ANDHRA KESARI UNIVERSITY

University COLLEGE OF AKU

DEPARTMENT OF MICROBIOLOGY

M.Sc. BOTANY 2025-26

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	4			4	30	70	100
	(B) Elective-I – Principles and Methods of Plant Propagation							
	(C) Elective-I – Mushroom Cultivation and Single Cell Protein							
BOT 3.4 A/B/C	(A) Elective- II – Molecular Biology of Plants	4			4	30	70	100
	(B) Elective- II – Advanced Molecular Tools							
	(C) Elective- II – Phytoremediation							
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	4			4	30	70	100
	(B) Elective-I – Genomics, Proteomics and Metabolomics							
	(C) Elective-I – Genetic engineering and Bioinformatics							
BOT 4.3 A/B/C	(A) Elective- II –Horticulture and Landscaping	4			4	30	70	100
	(B) Elective- II – Organic Farming and Vermi Composting							
	(C) Elective- II – Biofertilizer Technology							
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.

FIRST SEMESTER

ANDHRA KESARI UNIVERSITY UNIVERSITY COLLEGE OF SCIENCES DEPARTMENT OF BOTANY & MICROBIOLOGYM.Sc. BOTANY SEMESTER-I

Semester	BOT 1.1: PLANT SYSTEMATICS	L	T	P	C
1		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	The aim of the course is to impart knowledge in diversity of plants, their identification, nomenclature and their classification based on various aspects including recent advances in the field.

COURSE OBJECTIVE (CO):

CO1	The student will be able to Learn the hierarchical taxonomic structure and Know the principles and rules of nomenclature for naming the plants.
CO2	The student will be able to understand the recent advances in the classification of plant groups.
CO3	The student will be able to Identify the role of various taxonomic evidences in classification of plants. Know the importance of Botanical Survey of India in Systematic studies.
CO4	The students will be able to Identify the plants by using various methods and get acquaintance on herbarium preparation and preservation of specimens.
CO5	The student able to learn the technique of constructing cladograms by using cladistic methods.

UNIT-I

Systematics: Concepts and basic components; Taxonomic structure; Taxonomic hierarchy-species to division; International Code of Nomenclature (ICN) of algae, fungi and plants - Principles, Rules and Recommendations, Ranks, Principle of Priority, Typification, Author citation, Effective and Valid publication.

UNIT-II

System of classification of Armen Takhtajan and its merits and demerits; Angiosperm Phylogeny Group (APG) classification; A brief account of selective clades like basal angiosperms, Magnolids, Monocots (including Commelinids), Eudicots, Rosids, Asterids.

UNIT-III

Taxonomic evidence: Morphology, Anatomy, Embryology, Palynology and Cytology in relation to taxonomy; Data information systems; Botanical Survey of India (BSI): Objectives, activities, organization and publications.

UNIT-IV

Process of Plant Identification: Construction, types and use of Taxonomic keys; Herbarium methodology: Collection of plants, processing and preservation of specimens; ImportantWorld and Indian herbaria; Major botanical gardens of the World and India; DNA barcoding in plants and its practical implications.

UNIT-V

Chemosystematics: Primary and Secondary metabolites, Semantides and Non-semantides etc. in plants; Phylogenetic Systematics: operational units, characters, coding and construction of cladograms; Serosystematics: Methodology and its applications in systematics; Molecular Systematics: Gene sequences, Phylogenetic analysis, Restriction site analysis, allozymes etc.

REFERENCE BOOKS:

1) **International Code of Nomenclature for algae, fungi, and plants** (Schenzhen Code), 2018. (online version) adopted by the *Nineteenth International Botanical Congress*, Chenzehen, China.
2) **Angiosperm Phylogeny group**, 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnaean Society* 181: 1-20.
3) **Judd,W.S. Campbell, C.S.,Kellogg, E.A.,Stevens, P.A. and Donoghue**, M.J.2016. *Plant Systematics: A Phylogetic Approach.* Sinauer Associates, Inc.,Massachusetts.
4) **Simpson, M. G.** 2006. *Plant Systematics*. Elsevier Academic Press, Canada.
5) **Sambamurthy, A. V. S. S.** 2005. *Taxonomy of Angiosperms*. I.K.International Pvt. Ltd, New Delhi.
6) **Crawford, D.J**.2003. Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
7) **Gurcharan Singh**.1999. *Plant Systematics - Theory and Practice*. Oxford & IBH Publishing company Pvt. Ltd., New Delhi.
8) **Radford, A. E**. 1986. *Fundamentals of Plant systematics*. Harper & Row Publisher, New York.
9) **Davis, P. H.** and **Heywood**, **V. M.**1973. Principles of Angiosperm Taxonomy. Robert. Kereiger Publishers, New York.
10) **Gamble, J. S.** and **Fisher, C. E. C**. 1915-35. *Flora of Presidency of Madras*. 3 Volumes. BSMS, Dehradun.

