Collection 6 hrs

Data collection methods – Framing a hypothesis, designing controlled experiments, choosing the sample size, sampling bias, importance of independent replicates, conducting an experiment, maintaining a lab notebook to record observation. Identifying experimental errors. Case studies on well-designed experiments versus poorly designed experiments. Correlations versus Causation. Good laboratory practices.

Safety practices in laboratories, Introduction to Chemdraw, Chemsketch, and other basic software.

Unit-3 Data analysis (Practical): Data presentation and Writing 14 hrs

Technical presentation, technical writing, formatting citations. MS Excel for plotting the data (Pie chart, plots, bar chats)

Analysis using software tools: Descriptive statistics: Mean, standard deviation, variance, plotting data, and understanding error bars. Curve fitting: Correlation and regression. Distributions: Normal Distribution, Gaussian distribution, Skewed distributions. Inferential statistics: Hypothesis testing and understanding p-value. Parametric tests: Student's t-test, ANOVA. Tests to analyse categories data: Chi-square test.

REFERENCES

1. C.R. Kothari, Research methodology: Methods and Techniques. II Ed. New Age International Publishers (2009)
2. Shanthibhushan Mishra, Shashi Alok, Hand Book of Research Methodology, I Ed, 2017, Educreation Publishers
3. Basic Statistical Tools in Research and Data Analysis (https://w.w.w.ncbi.nlm.nih.gov/pmc/articles/PMC5037948/).
4. Introduction to statistical methods with MATLAB (MATLAB and Simulink Training (mathsworks.com)

COURSE OUTCOMES

1. Find gaps in the existing research of their interest and conduct the research accordingly
2. To write a research proposal
3. Publish research and review articles in the journal with impact factor
4. Write a project report as well as a research paper
5. To enable the use of statistical, graphical and algebraic techniques wherever relevant. To gain a proper understanding of statistical applications in research

M.Sc. Botany III Semester

Course: **Plant Physiology**	Course code: **21BOT3C7P**
Teaching hours/week (L-T-P): **0-0-2**	No. of credits: **02**
Internal assessment: **20 marks**	Semester End Examination: **30 Marks**
Total Contact Hours – **35**	

COURSE OBJECTIVES

To enable students with practical and analytical skills in different analyses and quantification of elements responsible for the overall physiological activities of plants.

LIST OF EXPERIMENTS

1. Determination of total and titrable acidity. Estimation of proteins in seeds by Lowry's method.
2. Separation of chloroplast pigments by solvent method
3. Determination of chlorophyll a, chlorophyll B, and total chlorophylls in C3 and C4 plants.
4. Estimation of reducing sugars in fruits.
5. Determination of iodine number. Quantitative estimation of carbohydrates by Benedict's and DNS method.
6. Estimation of total fat content in seeds To determine the Chlorophyll A and chlorophyll B ratio in C3 and C4 plants
7. Quantitative estimation of calcium by EDTA method.
8. Study of Kranz anatomy in C4 plant leaves. effect of red and far-red light on seed germination.

COURSE OUTCOMES:

1. Students will gain technical practice in determining various pigments in plants.
2. Students have got familiarity in process of quantification of carbohydrates, fat, and calcium from crop plants.
3. Understand various aspects of photo physiology like Photoperiodism, vernalization, circadian rhythms.

4. Are able to distinguish between C3 and C4 plants by performing several tests

5. Are able to estimate sugars from fruits.

REFERENCES:

1. Laboratory manual experimental plant physiology-I .2004.
2. Laboratory manual experimental plant physiology-II .2004.

M.Sc. Botany III Semester

Course: **-Molecular Biology**	Course code: **21BOT3C8P**
Teaching hours/week (L-T-P): **0-0-2**	No. of credits: **02**
Internal assessment: marks – **20 marks**	Semester End Examination: **30 Marks**
Total contact hours: **35**	

COURSE OBJECTIVES

This course is aimed to teach students different approaches to performing molecular biology practical aspects and their practical applications in advanced biomolecular research as well as in pharmaceutical industries.

LIST OF EXPERIMENTS

1. Isolation of genomic DNA
2. DNA isolation from cauliflower head
3. Restriction digestion of DNA
4. Bacterial transformation of plasmids
5. Plasmid DNA isolation
6. Estimation of RNA by Orcinol method
7. Ligation of DNA into plasmid vectors
8. Estimation of DNA by diphenylamine reagent / UV spectrophotometry
9. Study of DNA replication mechanisms through photographs (rolling circle, theta replication, and semi-discontinuous replication).
10. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al., Griffith's, Hershey and Chase's, and Fraenkel and Conrad's experiments)
11. Study of the following mechanisms through photographs: Assembly of spliceosome machinery, splicing mechanism in group-I and group-II introns, ribozyme, and alternative splicing.
12. Identification of gene by colony PCR
13. cDNA synthesis by RT-PCR

REFERENCES

1. Michael R Green and Joseph Sambrook (2012) Molecular Cloning – A laboratory manual – Fourth Edition. Cold Spring Harbor Laboratory Press
2. Plummer DT (1988) An introduction Practical Biochemistry, 3rd ed., TaTa Mc Graw-Hill Pub. Co., New Delhi, pp221
3. Introductory Practical Biochemistry, Editors: SK Sawhney and Randhir Singh, Narosa Pub House, pp 74-75.

4. Molecular Biology of Cell by Bruce Alberts 4th Edition

COURSE OUTCOMES

1. To gain hands-on experience in genomic DNA and plasmid DNA isolation
2. Isolate proteins and RNA molecules from the different plant/animal tissue samples
3. Determine the concentrations of isolated DNA, RNA, and proteins
4. Cloning by PCR approach, DNA and PCR amplification for DNA fingerprinting analysis via RAPD and restriction digestion
5. To conduct gene amplification experiments by PCR analysis
6. This practical experience would enable them to begin a career in biotech as well as the pharmaceutical industry that engages in genetic engineering as well as in R & D laboratories conducting advanced research.