ANDHRA KESARI UNIVERSITY

University COLLEGE OF AKU

DEPARTMENT OF MICROBIOLOGY

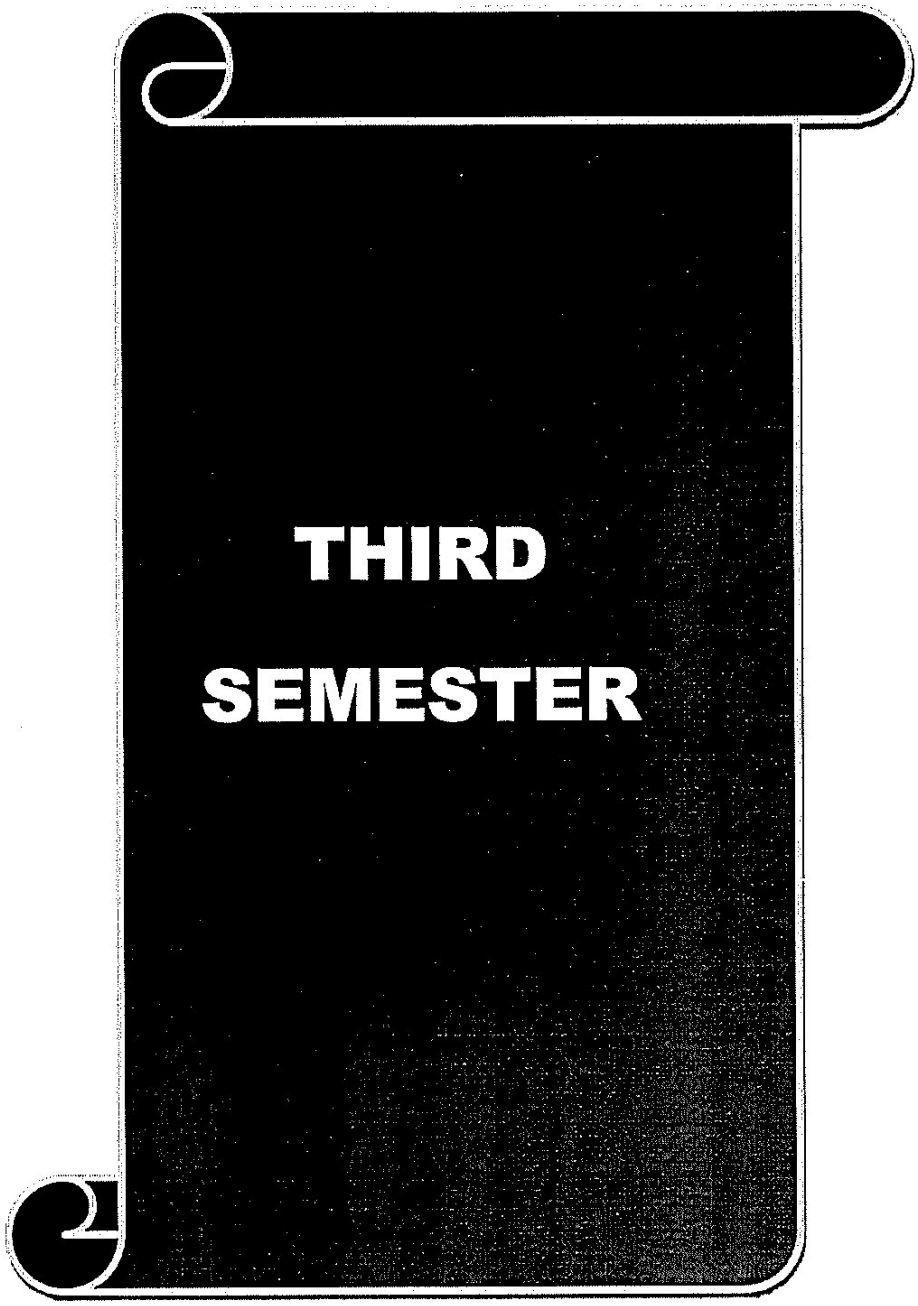
M.Sc. BOTANY: 2026-2027

Course Structure

Course code	M.Sc. BOTANY							
		L	P	S/M/P	C	CIA	ESE	Total
SEMESTER I								
BOT 1.1	Core - Plant Systematics	4			4	30	70	100
BOT 1.2	Core - Reproductive Biology of Angiosperms	4			4	30	70	100
BOT 1.3	Compulsory Foundation - Biology and Diversity of Viruses, Bacteria, Algae and Fungi	4			4	30	70	100
BOT 1.4 A/B/C	(A) Elective Foundation - Outlines of Bryophytes, Pteridophytes, Gymnosperms and Plant Fossils (B) Elective Foundation– Phycology (C) Elective Foundation - Evolutionary Biology	4			4	30	70	100
BOT PI	1.1 + 1.2		6		4	30	70	100
BOT PII	1.3 + 1.4		6		4	30	70	100
	Audit Course		2	6	2	50	-	-
	Sub-Total:				24			600
SEMESTER II								
BOT 2.1	Plant Ecology and Biodiversity	4			4	30	70	100
BOT 2.2	Plant Physiology	4			4	30	70	100
BOT 2.3	Compulsory Foundation – Cell Biology	4			4	30	70	100
BOT 2.4 A/B/C	(A) Elective Foundation - Plant Structure and Development (B) Elective Foundation – Principles of Forestry (C) Elective Foundation - Microorganisms in Health and Environmental Alleviation	4			4	30	70	100
BOT PI	2.1 + 2.2		6		4	30	70	100
BOT PII	2.3 + 2.4		6		4	30	70	100
Skill Development Course	MOOCS	2		6	2	50	-	-
	Sub-Total:				24			600

SEMESTER III								
BOT 3.1	Plant Pathology	4			4	30	70	100
BOT 3.2	Plant Metabolism	4			4	30	70	100
BOT 3.3 A/B/C	(A) Elective-I - Ethnobotany and Ethnomedicine (B) Elective-I – Principles and Methods of Plant Propagation (C) Elective-I – Mushroom Cultivation and Single Cell Protein	4			4	30	70	100
BOT 3.4 A/B/C	(A) Elective- II – Molecular Biology of Plants (B) Elective- II – Advanced Molecular Tools (C) Elective- II – Phytoremediation	4			4	30	70	100
BOT PI	3.1 + 3.2		**6**		4	30	70	100
BOT PII	3.3 + 3.4		**6**		4	30	70	100
Skill Enhancement Course	Through MOOCS			6				
	Sub-Total:				24			600
SEMESTER IV								
BOT 4.1	Plant cell, Tissue and Organ Culture	4			4	30	70	100
BOT 4.2 A/B/C	(A) Elective-I – Cytogenetics and Plant Breeding (B) Elective-I – Genomics, Proteomics and Metabolomics (C) Elective-I – Genetic engineering and Bioinformatics	4			4	30	70	100
BOT 4.3 A/B/C	(A) Elective- II –Horticulture and Landscaping (B) Elective- II – Organic Farming and Vermi Composting (C) Elective- II – Biofertilizer Technology	4			4	30	70	100
BOT PI	4.1 + 4.2			6	4	30	70	100
BOT PI	4.3 + 4.4			6	4	30	70	100
Project work				6	4	-	-	100
	Sub-Total:				24			600
	Grand Total				96			2400

Note: pass in audio course, skill development and skill enhancement courses are mandatory.


THIRD
SEMESTER

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. BOTANY

SEMESTER-III

Semester	BOT 3.1: PLANT PATHOLOGY	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	Impart knowledge about plant disease symptoms, different strategies of the pathogen invasion into host tissues, control measures for plant diseases and importance of Integrated Pest Management (IPM).