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

Semester	BOT 1.2: REPRODUCTIVE BIOLOGYOF ANGIOSPERMS	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	This course is meant to answer that how the innate biology is influenced by variety of developmental and ecological constraints and to impart an insight into the reproduction of the most evolved and advanced group of plants, especially angiosperms.

COURSE OBJECTIVE (CO):

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

CO1	Understand how floral differentiation takes place and what genes responsible for it; to know about factors responsible for the pollen sterility and this phenomenon could be exploited for crop improvement.
CO2	Get insight about pollen-pistil interaction and role of endosperm in embryo development.
CO3	Dnderstand the molecular mechanism and gene expression in embryogenesis and development of dicot and monocot embryos.
CO4	Develop skills about the practical applications of apomixes and get expertise resolving the systematic position of the disputed taxa.
CO5	Become an authority in the subject and develop the strategies to regenerate plants on commercial scale by using embryos and endosperm as explants in order to obtain the intergeneric hybrids and seedless fruits respectively.

UNIT-I

Historical account of Plant Reproduction.

Floral differentiation: Inflorescence and floral meristem, mutations affecting floral differentiation.

Male Gametophyte: Structure of anther, microsporogenesis, role of tapetum; pollen development; formation of vegetative and generative cells; pollen sterility; abnormal features of pollen.

Female gametophyte: Types of ovule, megasporogenesis, special features. Types of female gametophytes and their development, ultra structure of mature embryo sac; haustorialbehaviour of embryo sac, nutrition of embryo sac.

UNIT-II

Pollination: Pollen transfer, pollination mechanisms and vectors. Structure of style and stigma; pollen-pistil interaction.

Fertilization: Pollen germination and pollen-tube growth, path of pollen-tube, pollen tube discharge; double fertilization.

Endosperm: Types of endosperms, cytology and functions of endosperm.

UNIT-III

Embryogenesis: Gene expression during embryogenesis. Embryogenic in dicots and monocots. Underdeveloped and reduced embryos, Nutrition of embryo.

Polyembryony: Causes of polyembryony, experimental induction of polyembryony, classification of polyembryony and its practical applications.

UNIT-IV

Apomixis: Vegetative reproduction, apospory, causes of apomixis, significance of apomixis.

Embryology in relation to Taxonomy: Importance of embryological characters in taxonomic considerations, families with special embryological features. Role of palynology in taxonomy.

UNIT-V

Experimental Embryology: Embryo culture: Embryo rescue, embryo culture, microsurgical experiments and applications. Somatic embryogenesis: Direct and indirect somatic embryogenesis, embryoids, synthetic seeds, practical applications of somatic embryogenesis. Endosperm culture: The technique of endosperm culture, histology and cytology of callus, triploid production and their practical applications.

TEXT BOOKS:

1) Maheswari, P. A. 1950. *Introduction to Embryology of Angiosperms*. McGraw Hill Book
2) company.
3) Shivanna, K.R. and John, B.M. 1989.*The Angiosperm Pollen structure and Function*, WileyEastern Ltd., New Delhi.
4) Johri, B.M., Ambegaokar, K.B. and Srivastava, P.S. *Comparative Embryology of*
5) *Angiosperms*, Vol.I& II, Springer Verlag.
6) Bhojwani, S.S. and Bhatnagar, S.P. 2000. *Embryology of Angiosperms* (revised edition), Vikaspublishing House, New Delhi.
7) Fosket, D.E. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press, New York.
8) Raghavan, V. 1997. Molecular Embryology of Flowering plants. Cambridge University Press, Cambridge.
9) Khasim, S. M. 2002. *Botanical Microtechnique: Principles and Practice*. Capital Publishing company, New Delhi.

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

Semester	BOT 1.3: BIOLOGY AND DIVERSITYOF VIRUSES, BACTERIA, ALGAE AND FUNGI	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	This course is designed to enrich the student with knowledge on Distribution, Classification, Structural features and significance of viruses, Bacteria, Algae and Fungi.

COURSE OBJECTIVE (CO):

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

CO1	Acquaint with basic and advanced information on viruses and Comprehend the importance of viruses.
CO2	Understand the structural features, nutritional types and significance of Eubacteria, Archaebacteria, Actinomycetes and Cyanobacteria
CO3	Categorize the algal members and know the importance of algae.
CO4	Realize the distribution, classification and general characters of fungi.
CO5	Identify edible and poisonous mushrooms and can practice the cultivation of mushrooms for self-employment.

UNIT-I

Brief account of discovery of viruses; general properties, structure, cultivation, purification and transmission of viruses; brief account of bacteriophages and plant viruses; Economic importance.

UNIT-II

Morphology and ultra structure of bacteria; Nutritional types (autotrophs and heterotrophs); Growth of Bacteria; Recombination in bacteria (transformation, transduction and conjugation); General characters of Actinomycetes, Archaebacteria, Mycoplasmas and Cyanobacteria; Economic importance.

UNIT-III

Distribution, thallus organization, classification and economic importance of algae; Brief account of Chlorophyceae, Rhodophyceae, Phaeophyceae, and Bacillariophyceae. Algae as primary producers and commercial products. Algae as SCP. Algal blooms and toxins.