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Identify the symptoms caused by Fungi, Bacteria and Viruses useful in the process of identification of pathogenic organism.
CO2	Understand the pathogen invading mechanisms and also realize the role of a pathologist in disease forecasting and development of disease resistance.
CO3	Differentiate the pathogenicity of pathogens belongs to different classes of fungi.
CO4	Understand the nature of bacterial and viral diseases of plants.
CO5	Appreciate the role of plant quarantine centers in controlling the diseases and know the application of biological methods in pest control measure.

UNIT-I

Concept of disease in plants; Definitions of plant disease; Historical development of Plant Pathology. Methods of studying Plant disease; collection, preservation, isolation of pathogens and proving Koch postulates. Symptoms caused by plant pathogenic fungi, bacteria and viruses. Classification of plant diseases.

UNIT-II

Entry of pathogens into the host. Role of enzymes, toxins and phytoalexins in plant pathogenesis. Physiological changes in diseased plants.Plant disease forecasting.

Genetics of disease resistance.

UNIT-III

Detailed study of symptoms, etiology, epidemiology and control of the following fungal diseases of plants; late blight of potato, *Taphrina* leaf spot of turmeric, powdery mildew of cucurbits, black stem rust of wheat, blast of rice, tikka disease of groundnut, red rot of sugarcane.

UNIT-IV

Detailed study of the following bacterial and viral diseases: bacterial leaf blight of rice, angular leaf spot and black arm of cotton, citrus canker, tobacco mosaic disease.

UNIT-V

Principles of plant disease control: Plant quarantine, seed treatment, cultural practices chemical control, development of disease resistant varieties. Biological control of plant diseases. Integrated Pest Management - concept, system, benefits and limitations.

TEXT BOOKS:

1) Agrios, G.N. 1997. Plant Pathology, Academic Press, London.
2) Tar, S.A.J. 1972. Principles of Plant Pathology.
3) Singh, R.S. 1991. Plant diseases, 6th Edn., Oxford & IBH Co., New Delhi.
4) Singh, R.S. 1988. Principles of Plant Pathology, 3rd Edn., Oxford & IBH Co., New Delhi.
5) Mehrotra, R.S. 1980. Plant Pathology, Tata-McGraw Hill Publishing Company, New Delhi.
6) Rangaswami, G. and Mahadevan, A. 1999. Diseases of Crop Plants in India, 4th Edition, Printice Hall of India Publications.

OUTCOME MAPPING::

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	3	2	2	1	3	3	3	2	2	1	1
CO2	3	3	1	2	3	2	2	1	3	3	3	1	1	1	1
CO3	3	3	2	1	3	2	2	1	3	3	3	1	1	1	1
CO4	3	3	2	1	3	2	2	1	3	3	3	1	1	1	1
CO5	3	3	3	2	3	1	2	3	3	3	3	1	2	2	2

Semester	BOT 3.2: PLANT METABOLISM	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	Study the thermodynamics laws and the concepts of free energy and entropy Importance of oxidation-reduction reactions in biological energy transformations.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the laws of thermodynamics and concepts of free energy and entropy; and their importance in energy transformation in living systems..
CO2	Assimilate the knowledge on how the light energy is converted into chemical energy and ecological significance of C4 cycle and CAM metabolism..
CO3	Gain the knowledge on mechanism and importance of aerobic and anaerobic respiration.
CO4	Acquire knowledge on nitrogen metabolism and its role in plant growth; in addition to this gain knowledge on ecological significance of transformations of nitrogenous compounds.
CO5	Understand the structural and energetic importance of lipids.

UNIT-I

Energy and Enzymes: Energy flow through living systems, principles of the thermodynamics, free energy and chemical potential, free energy of oxidation–reduction reactions, redox potential, types of phosphorylation's, structure and functions of ATP. Enzymes: General aspects, nomenclature and classification of enzymes, mode of enzyme action, Michaelis – Mention equation and its significance, regulation of enzymes, enzymes inhibition and isoenzymes.

UNIT-II

Photochemistry and Photosynthesis: General concepts of photosynthesis, photosynthetic pigments, structure of photosynthetic apparatus, photosynthetic electron transport (Non- cyclic, cyclic), proton transport and ATP synthesis. Carbon assimilation: The carbon cycle, photorespiration and its significance, C_4 and CAM pathways and their physiological and ecological significance. Biosynthesis of starch and sucrose, translocation by phloem, phloem loading and unloading.

UNIT-III

Respiration: Over view of plant respiration, glycolysis, pentose phosphate pathway, TCA cycle, electron transport chain (ETC), chemiosmotic hypothesis of ATP synthesis, alternative oxidase system, Alcohol and Lactic acid fermentations.

UNIT-IV

Nitrogen metabolism: Sources of nitrogen to plants, biological nitrogen fixation, nodule formation and nod-factors, mechanism of nitrate uptake and reduction, ammoniumassimilation (reductive amination, transamination and GS-GOGAT).

Sulfate metabolism: Uptake, transport and assimilation.

UNIT-V

Lipid metabolism: Structure and function of lipids, classification of lipids, fatty acids andtheir biosynthesis. Synthesis of phospholipids and storage lipids; catabolism of lipids; glyoxylate cycle.

REFERENCE BOOKS:

1) Dennis et al., 1997. Plant Metabolism (2nd ed.), Longman, Essex, England.
2) Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
3) Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology, Academic Press, San Diego, USA.
4) Taiz and Zeiger, 1998. Plant Physiology (2nd ed.)
5) Voet and Voet, 1992. Biochemistry, John Wiley & Sons, Inc., New York, USA.
6) Raghavendra, S. 1988 Photosynthesis, A comprehensive Treatise, Cambridge University press, Cambridge, UK.

OUTCOME MAPPING:

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CO2	3	3	1	2	3	1	2	2	3	3	2	2	3	1	1
CO3	3	3	1	2	3	1	2	2	3	3	2	2	3	1	1
CO4	3	3	2	3	2	2	2	1	3	3	3	3	1	2	1
CO5	3	3	2	2	3	1	2	2	3	3	2	2	3	1	1

Semester	BOT 3.3 (A): ETHNOBOTANY AND ETHNOMEDICINE	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	Ethnobotany and Ethnomedicine course could address the contemporary issues related to human health and problems, such as Biopiracy, Intellectual Property Rights etc., faced by indigenous communities of the world, particularly in India.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the how many communities are living in Eastern Ghats of Andhra Pradesh, and their socio-economic conditions, and to develop the questionnaire for collecting the field data related to the usage of plants by local communities for various purposes.
CO2	Knowledge how the native people are cultivating the medicinal plants traditionally and and develop the skills their commercial production through tissue culture technology.
CO3	Detect the drug adulteration going on in the market and to get skilled in drug discovery based on ethnobotanical knowledge.
CO4	Understand the various secondary metabolites in plant kingdom and their importance; it is useful further in isolation and purification of compounds from the medicinal plants.
CO5	Gain knowledge the importance of probiotics and prebiotics and their usage in daily life and, the market potential and trade of plant medicine by adhering to various international agreements such as TRIPS, IPR etc.

UNIT-I

Concept, history, scope and importance; Plants used in various systems of medicine – Ayurveda, Unani and Homeopathic system. Indigenous knowledge and traditional practices of indigenous communities of Eastern Ghats of Andhra Pradesh.Sacred groves of Andhra Pradesh and biodiversity conservation.

UNIT-II

Macro and micropropagation of medicinal plants such as *Rauwolfiaserpentina, Withaniasomnifera, Aeglemarmelos and Vanilla planifolia;* commercial production of bio-active molecules through tissue culture technology.

UNIT-III

Identification of locally available medicinal plants and their biological active principles.Ayurvedic drug preparation and dosage form; pharmacognostical studies to check adulteration.Approaches to drug discovery from ethnobotanical knowledge.

UNIT-IV

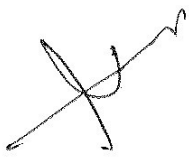
Secondary metabolites (natural products) from plants, major classes and their importance, in particular reference to alkaloids, flavonoids, glycosides, steroids and tannins from plant kingdom. Functions of secondary metabolites in plant defense.

UNIT-V

Developing the questionnaire for the usage of plants by local communities for various purposes.Herbal cosmetics and nutraceuticals.Methods of collection, processing, storage, market potential and trade of plant medicine. IPR, Biopiracy, TRIPS.

TEXT BOOKS:

1) Jain, S.K. 1981. *Glimpses of Indian Ethnobotany*, Oxford and IBH Publishing Co., New Delhi.
2) Rao, P.S. Venkaiah, K. & Padmaja, R. 1999. *Field guide on Medicinal Plants*. A. P. Forest Department.
3) Trivedi, P.C. 2002. *Ethnobotany*. Avishkar Publishers, Jaipur, India.
4) Arber, A. 2008. *Herbal Plants & Drugs*. Agro Science Book Centre, New Delhi.
5) Cutler. S.J. & Cutler. H.G. 1999. *Biologically Active Natural Products – Pharmaceuticals*. Agro Science Book Centre, New Delhi.
6) Harborne, J.B. 1948. *Phytochemical Methods*. Chapman and Hall, London.
7) Kokate, C.K. Purohit, A.P. Gauchely, S.B. 1990. *Pharmacognosy*, NiraliPrakashan, Pune.
8) Khare, C.P. 2000. *Indian Herbal Therapies*. Delhi Book Co., New Delhi.
9) Nadkarni, K. M.2004. *Indian Plants & Drugs with their Medicinal Properties*. Agro Sci. Publ. Centre, New Delhi.
10) Panda, H. 2003.*Medicinal Herbs & Their Uses with Formulations*. Daya Publishing House, New Delhi.
11) Trease, G.E. and Evans, W.C. 1983. *Pharmacognosy.* (12th Ed.), Bailine, London.
12) Wallis, T.E. 1999. *Text Book of Pharmacognosy*, (5th Ed.) CBS Publishers & Distributions, New Delhi.
13) Paroda, R.S. &Arora, P.K. 1991. *Plant Resources conservation and management concepts and approaches,* New Delhi.
14) Martin, G.J. 1995. *Ethnobotany: Principles and Applications*. John Wiley and Sons, Chichester.
15) Yamin, F. 1995. *The Biodiversity Conservation and Intellectual Property Rights*, Switzerland.

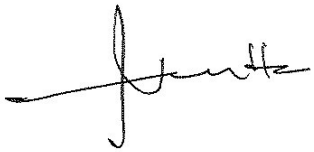


16) Kaushik, P. 2009. *Indigenous Medicinal Plants including Microbes and Fungi*. Today & Tomorrow's Printers and Publisher, New Delhi.

17) Das, A.P. &Pandey, A.K. 2007. *Advances in Ethnobotany*. Bishen Singh and Mahendra Pal Singh, Dehra Dun.

OUTCOME MAPPING:

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CO2	3	3	1	2	3	1	2	2	3	3	2	2	3	1	1
CO3	3	3	1	2	3	1	2	2	3	3	2	2	3	1	1
CO4	3	3	2	3	2	2	2	1	3	3	3	3	1	2	1
CO5	3	3	2	2	3	1	2	2	3	3	2	2	3	1	3



Semester	BOT 3.3 (B): PRINCIPLES AND METHODS OF PLANT PROPAGATION	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	The main objective of the Plant Propagation course is to impart knowledge on multiplication of the plants on commercial scale, so that it would be useful to mankind and plant nursery industry.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Gain the knowledge about the importance of plant propagation in human life. And to develop the skills to establish Greenhouses and their maintenance to preserve the plants on large scale.
CO2	To understand the various environmental factors influencing the seed germination..and to learn the seed production and handling techniques.
CO3	Gain skills in various methods of vegetative propagation through cuttings and the management practices cutting propagation.
CO4	Acquire the knowledge about the biology of grafting and grafting approaches.and gets trained in budding and layering techniques in plant propagation industry.
CO5	Develop the skills in the propagation of some important commercial crops. and get acquainted with the knowledge of *in vitro* propagation (Micropropagation) which is an emerging technoleogy in plant industry.

UNIT-I

General aspects of plant propagation: Role of plant propagation in human history. Life cycles in plants including seedling life cycle, clonal life cycle and apomictic life cycle. Concept of hormonal control of plant growth and development.Greenhouse equipment and media.Structure and types of seeds (recalcitrant and orthodox seeds).

UNIT-II

Techniques of seed production and handling: Commercial seed sources; seed testing; techniques of seed production; harvesting and post-harvesting handling of seeds.

Propagation by seeds: Seed germination, environmental factors influencing germination. Seed propagation systems; field nurseries for transplant production.

UNIT-III

Vegetative propagation: Reasons for using clonal cultures. Descriptive observation of adventitious roots and bud formation. Types of cuttings.leaf cuttings and leaf bud cuttings. Preparing the propagation beds, bench, rooting flats and containers and inserting the cuttings. Management practices of cutting propagation; handling of field propagated plants.

UNIT-IV

Biology of grafting, techniques of grafting—whip and tongue, wedge and cleft, bark, side grafting approach; production process of graftage. Types and techniques of of budding---T-budding, patch budding, chip budding, and ring budding. Layering and its natural modifications, simple layering, tip layering, mound and stool layering, air layering, compound and serpentine layering, and serpentine layering.

UNIT-V

Vegetative propagation by specialized stems and roots. Propagation methods for important cash crops such as *Coffeaarabica, Heveabrasiliensis*and *Malusdomestica (*apple).A brief introduction to Micropropagation.

TEXT BOOKS:

1) Hartman, H.T., Kester, D.E., Davies Jr. F.T. &Geneve, P.L. 2015. Plant Propagation: Principles and Practices. Prentice Hall of India, New Delhi.
2) Chada, K.L., 2014. Handbook of Horticulture. ICAR, New Delhi.
3) Joel Kroin, 2016. Hortus Plant Propagation from cuttings: A guide to using plant rooting hormones by foliar and basal methods. (Third edition). Hortus USA Corp.
4) Tarai, R.K., Naik, B., Sahoo, A.L. &Mandal, P. 2020. Plant Propagation and Nursery Management, New India Publishing Agency, New Delhi.
5) Adriance, G.W. &Brison, F.R., 2010. Propagation of Horticultural Plants. Axis Books (India), Jodhpur.

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CO2	3	3	1	2	3	1	2	2	3	3	2	2	3	1	2
CO3	3	3	1	2	3	1	2	2	3	3	2	2	3	1	2
CO4	3	3	2	3	2	2	2	1	3	3	3	3	1	2	2
CO5	3	3	2	2	3	1	2	2	3	3	2	2	3	1	3

Semester	BOT 3.3 (C): MUSHROOM CULTIVATION AND SINGLE CELL PROTEIN	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	The aim of the course is to impart skilled knowledge on mushroom cultivation and single cell protein useful for self-employment and entrepreneur ship.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Know the importance of mushrooms and their scope in present and future prospects.
CO2	Understand the basic principles, culture techniques of mushroom farming, growth media and spawn running acquire hands-on experience in culturing and harvesting different mushrooms.
CO3	Acquire knowledge and hands on skill in post-harvest processing, drying and preservation of mushrooms and on economics of mushroom cultivation like packing and marketing.
CO4	Gain knowledge in understanding the scope and importance of SCP.
CO5	Improve their hands-on skill for protein extraction from pure or mixed cultures of algae, yeasts, fungi and bacteria and in post harvesting technology of product recovery.

UNIT-I

Importance of mushrooms, Scope, past, present status and future prospects. Morphology, classification, edibility and poisonous properties, sterilization, contamination, structural changes during the development of the mushroom fungi. Life cycles of *Volvariella* sps, *Pleurotus* sps., *Agaricus* sps. Button mushroom and genetic improvement of mushroomstrains.