UNIT-IV

General characters; Nutrition and reproduction of fungi; classification of Fungi (Ainsworth system); Brief account of Zygomycotina, Ascomycotina, Basidiomycotina and Deteuromycotina.

UNIT-V

Ecto and endomycorrhizal associations; Edible and poisonous mushrooms, Mushroom cultivation; Importance of Fungi in Agriculture and industry. Mycotoxins.

TEXT BOOKS:

1) An Introduction to Fungi: by Webster, J. (1985). Cambridge Univ. Press.
2) Brock Biology of Microorganisms: by Madigan. Mordinko and Parker (2000).
3) Prentice Hall.
4) Introduction to Plant Viruses: by Mandahar. C.I. (1978). Chand & Co., New Delhi.
5) Introductory Phycology by Kumar, H.D. (1988). Affiliated East-West Press. Ltd,
6) New Delhi.
7) An Introduction to the Algae by Morris. J. (1986). Cambridge University' Press,
8) U.K
9) Microbiology: by Prescott, L.M., Harley, J.P. and Klein, D.A. (1992), WCB
10) Publishers.
11) Introductory Mycology: by Alexopoulos, C.J. Mims, C.W. and Blackwell, M.
12) (1996). John Wiley & Sons.
13) The Biology of Algae by Round. F.E. (1986). Cambridge University Press. U.K.

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

Semester	BOT 1.4 (A) : OUTLINES OF BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PLANT FOSSILS	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To acquire the knowledge about general characters, distributional diversity, economic role, model plants, recent trends, evolutionary and ecological importance of Bryophytes, Pteridophytes, Gymnosperms and Fossils.

COURSE OUTCOMES (CO):

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

CO1	Learn about general characters, morphology, evolution of sporophytes and gametophytes of Bryophytes.
CO2	Know the general characters, phylogeny, origin of stele and seed habit of Pteridophytes.
CO3	Appreciate the structure, reproduction and economic uses of Gymnosperms.
CO4	Gain information about geological time scale, types of fossil, process of fossilization and fossils of various plant groups.
CO5	Understand the environmental and economic importance of above plant groups, recent trends and models plants from lower groups.

UNIT-I

Classification, general characters, range of thallus organization and reproduction in Hepaticopsida, Anthocerotopsida and Bryopsida. Evolutionary trends in gametophytes and sporophytes of Bryophytes.

UNIT-II

General characteristics and classification of pteridophytes; Study of morphology, anatomy and reproduction of Psilopsida, Psilotopsida, Lycopsida, Sphenopsida and Pteropsida. Origin and phylogeny of pteridophytes.Evolution of stele in Pteridophytes. Heterospory and seed habit in pteridophytes.

UNIT-III

Classification, distribution and economic importance of Gymnosperms.Structure and reproduction in living (modern) Cycads, Coniferopsida and Gnetopsida.Wood of gymnosperms; Male and female gametophytes of gymnosperms.

UNIT-IV

Principles of Paleobotany; Geological time scale; determination of age of plant fossils;process of fossilization; types of fossils; a comprehensive account of fossil algae, fossil bryophytes, fossil pteridophytes and gymnosperms.

UNIT-V

Ecological, economic, evolutionary and industrial applications of Bryophytes, Pteridophytes, Gymnosperms and Plant Fossils. Recent trends and model plants from Bryophyte and Pteridophyte plants.

REFERENCE BOOKS:

1) Agashe, S.N. 1995. Palaeobotany. Oxford & IBH, New Delhi
2) Arnold, C.A. 1947. An introduction to Palaeobotany, New York
3) Bhatnagar, S.P. and Moitra, A. 1996. Gymnosperms, New Age Int. Pvt. Ltd. New Delhi.
4) Parihar, N.S. 1991. Bryophytes. Central Book Depot, Allahabad.
5) Parihar, N.S. 1996. The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad.
6) Puri, P. 1980. Bryophytes.Atma Ram & Sons, New Delhi.
7) Sporne, K.R. 1991. The Morphology of Pteridophytes.B.I.Publication. Pvt. Ltd.
8) Sporne, K.R. 1965. The Morphology of Gymnospermae.B.I.Publications, NewDelhi.

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

Semester	BOT 1.4 (B): PHYCOLOGY	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	To impart knowledge to the students on recent cultivation and harvesting practices of algae and make the students cognizant of beneficial and detrimental impact of algae and algal products.

COURSE OBJECTIVE (CO):

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

CO1	Understand the molecular phylogeny approach in classification of algae and algal members of different aquatic habitats and so get familiarity to identify the algal members.
CO2	Become mindful with the requirements and different cultivation methods of micro and macro algae to produce ideal algal cultures.
CO3	Develop awareness on the activities and role of algae in impacting the aquatic life and human health.
CO4	Know the importance of algal members in safeguarding the environment.
CO5	Get awareness about various algal products and their use for the benefit of mankind.