UNIT-II

Culture techniques of mushroom farming, growth media, spawn running. Cultivation of different mushrooms: paddy straw mushroom, oyster mushroom, milky mushroom and button mushroom. Harvesting of mushrooms. Composting: importance in waste recycling.

UNIT –III

Post harvest technology: Processing of mushrooms, production of dried mushrooms from fresh mushrooms, Preservation of mushrooms – freezing, dry freezing, drying, canning, quality assurance and economics of mushroom cultivation. Value added products of mushrooms. Health benefits of mushrooms - Medicinal and nutritional values of mushrooms.

UNIT–IV

Introduction, History and importance of Single Cell Proteins, Scope and future prospects.

Different genera of Algae, Yeasts, Fungi and Bacteria as single cell protein.

UNIT-V

Production of single cell protein - Media optimization, culture maintenance and product evaluation. Post harvest technology- recovery, drying, economic significance of SCP. Processing of SCP for food usage, advantages and limitations of SCP. Applications of SCP.

TEXT BOOKS:

1) Nita bahl,2002, Handbook on mushrooms, 4th edition vijaya primal for Oxford & IBH publishing Co. pvt Ltd., New Delhi.
2) Hand book on mushroom cultivation 1999.tnau publication
3) Chang T.S. and Hayes W.A.., 1978.The biology and cultivation of Edible Mushrooms. Acadamic Press, Newyork.
4) M.c, Nair, C.Gokulapalan and Lulu das1997.Topics on mushroom cultivation, scientific publishers, Jodhpur, India.
5) Ignacimuthu, S. 1997. Applied plant biotechnology, Oxford & IBH publishing Co. Pvt.Ltd., New Delhi.

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CO3	3	3	2	1	3	2	2	3	3	3	3	2	1	2	3
CO4	3	3	1	1	3	2	2	2	3	3	3	1	1	1	1
CO5	3	3	3	2	3	2	2	2	3	3	3	2	1	2	3



Semester	BOT 3.4 (A): MOLECULAR BIOLOGYOF	L	T	P	C
III	PLANTS	4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To enrich information about physico-chemical structure and functional regulation of DNA; protein translation and sorting; and working principles of biophysical techniques of DNA sequencing, microscopy, electrophoresis and spectroscopy.

COURSE OUTCOMES (CO):

At the end of the course, the student will be able to

CO1	Know experimental evidences for DNA as genetic material; structure and replication of DNA; and DNA damage repair mechanisms.
CO2	Get insight in to the mechanistic details of transcription, translation and protein sorting.
CO3	Gain information on gene regulation by genetic and epigenetic means, transposons, cis and transacting elements.
CO4	Appreciate the information on regulation by small RNAs, RNAi and genome editing technologies mediated by mega nucleases and CRISPR-cas9 systems.
CO5	Understand the working principle of biophysical and biochemical techniques like DNA sequencing, microscopy, electrophoresis and spectroscopy.

UNIT-I

Evidence for DNA as genetic material, physical and chemical structure of DNA, mechanism of DNA replication, DNA damage and DNA repair mechanisms. C value and C valueparadox. Cot curves.

UNIT-II

Transcription in prokaryotes and Eukaryotes, mRNA processing and other RNA processing events, mechanism of Translation, RNA splicing, genetic code, protein biosynthesis. Protein sorting and targeting of proteins to the organelles.

UNIT-III

Principles of gene regulation in prokaryotes (lactose and tryptophan operons), role of chromatin remodeling and DNA methylation in gene regulation. Transposons, mechanism of transposition and genetic consequences of transposition. Cis-acting and trans-acting factors in eukaryotic gene regulation.

UNIT-IV

RNA Biology and Genome editing: RNA world hypothesis. Small RNA (Micro RNA) mediated transcriptional and translational regulation. Gene knock-down using RNAi. TALENS, ZFNs and CRISPR-CAS9 based genome editing technologies. Applications of Genome Editing Technologies in plant biology.

UNIT-V

Next generation DNA sequencing methods. Atomic Force Microscopy, Cryo-EM and Confocal Microscopy. Principles and types of electrophoretic techniques. LC-MS, and Labeled tracers.

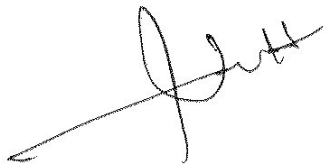
REFERENCE BOOKS:

1) Alberts, B., Bray, D., Lewis, I Rail, M., Roberts, K. and Watson. J.D, Molecular biology of the cell, Garland Publishing Inc., New York.
2) Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. arid D1ieil, J 2000. Molecular Cell Biology. W.H. Freeman and Co., New York, USA.
3) Richard, M., Twyman and Wisden, W. 1999. Advanced Molecular Biology, Viva Books Pvt. Ltd.
4) Turner, P.C., Mclenann, A.G., Bates, A.D. and White, M.R.H. 2001 Instant notes on molecular biology.
5) Snustad Peter, D. Michael J. Simmons. Principles of Genetics, John Wiley Sons.
6) Robert H. Tamarin. Principles of Genetics, Tata McGraw Hill Company.
7) Benjamin Lewin. Genes VIII, Prentice Hall. 8. West head, D.R. J.H. Parish & R.M. Twyman. Bioinformatics. Viva Books.
8) Adams, R. L. P., Knowler, J. T. and Leader, D. P. 1994.The Biochemistry of the Nucleic acids. Chapman & Hall.
9) Brown, T. A. 1999. Genomes 3. John Wiley & Sons, New York, USA.
10) Watson JD, Baker TA, Bell SP, Gann A, Levine M, Losick R. 2004 Molecular biology of the Gene (5th Ed.) Benjamin Cummings.
11) Robert F. Weaver, 2008. Molecular Biology. Mc Graw Hill Higher Education.
12) Buchanan, B. B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. Am. Society of Plant Physiologists, Maryland, USA.
13) Upadyaya, A., Upadyaya, K., and Nath, N. Biophysical Chemistry-Principle and Techniques, Himalaya Publishing House, New Delhi
14) Keith Wilson and John Walker (Editors) 2005.Principles and Techniques of Biochemistry and Molecular Biology (6th Ed.)Cambridge University Press, New York.



OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	2	2	2	3	1	3	3	3	2	2	2
CO2	3	3	2	2	2	2	2	3	1	3	3	3	2	2	2
CO3	3	3	2	2	2	2	2	3	2	3	3	3	2	2	2
CO4	3	3	2	2	2	2	2	3	2	3	3	3	2	2	2
CO5	3	3	2	2	2	2	2	3	2	3	3	3	2	2	1



Semester	BOT 3.4 (B): ADVANCED MOLECULAR TOOLS	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To expose students to latest molecular tools and techniques of microscopy; electrophoresis and rDNA technology; genomics and proteomics.

COURSE OUTCOMES (CO):

At the end of the course, the student will be able to

CO1	Learn about working principles and mechanism of working of Cryo-EM, FRET, AFM and Confocal microscopy.
CO2	Gain knowledge pertaining to different types and working principles of electrophoresis, spectroscopy and ECL.
CO3	Understand the principles and applications of RELP, blotting techniques, PCR and DNA finger printing techniques.
CO4	Explore information related to the functional identification of genes through insertional mutagenesis, RNAi, CRISPR-Cas9 genome editing, TILLING and Microarray.
CO5	Gain adequate information on 2-D Gel Electrophoresis, LC-MS, protein sequencing, protein microarrays and antibody-based protein detection assays.

UNIT-I

Advances in microscopy: Working principle, magnification, resolution and application of Cryo-Electronic Microscopy, Fluorescence Resonance Energy Transfer (FRET) Microscopy, Atomic Force Microscopy and Confocal microscopy.

UNIT-II

Electrophoretic, spectrophotometric and autroradiographic techniques Electrophoresis: Principles involved in disc and slab types. Mechanism of staining and destaining of enzyme gels. Isoelectric focusing. Time resolved florescence spectroscopy, CD Spectroscopy and applications. General principle and applications of Enhanced Chemiluminescence.

UNIT-III

Recombinant DNA techniques: Principles and applications of RELP, Blotting techniques, PCR and DNA finger printing techniques.

UNIT-IV

Functional Genomics: Experimental techniques for functional identification of genes: Insertional mutagenesis, RNAi, CRISPR-Cas9 genome editing, TILLING, DNA Microarray, and SAGE.

UNIT-V

Proteomics: Protein sample preparation and separation through 2D - Gel Electrophoresis, Liquid Chromatography and Mass spectrometry (LC-MS), protein sequencing, protein micro arrays. Yeast two hybrid assay, immunoprecipitation, pull down assays, and co-immunoprecipitation assays.

REFERENCE BOOKS:

1) Upadyaya, A., Upadyaya, K., and Nath, N. Biophysical Chemistry-Principle and Techniques,Himalaya Publishing House, New Delhi
2) Keith Wilson and John Walker (Editors) 2005.Principles and Techniques of Biochemistry and Molecular Biology (6th Ed.)Cambridge University Press, New York.
3) Christopher A. Cullis. 2004. Plant Genomics and Proteomics. John Wiley & Sons, New Jersey.
4) Jolls, O. and Jornvall, H. (eds.) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.
5) Lewin, B. 2006. Gene VIII, Oxford University Press, New York, USA.
6) Brown, T. A. 1999. Genomes 3. John Wiley & Sons, New York, USA.
7) Primrose, S.B. & Twyman, R. M. 2003.Principles of Genomic Analysis and Genomics. (7th Ed.). Blackwell Science.
8) Gustafson, J. P. 2000. Genomes, Kluwer Academic plenum publishers, New York, USA.
9) Jolls, O. and Jornvall, H. (eds.) 2000. Proteomics in Functional Genomics. Birkhauser Verlag, Basel, Switzerland.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	2	2	2	2	3	3	2	3	1	2	3
CO2	3	3	3	2	2	2	2	2	3	3	2	3	1	2	3
CO3	3	3	3	2	2	2	2	2	3	3	2	3	1	2	3
CO4	3	3	3	2	2	2	2	2	3	3	2	3	1	2	3
CO5	3	3	3	2	2	2	2	2	3	3	2	3	1	2	3

Semester	BOT 3.4 (C): PHYTOREMEDIATION	L	T	P	C
III		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	To enlighten the students about Global approaches, evaluation technologies and applications of transgenic approaches and nanotechnology in Phytoremediation in the context of soil and aquatic contaminants.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the concept and global approaches of phytoremediation and the significant role of microbes in phytoremediation.
CO2	Comprehend the design of phytoremediation strategies and technologies with the knowledge on different mechanisms used by plants and microbes for detoxification of pollutants.
CO3	Gain the knowledge on different contaminants of aquatic environment and use of major aquatic plants for phytoremediation
CO4	Have detailed information on hand about different soil contaminants and their phytoremediation.
CO5	Know the use of transgenic approaches and nanoparticle technology application for phytoremediation.

UNIT-I

Introduction to Phytoremediation; Types and processes of phytoremediation; Advantages and limitations of phytoremediation; Need and Scope of phytoremediation. Global approaches of phytoremediation – American approach, European approach and Japanese approach.Role and importance of microbes in phytoremediation.

UNIT-II

Evaluation of Phytoremediation technologies – Phytoextraction, Rhizofiltration, Phytostabilization, Rhizodegradation, Phytovolatization. Designing of phytoremediation strategies – site assessment, choosing right plants, soil amendments, implementation and moniforing. Physiological, molecular and biochemical mechanisms utilized by plants and microbes for uptake, transport and detoxification of pollutants.

UNIT-III

Contaminants in aquatic environment – physical, chemical and biological contaminants.

Major aquatic plant species for phytoremediation – Free-floating, Submerged, emergent and other plant species. Mechanisms for removal of contaminants (inorgnic and organic) by aquatic plants.

UNIT-IV

Phytoremediation of soil contaminants – Herbicides and pesticides, Mineral fertilizers, Hydrocarbons (trichloro ethylene, carbon tetrachloride), Textile Dyes, Heavy metals (Arsenic, Lead, Mercury), Explosive nitro-aromatic compounds (TNT, RDX).

UNIT-V

Factors affecting the phytoremediation. Hyperaccumulator and Non-hyperaccumulator plants for envionmental waste management. Transgenic approach for phytoremediation. Application of nanoparticle technology in phytoremediation.

TEXT BOOKS:

1) Ram Chandra, N.K. Dubey, Vineet Kumar, 2018. Phytoremediation of Environmental Pollutants, CRC Press.
2) Jean-Louis Morel, G. Echevarria, N. Goncharova, 2006. Phytoremediation of Metal-contaminated Soils, Springer.
3) James E. Landmeyer, 2012. Introduction to Phytoremediation of Contaminated Ground water – Historical Foundation, Hydrologic control, and Contaminant Remediation, Springer.
4) A. singh and O.P.Ward (Eds), 2004. Applied Bioremediation and Phytoremediation, Springer-Verlag.
5) Abid a. Ansari, Sarvajeet Singh Gill, Ritu Gill, Guy R. Lanza, Lee Newman, 2018. Phytoremediation – Management of Environmental Contaminants, Vol.6, Springer.
6) Ivan A. Golubev, 2011. Hand Book of Phytoremediation, Nova Science Publishers, New York.
7) Bhupinder Dhir, 2013. Phytoremediation: Role of Aquatic Plants in Environmental Cleanup, Springer.
8) Introduction to Phytoremediation, 2000, National Risk Management Research Laboratory, Ohio.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	1	1	1	2	2	1	3	3	1	3	1	1
CO2	3	3	2	2	2	1	2	1	3	3	3	1	3	1	1
CO3	3	3	2	1	2	2	2	1	3	3	3	2	1	1	1
CO4	3	3	2	2	1	3	2	2	2	3	3	2	3	2	3
CO5	3	3	2	2	1	2	2	2	2	3	3	1	1	1	1

FOURTH SEMESTER

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. BOTANY

SEMESTER-IV

Semester	BOT 4.1: PLANT CELL, TISSUE AND ORGAN CULTURE	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To train the students on practical and theoretical aspects of plant tissue culture, and to develop skills for the extraction of secondary metabolites on industrial scale.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Learn about laboratory organization and needs of plant tissue culture lab.
CO2	Develop skills for preparation and sterilization of various plant tissue culture media, and become master on totipotency, differentiation and morphogenesis phenomena.
CO3	Become authority on applications of micropropagation, somatic embryogenesis, synthetic seeds, and somaclonal variations in terms of theory and practical experience.
CO4	Get hands on experience on production of somatic hybrids, cybrids, callus and embryo culture.
CO5	Develop skills to produce haploids by anther and microspore cultures, secondary metabolite harvesting by cell cultures on industrial basis and cryopreservation methods for germplasm storage.

UNIT-I

Plant tissue culture laboratory organization and requirements.Various explant and non- explant sterilizationtechniques.Tissue culture media: Composition and preparation ofdifferent types of media.

UNIT-II

Basic concept of regeneration: Concept of Cellular Totipotency and Differentiation. Fundamental aspects of Morphogenesis.Organogenesis- direct & indirect.Role of plant growth regulators and factors governing *in vitro* behavior of cultures.

UNIT-III

Propagation and variation: stages and applications of micropropagation. Photoautotrophic micropropagation and acclimatization of tissue culture plants. Production of pathogen free plants and their application. Somatic embryogenesis, role of physical and chemical factors in the induction of synthetic seed-production and their uses. Somaclonal variations and their applications.