UNIT-I

Contributions of Phycologists. Classification of algae: Classical and Recent developments; Molecular Phylogeny – Polyphasic approach. Algae of Diverse habitats – Fresh water (Lentic & Lotic communities), Marine water and Brackish water. Algal communities of Extreme environments – Thermal hot springs and Cold springs. Fossil algae.

UNIT-II

Algal culture techniques; General Principles; Physical parameters; Culture media; Strain improvement. Different Cultivation and Harvesting methods for Micro algae and Macro algae. Algal cultivation and production in India.

UNIT-III

Algal bloom formation and Eutrophication; Significance of algal blooms and control measures. Toxins produced by different algal groups. Bioaccumulation and Biomagnification of algal toxins. Impact of algal toxins on aquatic life and humans.

UNIT-IV

Role of algae in pollution control, CO_2 sequestration, Bioredemiation, Soil fertility and treatment of waste water plants. Algal Biofuels – bio-diesel, bio-ethanol and biological hydrogen production.

UNIT-V

Algal products as – Nutraceuticals, Biomedical compounds, Biofertilizers, Polysaccharies, Pigments, Dietary fibres, Animal feed, Food colourants and Cosmetics.

TEXT BOOKS:

1) Fritsch, F.E. 1945. The Structure and Reproduction of Algae Vol. I & II. Cambridge Univ. Press, Cambridge, London.
2) Sharma O.P. 2011. Algae. TATA McGraw-Hill, India.
3) South G.R. and Whittick A. 1987. Introduction to Phycology. Blackwell Scientific Publications, London.
4) Lee R.E. 1989. Phycology Vol. II. Cambridge Univ. Press. Cambridge, London.
5) Anderson R.A. 2005. Algal Culturing Techniques. Physiological Society of America, Elsevier Academic Press, USA.
6) Sahoo D. and Qasim S.Z. (Eds). 2002. Sustainable Aquaculture. APH Publishing Corporation, New Delhi, India.
7) Murthy A.V.S.S. 2005. A text book of algae. I.K. International Pvt., Ltd., New Delhi.
8) Southcott G.R. and Whittick A. 1987. Introduction to Phycology. Blackwell Scientific Publication, UK.
9) Venkataraman, G.S. 1974. Algae form and function. Today and Tomorrow's Pub., New Delhi.
10) Bux et al. (eds). 2016. Algae Biotechnology: Products and Processes, Springer.
11) Chu W. 2012. Biotechnological Applications of Microalgae. IeJSME 6(1): S24-S37.
12) Lee R.L. 2008. Phycology (4^{th} edition). Cambridge University Press.
13) Richmond A. (ed) 2003. Hand Book of Microalgal culture. Blackwell Publishing House.
14) Barsanti L. and Gualtieri P. 2006. Algae – Anatomy, Biochemistry and Biotechnology. Taylor & Francis.

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

Semester	BOT 1.4 (C): EVOLUTIONARY BIOLOGY	L	T	P	C
I		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To provide a comprehensive overview of concept of evolution and origin of life, theories of evolution, population genetics, genetic drift, natural selection, micro-evolution, speciation and phylogenetic tree.

COURSE OUTCOMES (CO):

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

CO1	Appreciate the concept of evolution, origin of life and different theories of evolution.
CO2	Gain information about the embryological, paleontological and molecular phylogeny evidences of evolutionary processes.
CO3	Get the good knowledge about variations in population, population genetics, genetic drift and natural selection.
CO4	Will gain knowledge on microevolution, species and speciation and adaptive radiation.
CO5	Construct the phylogenetic trees basing on morphology, phytochemistry and molecular sequences with the aid of relevant software's. Analyze the same forsolving other biology related practical problems with potential applications.

UNIT-I

Origin of life and Historical Review of Evolutionary Concept

Concept of Evolution, Origin of Life, Prokaryotes and Eukaryotes. Explanation of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism.

UNIT- II

Evidences of Evolution

Analogy and Homology, Embryological Evidences of Evolution, Evolutionary, Paleontological and Molecular Phylogeny evidences.

UNIT- III

Sources of Variations and Population Genetics

Variations and Mutations, Hardy-Weinberg Law, factors influencing equilibrium and gene frequencies and Genetic Drift.Types of Natural Selection.

UNIT- IV

Product of Evolution

Micro-evolutionary Changes, Concept of Species, Types of speciation, models of speciation, pattern of speciation, species formation, signification of speciation; Adaptive Radiation.

UNIT- V

Phylogenetic Trees

Types of phylogenetic trees based on morphology, chemistry and molecules. Construction of molecular phylogenetic trees.Various software's used for construction of phylogenetic trees. Implications of Phylogenetic Trees in other fields of biology. Tracing ancestor-descendant relationships. Phenetics and cladistics.

REFERENCE BOOKS:

1) Bishop, B. A., & Anderson, C. W. (1990). Students' conceptions of natural selection and its role in evolution. *Journal of Research in Science Teaching, 27,* 415-427.
2) Hafner, M.S. (1994). *Evolution laboratory: Laboratory exercises and discussions in evolutionary biology.* Baton Rouge, LA: Louisiana State University.
3) Hartl, D. L. (1988). *A primer of population genetics* (2nd edition). Sunderland, MA: Sinauer Associates.
4) Minkoff, E. C. (1983). *Evolutionary biology.* Reading, MA: Addison-Wesley Publishing Company.
5) Sober, E. (1994). *Conceptual issues in evolutionary biology.* Cambridge, MA: MIT Press.
6) Mark Ridley. Evolution. 3rd Edition. Blackwell Pubishing. (2004).
7) Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.
8) P. S. Verma and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
9) Strickberger. Evolution.Prentic Hall. (2002).
10) Theodore H., Jr Eaton.Evolution.1st Edition. W. W. Norton Publication. (1970).

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

SECOND SEMESTER

DEPARTMENT OF BOTANY & MICROBIOLOGY

M.Sc. BOTANY

SEMESTER-II

Semester	BOT 2.1: PLANT ECOLOGY AND BIODIVERSITY	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	The aim of the course is to impart knowledge of concepts and principles of ecology, ecosystem function, nutrient cycling, biodiversity conservation and sustainable development, and application of these concepts to solve environmental problems.

COURSE OBJECTIVE (CO):

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

CO1	Identify the factors controlling the equilibrium of ecosystem.
CO2	Understand the theory of continental drift for the evolution of floras of the various regions of the world.
CO3	Identify the biodiversity hot spots of the world and to understand the various measures to be taken to conserve them effectively.
CO4	Gain the knowledge about the *in situ* and *ex situ* conservation of natural resources.
CO5	Understand the sustainable development, Phytoremediation and the role of Remote sensing and GIS in biodiversity management.

UNIT-I

Levels of Ecological Organization; Population characteristics and dynamics; Communities characteristics and their analysis; Structure and function of ecosystem; Energy flow in ecosystem; Homeostasis of ecosystem; Biomes and their types.

UNIT-II

Soils: Soil properties and types of soils; Global biogeochemical cycles of Carbon and Sulfur; Dynamic Phytogeography: Basic principles, Age and area theory; Centre of origin; Endemism, Migration and Continental drift.

UNIT-III

Biodiversity: Current concepts, Levels of Biodiversity like Species, Ecosystem and Genetic diversities, IUCN categories of threat; Causes of biodiversity loss; Keystone species; Biodiversity hotspots of India and world; Organizations involved in biodiversity conservation: IUCN, WWF,UNEP and UNESCO.

UNIT-IV

Strategies for *in situ* conservation: Protected areas: Sanctuaries, National Parks, Biosphere Reserves and Mangroves; Strategies for *ex situ* conservation: Botanical Gardens, Seed Banks, Field Banks, Gene Banks, *in vitro* preservation;

UNIT-V

Air pollution and climate change; Sustainable development; Phytoremediation; Application of Remote sensing and Geographical Information System (GIS) in biodiversity studies.

TEXT BOOKS:

1) **Marchese**, **C**, 2014. *Biodiversity hot spots: A shortcut for more complicated concept.Global Ecology and conservation*. http://dx.doi.org/10.10.16/j.gecco.2014.12.008.
2) **Odum, E.P**. and **Gary W. Barrett**, 2011. *Fundamentals of Ecology* (5th Edition), Saunders ISBN.
3) **Russel, P.J**., **Wolfe,S**. **L.,Hertz, P. E., Starr, C.** and **Mc Million B.**, 2008. *Ecology*, Cengage Learning India PvtLtd.,New Delhi.
4) **Wilkinson, D.A**. 2007. *Fundamental Processes in Ecology: An Earth system Approach*. Oxford.
5) **Chapman, J.L.** and **Reiss, M.J.,** 2003. *Ecology: Principles and Applications*, (2nd Edition) Cambridge University Press, UK.
6) **Ambasht, R.S.** and **Ambasht, N.K**., 1999. *A Text Book of Ecology*, CBS Publishers and Distributers, New Delhi.
7) ***IUCN** Red List of threatened species* Version 2019.1.
8) **Chauhan, S.S.** 2014. *Status of Biodiversity in India: Issues and Challenges.* Indian Journal of Plant Sciences 3(1): 35-42.
9) **Wood,A.,Pamela,S.E.** and **Johanna,M**. 2000. *The root causes of biodiversity loss*. United Kingdom: Early-Scan Publications.
10) **Richard B. Primack**, 1993. *Essentials of Conservation Biology* (6th Edition) Oxford University Press.
11) **Heywood, V.M.** and **Watson,R.T**. 1985. Global Biodiversity Assessment, Cambridge University Press, Cambridge.
12) **Swaminathan M.N. & Jam R.S.**, 1982. *Biodiversity: Implications for Global Security*, Macmillan.

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

Semester	BOT 2.2: PLANT PHYSIOLOGY	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To study the photobiology of plants and its role in flowering and photo morphogenesis. To study the growth regulators in growth and development of plants To study the effects and responses of plats to abiotic stresses.