UNIT-IV

Somatic hybridization: Protoplast isolation, fusion and culture, selection and characterization of hybrids. Symmetric, asymmetric hybrids and cybrids, significant achievements and limitations of Protoplast research, production of test tube plants. Callus and embryo culture, production of seedless fruits.

UNIT-V

Applications of plant tissue culture: production of haploids and its significance in crop improvement. Secondary metabolite production through cell and organ culture (Hairy roots). Cryopreservation and conservation of Germplasm. Gene Banks.

TEXT BOOKS:

1) Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA.
2) Bojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations, Elsevier Science Publisher, New York, USA.
3) Vasil, I.K. and Thorp e, T.A. 1994. Plant Cell and Tissue Culture, Kluwer Academic Press, The Netherlands.
4) Razdan, M.K. 1994. An Introduction to Plant Tissue Culture: Oxford & IBH Publishing Company Private Limited, New Delhi.
5) Chawla, H.S. 2003. Introduction to Plant Biotechnology.Oxford& IBH, New Delhi.
6) George, E.F., Vol-I (1986) and Vol II (1993) Plant propagation by Tissue culture.
7) Kartha, K.K. 1985. Cryopreservation of plant cells and organs. CRC Press, Boac Raton, Florida, USA.
8) Reinert, J. Bajaj, YPS (Eds.). 1977. Applied and fundamental aspects of plant cell, tissue, and organ culture. Springer-Verlag, New York.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	1	2	2	2	2	3	3	3	2	2	2	1
CO2	3	3	2	2	2	2	2	2	3	3	3	1	1	2	1
CO3	3	3	3	2	3	2	2	2	2	3	3	3	2	2	2
CO4	3	3	3	2	3	2	2	1	1	3	3	2	1	1	1
CO5	3	3	3	3	3	3	2	1	2	3	3	3	1	1	1

Semester	BOT 4.2 (A): CYTOGENETICS AND PLANT BREEDING	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	To impart information on the objectives of plant breeding to develop improved varieties of crop plants that will be commercially successful.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Identify the breeding methods of self and cross- pollinated species.
CO2	Ascertain the sources of genetic variation to perform breeding program in different crops and understand the process for the development of male sterile and polyploidy in plants towards crop improvement.
CO3	Understand the process of mutation breeding and its role in crop improvement and development of both biotic and abiotic stress resistant plants.
CO4	Recognize the importance of plant genetic resources as a source of variability in plant breeding programs.
CO5	Calculate and interpret some basic statistical parameters commonly used in plant breeding.

UNIT-I

Principles of plant breeding- Objectives and achievements; Breeding methods in clonally propagated, self-pollinated and cross-pollinated crops; Selection-types of selection and significance; Hardy-Weinberg Law.

UNIT-II

Plant genetic resources and centers of origin; Heterosis- theories and importance; Hybridization-types, Hybrids- production and significance; Male sterility (MS)- classification (GM, CMS, CGMS and chemically induced MS) and its importance in breeding; Polyploidy-types, polyploidy breeding and its significance.

UNIT-III

Mutation breeding- mutation types, mutagens, procedure and significance of mutation breeding in crop improvement; Breeding methods for resistance- to biotic (Fungi, Viruses, Insect and Pests) and abiotic (Drought and Salt) stresses.

UNIT-IV

Markers - Morphological, biochemical and molecular (RFLP, RAPD) markers and their applications in plant breeding; Marker assisted selection (MAS); Molecular maps- Genetic and physical maps, QTL maps and linkage maps. National and International plant organizations associated with crop improvement programmes.

UNIT-V

Molecular Cytogenetics - FISH, GISH, Flow Cytometry and applications of molecular Cytogenetics; Microdissection and Microcloning techniques. Introduction to statistical constants- Mean, Mode, Median, Variance, Standard Deviation and Standard Error, Normal distribution curve, ANOVA, Students **t**-test and **F**-test.

TEXT BOOKS:

1) Russel, P.J. 1998. **Genetics.** The Benjamin/Cunnings Publishing Co., Inc., USA.
2) Khush, G.S. 1973. **Cytogenetics of Aneuploids,** Academic Press, London.
3) Gupta, P.K. 2005. **Molecular Biology and Genetics Engineering**
4) Snustad, D.P. and Simmons, M.J. 2000. **Principles of Genetics.**
5) Chahal, G.S. and Gosal, S.S. **Principles and Procedures of Plant Breeding.**
6) **Biotechnological and Conventional Approaches,** Narosa Publishing House, New Delhi.
7) Darbeshwar Roy, 2000. **Plant Breeding: Analysis and Exploitation of variation,** Narosa Publishing House, New Delhi.
8) Singh, P. 2001. **Essentials of Plant Breeding,** Kalyani Publishers, Hyderabad.
9) Primrose, S.B. 1994. **Molecular Biotechnology** (2nded) Blackwell Sci. Publ. Oxford. Balasubramanian, D. 2005. **Concepts of Biotechnology**
10) Old, A. and Primrose, S.B. 2002. **Principles of gene manipulation.** Blackwell Publ.Oxford.
11) Singh, R.J. (2014).**Plant Cytogenetics,** CRC Press.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	1	2	2	2	2	3	3	3	1	2	2	1
CO2	3	3	2	2	2	2	2	2	3	3	3	1	1	1	1
CO3	3	3	3	2	3	2	2	2	2	3	3	3	2	2	2
CO4	3	3	3	2	3	2	2	1	1	3	3	2	1	1	1
CO5	3	3	3	3	3	3	2	1	2	3	3	3	1	1	1

Semester	BOT 4.2 (B): GENOMICS, PROTEOMICS AND METABOLOMICS	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	The objective of the course is to introduce genomics, proteomics and metabolomics to students followed by practical training involving a series of experiments and statistical analysis of the obtained data.

COURSE OUTCOMES (CO):

At the end of the course, the student will be able to

CO1	Know about DNA sequencing, assembly and annotation, comparative genomics, population genetics, genome wide association studies and genomics.
CO2	Gain knowledge pertaining to experimental techniques for functional identification of genes and transcript profiling.
CO3	Appreciate the basic principles of proteomics like 2- dimensional electrophoresis, chromatography and mass-spectroscopy.
CO4	Comprehend the protein sequencing, protein micro arrays and analysis of protein-protein interactions.
CO5	Have strong foundations and first hand scientific understanding of current trends in Metabolomics.

UNIT-I

Overview of genomes, sequencing, assembly and annotation, comparative genomics, population genetics and genomics, Gene and genome duplications, and transposable elements, population-level variation (SNPs, MNPs, indels), and evolutionary genomics. Resequencing mapping and genome wide association studies (GWAS).

UNIT-II

Functional Genomics: Experimental techniques for functional identification of genes: Insertional mutagenesis, Targeting Induced Local Lesions in Genomes (TILLING),Transcript profiling – DNA Micro array, Serial Analysis of Gene Expression (SAGE) and Massively Parallel Signature Sequencing (MPSS).

UNIT-III

Proteomics: Protein sample preparation, solubilization, reduction, and separation of proteins in – 2D - Gel Electrophoresis analysis, analysis of 2-DE gel images, correlative mass spectrometric based identification strategies, and 2-DE gel electrophoresis coupled with mass spectrometry.

UNIT- IV

Analysis of Proteomes: Protein sequencing, protein micro arrays. Analysis of protein interactions and protein complexes. Micro array techniques- types of microarrays, designing a microarray experiment, protein microarray technology and its applications.

UNIT-V

Metabolomics: Metabolites and metabolite profiling, Metabolomics - applications and its role in systems biology with case studies, Targeted and untargeted metabolomics, General work flow including quenching and sample preparation, Detection and quantification ofmetabolites by advanced analytical techniques (NMR/Mass spectroscopy, HPLC). Statistical methods (PCA, PLS, PLS-DA) in metabolomics. Pathway and metabolome databases. Software tools available for metabolomics analysis.

REFERENCE BOOKS:

1) Lewin, B. 2006. Gene VIII, Oxford University Press, New York, USA.
2) Brown, T. A. 1999. Genomes 3. John Wiley & Sons, New York, USA.
3) Primrose, S.B. & Twyman, R. M. 2003.Principles of Genomic Analysis and Genomics. (7th Ed.). Blackwell Science
4) Christopher A. Cullis. 2004. Plant Genomics and Proteomics. John Wiley & Sons, New Jersey.
5) Gustafson, J. P. 2000. Genomes, Kluwer Academic plenum publishers, New York, USA.
6) Jolls, O. and Jornvall, H. (eds.) 2000. Proteomics in Functional Genomics. Birkhauser
7) Verlag, Basel, Switzerland.
8) Metabolomics–A powerful Tool in Systems Biology, Edited by J. Nielsen and M. C. Jewett, Springer Publishers.
9) Metabolome Analyses: an Introduction by Dr. Silas G. Villas-Bôas, Dr. Ute Roessner, Dr. Michael A. E. Hansen, Dr. Jørn Smedsgaard, Dr. Jens Nielsen. John Wiley & Sons, Inc.
10) S. Sahai-Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.
11) Pennington & Dunn-Proteomics from Protein Sequence to Function, 1st edition, Academic Press, San Diego, 1996.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	2	2	2	2	3	3	3	3	1	2	3
CO2	3	3	3	2	2	2	2	2	3	3	3	3	1	2	3
CO3	3	3	3	2	2	2	2	2	3	3	3	3	1	2	3
CO4	3	3	3	2	2	2	2	2	3	3	3	3	1	2	3
CO5	3	3	3	2	2	2	2	2	3	3	3	3	1	2	3

Semester	BOT 4.2(C) : GENETIC ENGINEERING AND BIOINFORMATICS	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LOI	To learn about tools and techniques involved in genetic engineering and plant transformation technologies; biosafety, bioethical and IPR issues of GM plants; functional identification of genes by TILLING, RNAi, genome editing technologies and microarrays; basic working principles of bioinformatics.

COURSE OUTCOMES (CO):

At the end of the course, the student will be able to

COI	Know about various tools and techniques employed in the application of genetic engineering technology.
CO2	Gain information on gDNA / cDNA library construction and screening procedures, and blotting techniques.
C03	Appreciate information related to various plant transformation technologies and their applications in production of desired plants; biosafety, bioethical and IPR related issues.
C04	Explore the basic and working principles of bioinformatics, databases, search engines and sequence analysis.
COS	Enrich information about various biological databases, prediction of gene function, its translation and prediction of protein domain and motif structure.

UNIT-I

Recombinant DNA technology: Tools and methods involved in generating r-DNA molecules, gene cloning-techniques, and identification of clones by screening procedures,

UNIT-II

Construction and screening of genomic and c-DNA libraries; PCR, types and its applications; Principles, types and applications of Blotting techniques.

UNIT-III

Genetic Engineering of plants: Plant transformation with Ti-plasmid of *Agrobacterium tumefaciens,* physical methods of transferring genes to plants, reporter genes and use of different promoters. Transgenic plants. Bio-safety and Bio-ethical issues of GM crops, and IPRs.

UNIT-IV

Bioinformatics: definition, introduction, scope and applications. Databases - CBI GenBank, PDB, OMIM, EMBL. Literature Databanks - Pub Med, Med line. Sequence Alignment based on Matrices (BLOSUM and PAM), Tools for sequence alignment- BLAST, FASTA. Pair wise and Multiple sequence alignment and phylogenetic analysis.

UNIT-V

The biological databases and types; Sequence databases; Structural databases; Prediction of genes and gene function. Translation of gene into protein; Protein secondary structure prediction; Prediction of domains, motifs and profiles of proteins.

REFERENCE BOOKS:

1) Purohit, S.S. 2000. Biotechnology; Fundamentals and Applications, Agrobios, New Delhi.
2) Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Waston, J.D. 1989. Molecular Biology of the Cell, Garland Publishing Inc., New York.
3) Gupta, R.K. Molecular Biology & Generic Engineering, Rastogi Publication.
4) Adrian Slater, Nigel Scott, and Mark Fowler (2006). Plant Biotechnology
5) Brown, T.A.2001.Gene cloning and DNA Analysis- An introduction (5th Ed.), Blackwell Scientific Publications, Oxford, U.K.
6) Arthur M. Lesk. 2002. Introduction to Bioinformatics. Oxford University Press, USA
7) Mount, D., 2004. Bioinformatics: Sequence and Genome Analysis. (2nd Ed.) Cold Spring Harbor Laboratory Press.
8) Bioinformatics. A practical guide to analysis of genes and proteins. 1998. Baxevanis and Quellette.
9) Bioinformatics: A biologist's guide to biocomputing and the internet. 2000. Stuart M. Brown.
10) Bioinformatics: Sequence and genome analysis. 2001. David W. Mount.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	3	2	2	2	2	3	3	3	2	3	2	2	3
CO2	3	3	3	2	2	2	2	3	3	3	2	3	2	2	3
CO3	3	3	3	2	2	2	2	3	3	3	2	3	2	2	3
CO4	3	3	3	2	2	2	2	3	3	3	2	3	2	2	3
COS	3	3	3	2	2	2	2	3	3	3	2	3	2	2	3

Semester	BOT 4.3 (A): Horticulture and Landscaping	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	The aim of the course is to impart knowledge about nurseries, propagation methods, cultivation practices and production of flower, fruit and vegetable and other ornamental plants, principles of landscape designs, and landscape gardening.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Develop different types of nurseries and propagation methods.
CO2	Produce important flower crops and understand the nutritional aspects of different fruits.
CO3	Understand the nutritional aspects of different vegetables and produce fruit and vegetable crops.
CO4	Gain knowledge on garden ornaments, types and styles of gardens and the importance of gardening in aesthetics.
CO5	Analyze the site to develop landscape gardening designs identify different ornamental plants for landscaping.

UNIT-I

Importance of horticulture; Nursery and types of nursery beds; Orchard plan and systems of planting; Propagation of plants by asexual methods (cutting, layering, grafting and budding).

UNIT-II

Commercial floriculture: Propagation and production of flower crops like Roses, Chrysanthemum and Jasminum; Pomology: Nutritive value of fruits, Cultivation practices and production of fruit crops like Mango, Banana and Guava.

UNIT-III

Olericulture: Importance of vegetables in human nutrition, Types of vegetable gardens. A brief study of inter-cultivation practices of major vegetable crops of regional importance.

UNIT-IV

Importance and scope of landscape gardening; Principles of landscape design; Garden adornments; Garden features: Wall, Fencing, Steps, Garden, Garden drives and Paths, Hedges, Arches, Pergola, Lawn, Carpet bedding, Flower beds, Shrubbery, Borders, Rockery, Water gardens, Bonsai, Topiary; Garden types: Indoor garden, Outdoor garden; Gardenstyles: Formal gardens, Informal gardens and Free style gardens.

UNIT-V

Site analysis; Elements in landscape design: Land form, Water garden furniture, Lights, Paving etc.; Study of different trees, shrubs, herbs, ground cover, indoor plants etc., suitable for landscaping and their identification; Landscaping of historical monuments and places of Tourist importance.