COURSE OBJECTIVE (CO):

CO1	Understand the mechanism of transport of water and solutes. Basic principles on ionic transport facilitate the student to understand the gas exchange mechanism of plants with surrounding environment.
CO2	The student is able to understand the sensory photobiology which helps acquire knowledge on floriculture.
CO3	Student able to learn the importance of growth regulators in plant growth and development
CO4	Student acquire knowledge on analytical techniques involved in isolation, purification and assays on Biomolecules. Student fit to work-in in scientific laboratories
CO5	Student gain the knowledge on plant adaptations to different abiotic stresses

UNIT - I

Membrane transport and translocation of water and solutes**:** The structure and properties of water; water transport processes (diffusion, bulk flow, osmosis, water potential, components of water potential); Mechanism of water transport through xylem; Solute transport by active and passive mechanisms. Structure and properties of membrane transport proteins.

UNIT - II

Water loss by transpiration; Mechanism of stomatal movements; antitranspirants. Sensory Photobiology: Historical discovery of phytochromes, structure and functions of phytochrome, photochemical and biochemical properties of phytochrome, phytochrome induced plant responses, molecular mechanism of action of phytochrome in gene expression, Cryptochrome and its role in photomorphogenesis.

UNIT - III

The flowering process- Photoperiodism and its significance, initiation of flower primordia, flowering stimulus, vernalization, endogenous clock and its regulation. Plant growth regulators: Physiological effects and mode of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, jasmonic acid and salicylic acid.

UNIT-IV

Signal transduction: Over view, receptors and G proteins, second messengers, two component sensor regulator system in bacteria and plants, signal transduction and gene expression. Essential nutrients, deficiencies and plant disorders.

UNIT - V

Stress Physiology: Water stress, salt stress, temperature stress (HSP), biotic stress (HR and SAR), heavy metal stress; Stress avoidance and tolerance mechanisms; Structural, physiological, biochemical and molecular responses of plants to environmental stresses; Reclamation of saline and heavy metal contaminated soils.

REFERENCE BOOKS:

1) Devline and Witham, 1986. Plant Physiology.CBS Pubis and Distributors. New Delhi.
2) Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA.
3) Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer Verlag, New York, USA.
4) Singhal *et al*. 1999. Concepts in Photobiology. Photosynthesis and Photo-morphogenesis, Narosa Pub. House. New Delhi.
5) Taiz and Zeiger, 1998. Plant Physiology. Sinauer Associates Inc., Publishers, Sunderland.
6) Salisbury F.B & C. W. Ross, 1992. Plant Physiology, 4th Edition. Wadsworth Publishing Co., Belmount, California.

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

Semester	BOT 2.3: CELL BIOLOGY	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	The aim of the course is to impart knowledge on structure and functions of cell and cell organelles, chromosome types and their alterations, cell cycle based on various aspects including recent advances in this field.

COURSE OBJECTIVE (CO):

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

CO1	Understand structural organization and functions of the cell organelles.
CO2	Know the fine structure and organization of chromosomes, chromatin types and special types of chromosomes
CO3	Understand the mechanism of cell division, cell cycle phases and the role of check points, cyclins and cyclin dependent kinases.
CO4	Gain knowledge about Apoptosis, oncogene and tumor suppression genes.
CO5	Apprehend different aspects of structural and numerical alterations in chromosomes.

UNIT- I

Eukaryotic cell: Organelles – Chloroplast, Mitochondria, Ribosomes, Endoplasmic reticulum, Peroxisomes, Golgi apparatus, Lysosomes and plant vacuoles and Cytoskeleton.

UNIT- II

Nucleus; Ultrastructure of prokaryotic and eukaryotic chromosome; chromosome banding; Karyotype; Euchromatin and heterochromatin. Special types of Chromosomes: Polytene, Lamp-brush, B-chromosomes, and Sex- chromosomes,

UNIT- III

Phases of Cell cycle: G1, S, G2 and M phases, Check points in cell cycle - Role of cyclins; Cyclin dependent kinases; Cell division; significance of meiosis.

UNIT- IV

Apoptosis –mechanism and significance, oncogene and tumour suppressor genes. Genomes of mitochondria and chloroplasts. Endosymbiotic theory.

UNIT-V

Structural alteration in chromosomes - Origin, Duplications, Deletions, Inversions and Translocations.Numerical alteration in chromosomes: Origin, Occurrence of haploids, polyploids and aneuploids.