TEXT BOOKS:

1) Gardner V R, Bradford F C and Hooker Jr. H D, 1952. *The Fundamentals of Fruit Production,* Mac Graw Hill Book Co., New York.
2) Hartman H T, Kester D E, Davies,Jr,FTand Geneve R L 1976. *Plant Propagation: Principles and Practices* (8th Edition). Prentice Hall, USA.
3) Sadhu M K,1996. *Plant Propagation*, New Age International Publishers, New Delhi.
4) Mukherjee S K and Majumder P K, 1973. *Propagation of Fruit Crops.* ICAR, New Delhi.
5) Bose T K and Yadav L P 1989. *Commercial Flowers,* Nayaprakash, Calcutta.
6) Mitra S.K. Rathore D S and Bose T K, 1992. *Temperate Fruits*, Horticulture and Allied Publishers, Calcutta.
7) Chaudhary B, 1992. *Vegetables*, National Book Trust, New Delhi.
8) Randhawa, M.S. 1971. *Beautiful Gardens*, ICAR, New delhi.
9) Nambisan K M P 1992. *Design Elements of Land Scape Gardening*, Oxford & IBH Publishing Company., New Delhi.
10) Hemla Naik B, Chandrashekhar SY and Jawaharlal M, 2017. Principles of Landscape Gardening, ICAR eCourse PDF Book, New Delhi.
11) Walker TD, 1991. *Planting Design* (Second Edition), John Wiley& Sons, Inc. New York.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	2	2	3	2	2	2	3	3	3	2	3	3	3
CO2	3	3	2	2	3	2	2	2	3	3	3	1	3	3	3
CO3	3	3	2	2	3	2	2	2	3	3	3	1	3	3	3
CO4	3	3	2	2	3	2	2	2	3	3	3	2	3	3	3
CO5	3	3	2	3	3	2	2	2	3	3	3	2	3	3	3

Semester	BOT4.3(B): Organic Farming and Vermicomposting	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	The aim of the course is to impart knowledge to minimize the use of chemical fertilizer by organic farming and to understand the scope, concept, advantages and disadvantages of organic farming.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Distinguish different soil types.
CO2	Understand the significance of organic farming.
CO3	Gain knowledge on types, nutritive value and preparation of organic manures.
CO4	Know the types, preparation, and applications of bio fertilizers.
CO5	Gain the knowledge on significance of vermin compost.

UNIT–I

Soil and its physical characters, Soil types- alluvial, laterite, clay, loam. Physical testing and assessment of soil types.

Soil conditioners – Lime, dolomite, gypsum, organic use of soil conditioners for better management of soil.

UNIT–II

Concept of Organic farming – Practical, positive and negative aspects of chemical fertilizer applications. Need for organic farming. Organic farming – Vision, concept, principles and benefits of organic farming.

UNIT–III

Conventional farming verses organic farming; Organic manures; Types of compost- green manure, farmyard manure. Nutritive value of compost; Methods of compost preparation.

UNIT–IV

Biofertilizers: Methods of compost preparation. Types, production, processing of Biofertilizers; Methods of application of biofertilizers.

UNIT-V

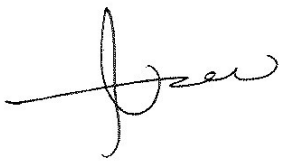
Vermicomposting: An overview of vermicomposting, introduction to vermicomposting, definition, meaning, their role in biotransformation of residues, maintenance of soil structure and economic importance. Local and useful species of earthworm, choosing the right worm.

TEXT BOOKS:

1) Hand book of organic farming and biofertilizers-M.K.GUPTA.
2) Biofertilizers technology – R.SHANKARA REDDY.
3) Biofertilizers technology- KHANNAIYAN. S.
4) Practical handbook of agriculture science – HANSON.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	1	1	2	2	1	1	3	2	1	1	1	1
CO2	3	3	1	1	2	2	2	2	1	3	3	1	1	2	2
CO3	3	3	2	2	2	2	2	1	2	3	3	2	1	2	2
CO4	3	3	2	2	3	2	2	3	3	3	3	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3	3	2	2	2	2



Semester	BOT 4.3 (C): Biofertilizer Technology	L	T	P	C
IV		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	Course helps in understanding the significant role of microbial biofertilizers, acquiring hands on skill for large scale production and field application of biofertilizers and to have a practical training towards entrepreneurship.

COURSE OBJECTIVE (CO):

At the end of the course, the student will be able to

CO1	Understand the biofertilizer microorganisms and acquire knowledge on preparation of biofertilizers.
CO2	Acquire knowledge on symbiotic and non-symbiotic inoculants, factors that influence inoculum production and acquire the skill for large scale bioprocessing.
CO3	Gain adequate awareness on detection and enumeration of mycorrhiza and phosphate solubilizers.
CO4	Gain hands-on experience on the production of vermin compost at industrial level.
CO5	Have awareness on quality maintenance and quality assurance of microbial products.

UNIT-I

Introduction: importance & scope of biofertilizers in agriculture & organic farming.

History of biofertilizer production; classification of biofertilizers, Factors influencing efficacy of biofertilizers.Advantage of biofertilizers over chemical fertilizers. Types of biofertilizers, qualitative screening of phosphate solubilization, ammonia and IAA production; mechanism of action of phosphatesolubilization, ammonia and IAA production. Benefits of biofertilizers.Buying and storage methods of biofertilizers.Cautions and limitations of biofertilizers. Carrier material: Different types of carrier materials, properties of carrier, sterilization methods of carrier, advantages and disadvantages of carrier material.

UNIT-II

Rhizobium – Morphology, molecular identification, collection and preservation of root nodules, isolation technology of different strains, screening of N_2 fixation. Bioprocessing (carrier based and liquid inoculants), Field application methods. Case study: Inoculation and fertilization methods of *Rhizobium* inoculants for Soy bean in Japan. *Azospirillum* - Morphology, molecular identification, collection and isolation technology of endophytic bacteria, associate bacteria from rice fields. Screening of ammonia production. Bioprocessing(mass inoculum and liquid inoculants), Field application methods.

CASE STUDY: Inoculation and fertilization methods of *Azospirillum* inoculants for corn in Indonesia.

UNIT-III

Mycorrhiza - Morphology, collection, identification, and isolation technology of Vesicular-arbuscularmycorrhiza from roots and spores. Bioprocessing (Trap culture and peat culture), preservation, field application methods.

Phosphate solubilizers - Morphology, collection, identification and isolation of inorganic phosphate and organic phosphate solubilizers from soil.Bioprocessing (carrier based and liquid inoculants), preservation, field application methods. Case study: Improvement of soil condition with phosphate solubilizers on fifty years long term experiments in rice in Korea.

UNIT-IV

Vermicompost - Importance of vermicompost, economic importance of earthworms in maintenance of soil structure. Useful species of earthworms (Local species of earthworms. Exotic species of earthworms).Limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors). Physico-chemical parameters of vermicompost. Different Methods of vermicomposting (Small- and large-scale Bed method, Pit method Small Scale Earthworm farming for home gardens). Nutritional composition of vermicompost for plants, comparison with other fertilizers.

UNIT-V

General concept of Quality control: Microbial function and shelf life of recommended biofertilizers, Properties of microbial products and Quality management. Quality control procedures- mother culture test, broth culture test, peat culture. Quality control of laboratory; preparation room, growth room and storage room. Inoculationon media, count of colony forming units. Quality text for certifications and prospects.

TEXT BOOKS:

1) The Complete Technology Book on Biofertilizer and Organic Farming (2nd Revised Edition) – 2012 by NIIR Board.
2) Microbes as Bio-fertilizers and their Production 2015-By S.G.Borkar.
3) Hand Book of Microbial biofertilizer 2006 - edited by M.K. Roy.

OUTCOME MAPPING:

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	3	1	2	3	2	2	3	3	3	3	1	1	2	2
CO2	3	3	1	2	2	2	2	3	3	3	3	1	1	2	2
CO3	3	3	1	2	3	2	2	3	3	3	3	1	1	2	2
CO4	3	3	1	2	3	2	2	3	3	3	3	1	1	2	2
CO5	3	3	1	2	3	2	2	3	3	3	3	1	1	2	2

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