TEXT BOOKS:

1) **Arun Kumar Sharma**and **Archana Sharma**, 1980. *Chromosome Techniques. Theory and Practice.*Third Edition, Butterworth -Heinemann, London.
2) **Brown, W.V.**and **Berke,E. M.** 1975.*Text Book of Cytology*, Saint Louis: C V Mosby Company, USA.
3) **Darlington, C.D**. 1903. *Recent Advances in Cytology*, Blakiston`s Son & Co., Philadelphia.
4) **De Robertis, E. D. P.** and **De Robertis, E. M. F**. 2010.*Cell and Molecular Biology,* 8th Edition, Wolters Kluwer, USA.
5) **Jean Brachet** and Mirsky, **Alfred E. (**Eds.): **The Cell**, Academic Press, Inc. New York, USA.
6) **Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick,** 2018. Lewin1s, B. 2018.
7) *Genes***.** 12th Edition, Jones& Bartlett Learning, Burlington, MA 01803.
8) **Stebbins, G.L.,** *Chromosomal Evolution in Higher Plants*, Edward Arnold Publications, London.
9) **Roy, S.C.** and **Kalyan Kumar De.,** 1977. *Cell Biology***,** New Central Book Agency, Calcutta.
10) **Wolfe, Stephen L.** 1993. *Molecular and Cellular Biology*. Wordsworth Publishing Company, California. USA.

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

Semester	BOT 2.4 (A): PLANT STRUCTURE AND DEVELOPMENT	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To gain knowledge on the development and regulation of shoot apex, root apex, leaf, and cambium; secondary growth and abnormal secondary growth; and leaf senescence in plants.

COURSE OUTCOMES (CO):

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

CO1	Understand the role of meristems in plant development; organization and regulation at the shoot and root apices.
CO2	Learn about nature and function of cambia and wood; normal and anomalous secondary growth; different tissue types.
CO3	Appreciate the structure and development of leaves and nodes, and significance of CAM and Kranz anatomy.
CO4	Understand embryo structure and pattern of its development; factors influencing the seed germination and seedling growth.
CO5	Know the factors inducing the dormancy; methods of breaking dormancy;senescence and their significance in plant development; and applications of anatomy in taxonomy and pharmacognosy.

UNIT-I

Types and functions of meristems, organization and regulation of Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM), floral meristems and MADS-Box genes.

UNIT-II

Structure and function of vascular cambium; wood- heart wood and sap wood, porous and nonporous wood, reaction wood; secondary growth in Dicots and Monocots; Anomalous secondary growth in Dicots and Monocots; structure and functions of simple and complex tissues.

UNIT-III

Structure and development of leaf, stomata, nodes their and evolution; special anatomical adaptations of Kranz and CAM anatomy features.

UNIT–IV

Plant embryo development, stages, cell division and pattern formation in embryo, cell polarity In embryo, genetic and hormonal regulation of embryo development. Seed germination and factors influencing the germination and seedling growth.

UNIT- V

Seed Dormancy- types, factors causing seed dormancy, mechanism of breaking seed dormancy, Programmed Cell Death (PCD); Senescence types and biochemical changes associated with leaf senescence; applications of anatomy in taxonomy and pharmacognosy.

REFERENCE BOOKS:

1) Atwell, B.J. Kriederusann, P.E. and Jumbull, C.G.N. (Eds.), 1999. **Plant in action**:
2) **Adaptation in nature, Performance in cultivation**, MacMillan Education. Sydney.
3) Bewley, J. D. and Black, M. 1994. **Seeds: Physiology of Development and Germination**, Plenum Press, New York.
4) Burgess, J. 1985. **An Introduction to Plant Cell Development**, Cambridge University Press, Oxford.
5) Fahn, A. 1982. **Plant Anatomy** (3Td Ed.), Pergamon Press, Oxford.
6) 5.Fosket, D.E. 1994. **Plant Growth and Development -** A Molecular approach, Academic Press, Oxford.
7) Lyndon, R.F. 1990. **Plant Development-The Cellular basis**, Unnin Hyman, London.
8) Raghavan, V. 1999. **Developmental Biology of Flowering Plants**, Springer-Verlag, NY.
9) Steeve, T.A. and Sussex, I.M. Patterns in Plant Development (2r Ed.), Cambridge University Press, Cambridge.
10) Singh, V., Pande, P.C and D.K.Jain (2ed.). Anatomy of Seed Plants. Rastogi Publications, Meerut, India.

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

Semester	BOT 2.4 (B): PRINCIPLES OF FORESTRY	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO1	To gain information on various aspects of forest types, composition, and their sustainable management; and usage of all the forest natural resources and biodiversity.

COURSE OUTCOMES (CO):

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

CO1	Appreciate the different forest types and their uses.
CO2	Understand the potential uses of allied branches of forestry, acts related to forests, and the role of forests in reducing global warming.
CO3	Enrich information related to world forests distribution, classification, practices and resources productivity.
CO4	Unravel the role of dendrology, ICBN and other systems of classification in tree identification and classification.
CO5	Will come to know about general problems of forest development and economy; and National and International organizations involved in Forest management.

UNIT-I

Forests; definitions, role, benefits-direct and indirect. History of forestry-definitions- divisions and interrelationships. Classification of forests-high forests, coppice forests, virgin forest and second growth forests, pure and mixed forests-even and uneven aged stands. Foresttypes of India-classification.

UNIT-II

Agroforestry-farm forestry, social forestry, joint forest management-concepts, programmes and objectives. Important acts and polices related to Indian Forests. Global warming –forestry options for mitigation and adaptation-carbon sequestration. Important events/dates related to forests and environment-themes and philosophy.

UNIT-III

Introduction to world forests-geographical distribution, and their classification, factors influencing global forests distribution, productivity and increment of world forests. Forest resources and forestry practices in different regions of the world. Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan and China.

UNIT-IV

Introduction to dendrology-history, significance of dendrological studies, and applications in tree identification; Botanical nomenclature, ICBN rules and codes, binomial and polynomials, systems of classification-natural, artificial, and phylogenetic classification. Principles of systematics.

UNIT-V

General problems of forest development and economy. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations inForestry.

REFERENCE BOOKS:

1) Beazley, M. 1981. The international book of Forestry. London Champion and Seth. 1968. Forest types of India.
2) Grebner, D.l., Bettinger, P and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google e book).
3) Khanna, L.S. 1989. Principles and practice of Silviculture. Khanna Bandu, New Delhi.
4) Mather, A.S. 1990.Global forest resources. Belhaven. London, Pearssson,R.
5) World Forest resources. 1992. Periodical experts. New Delhi.
6) Westuby, J. 1991. Introduction to world forestry. Wiley, 240 9.
7) Indian Forestry by K. Manikandan, S. Prabhu.
8) Introduction to Forestry Science by De Vere Burton.
9) Forest Resources and Sustainable Development by Kailash Chandra Bebarta.
10) Forestry: Principles and Applications by Antony Joseph Raj, S.B. Lai.

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

Semester	BOT 2.4 (C): MICROORGANISMS IN HEALTH AND ENVIRONMENTAL ALLEVIATION	L	T	P	C
II		4	0	6	4

LEARNING OBJECTIVE (LO):

LO	This course explains the concept, significant role and impact of microbes on different environments and particularly human health with the focus on important bacterial, viral and fungal pathogens.

COURSE OBJECTIVE (CO):

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

CO1	Gain knowledge on important human diseases.
CO2	Acquire useful information regarding the diagnosis of diseases
CO3	Improve the knowledge on different drugs and their mode of action.
CO4	Have awareness of microbes in different environments and understand the types of allergies and their control.
CO5	Gain adequate knowledge on the role of microbes as cleaners of pollution.

UNIT- I

Important developments in Medical Microbiology. Normal microbial flora of human body. Outlines on the role of microbes in human health – Study of the pathogen, pathogenesis, symptoms, epidemiology of diseases- Hepatitis and HIV: Typhoid and Cholera; fungal skin diseases and Amoebic dysentery, Malaria.

UNIT- II

Measures to control microbial infections- Diagnosis of the disease – collections of specimens, microscopic, biochemical and serological methods of diagnosis of bacterial infections-

UNIT- III

Outlines of Chemotherapy. Clinical use and mode of action of the following drugs.

Antibacterial drugs : Sulpha drugs, penicillin, Tetracyclines

Antiviral drugs : Amantadine, Acyclovir

Anti fungal drugs : Imidazoles, Nystatin

UNIT- IV

Brief account on microbes present in aerial, aquatic and soil environments. Study on allergy causing agents, types of allergies and control. Tests for water quality- Treatment of water for drinking purpose- Study on beneficial microbes present in soil.

UNIT- V

Outline on role of microbes in water and soil pollution- Control of polluted environments – role of microbes in cleaning of oil spills, degradation of pesticides, sewage water treatment – Solid waste treatment.

TEXT BOOKS:

1) Ananthanarayana, R. and Panicker, C.K.J. 2000. Text book of Microbiology, Oriental Longman publications
2) Jawetz *et al*. 1998. Medical Microbiology 21st Edn. Prentice Hall International Inc.
3) Bailey and Scott 1998 Diagnostic Microbiology (10th Edn.) Published by Mosby.
4) Madigan *et al*. 1997. Brock's Biology of Microorganisms 8th Edn. Prentice Hall International Inc.
5) Presscott *et al*. 2005. Microbiology 3rd. edition.
6) Raplh Mitchell 1978. Environmental Microbiology
7) Lynch & Poole 1979. Microbial Ecology: A conceptual approach
8) Paul & Clark 1989. Soil Microbiology & Biochemistry
9) Rheinheimer 1974. Aquatic Microbiology
10) Tilak. Aerobiology
11) Subba Rao 1995. Soil Microorganisms and Plant Growth
12) Subba Rao 199. Soil Microbiology
13) Atlas & Bartha 1997. Microbial Ecology
14) Maier, Peper & Gerba 2000. Environmental Microbiology

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

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::

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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:

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	3	1	2	2	1	3	3	2	2	1	1	1
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:

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
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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.

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	3	1	2	2	1	3	3	2	2	1	1	1
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, 4thedition 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.

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
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CO2	3	3	3	1	3	2	2	2	3	3	3	2	1	2	3
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 PLANTS	L	T	P	C
III		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 D1iei1, 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 (5^{th} 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
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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
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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:

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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) Bioinforrnatics: 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
COl	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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