Botany
SEMESTER III SYLLABUS

COURSE TITLE: PHYSIOLOGY OF PLANTS (THEORY)COURSE CODE:
BOT.III.C-5
MARKS: 100 (75Theory +25 Practical)
CREDITS: 4 (3 Theory +1 Practical)
COURSE DURATION: 45 HOURS
PREREQUISITE COURSES: Biology at XIIth preferred.

COURSE OBJECTIVE:

Relate physiological mechanism of plants and their functioning.
Analyze biosynthesis of valuable plant metabolites (primary/ secondary) and their role.

COURSE OUTCOME:

Upon successful completion of the course, students will be able to:
CO1: Analyse Physiological processes operational in the plants.
CO2: Compile various developmental process in plants
CO3. Formulate and design experiments to explain physiological concepts and interpret data.
CO4: Estimate and evaluate methods of quantitation of pigments, enzymes and metabolites
CO5: Describe and verify physiological processes through mini projects.

SR.NO	UNITS, TOPICS AND SUB-TOPICS	HOURS
MODULE -I: PLANT WATER RELATIONS AND SOLUTE TRANSPORT		**15**
1.1	Water and its significance to plants	
1.2	Osmotic & water potential of cell	
1.3	Transpiration, stomatal regulation & anti-transpirants	
1.4	Ascent of sap: Uptake, transport and translocation of water	
1.5	Essentiality of mineral nutrition and its uptake (active and passive); Role of membranes.	
1.6	Transport of organic solutes (source sink relationship); Assimilate partitioning	
MODULE II: PHOTOSYNTHESIS AND STRESS PHYSIOLOGY		**15**
2.1	Chloroplast, Photosynthetic pigments and Light harvesting complexes	
2.2	Light Reaction: Z scheme of photosynthesis & Mechanisms of electron transport	
2.3	Carbon fixation (C3, C4 and CAM pathways)	
2.4	Photoprotective mechanisms (photorespiration)	

2.5	Environment change and it's impact on photosynthesis	
2.6	Responses of plants to abiotic stresses	
MODULE III: PLANT GROWTH AND DEVELOPMENT AND SECONDARY METABOLITES		**15**
3.1	Role of phytochromes & cryptochromes and its functions	
3.2	Plant hormones, transport and physiological functions	
3.3	Photoperiodism & vernalization.	
3.4	Senescence, seed dormancy & germination	
3.5	Biosynthetic pathway of phenolic compounds, terpenes, alkaloids and their functions.	
	TOTAL	**45**

COURSE TITLE: PHYSIOLOGY OF PLANTS (PRACTICALS)COURSE CODE: BOT.III.C-5

MARKS: 25

CREDITS: 1

PRACTICAL SESSION: 15 (*Inclusive of 3 PA*)

Sr. No	**MODULE IV -TOPICS**	**PRACTICAL SESSIONS**
1	Determination of osmotic potential of plant cell sap by plasmolytic method.	**2**
2	Determine water potential of given tissue by falling drop/ tissue weight method	**2**
3.	Chromatographic separation of plant pigments and plant sugars by paper chromatography	**3**
4	Role of Plant hormones (Auxins/ Gibberellin) in plant growth	**2**
5	Mini Project: i. Mineral deficiency symptoms in plants ii. Secondary metabolites in plants (qualitative/ quantitative basis) iii. Oxygen evolution during photosynthesis iv. Starch production during photosynthesis v. Use of hydroponic technique for plant growth	**6**
	TOTAL	**15**

REFERENCES:

1. Harvey J.M. Hou, Najafpour, M. Mahdi., Moore, G. F., Allakhverdiev S. I. (2017) *Photosynthesis: Structures, Mechanisms, and Applications*. NY: Springer Publications.

2. Jordan Smith (2016) *Plant and Crop Physiology*. Syrawood Publishing House.
3. Taiz, Lincoln., Zeiger, Eduardo., Møller, I. Max and Murphy Angus (2018) *Fundamentals of Plant Physiology*.UK: Oxford University Press.
4. Taiz Lincoln and Zeiger, Eduardo (2015). Plant Physiology and Development. U.S: Sinauer Associates Inc.
5. Ray Noggle G and Fritz George J. (2010) Introductory Plant Physiology. Prentice Hall.

6. Taiz, L. and Zeiger, E. (2006). *Plant Physiology*, 4th edition, MA, USA: Sinauer Associates Inc . Salisbury F. B. and Ross C. W. (2002). Plant Physiology 3rd edition. CBS publishers and distributers.
7. Goodwin Y.W., and Mercer E.I. (2003) Introduction to Plant Biochemistry. 2nd edition CBS Publishersand distributors.
8. Moore T.C. (1989). *Biochemistry and Physiology of Plant Hormones.* New York, USA: Springer – Verlag,
9. Singhal G.S., Renger G., Sopory, S.K., Irrgang K.D and Govindjee (1999).*Concept in Photobiology;Photosynthesis and Photomorphogenesis*. , New Delhi: Narosa Publishing House.
10. Hopkins, W.G. and Huner, P.A. (2008) *Introduction to Plant Physiology*. John Wiley and Sons.
11. Nelson, D.I. and Cox M. M. (2000). *Lehninger. Principles of biochemistry*, 3rdedition, U.K: Macmillan.
12. Plummer D. T. (1985). *An introduction to Practical Biochemistry* 2nd edition. Tata Mcgraw HillPublishing company Ltd.

CURRENT LITERATURE (JOURNAL ARTICLES):
Plant Physiology, The Plant Cell, Journal of Plant Physiology, Physiologia Plantarum, Plant Physiology andBiochemistry, Postharvest Biology and Technology, Journal of the American Society for Horticultural Science, Nature, Scientific American and Science reporter.

WEB REFERENCES:

1. http://www.nrce.niepa.ac.in › ... › Life Science
2. http://exa.unne.edu.ar › biologia › fisiologia.vegetal
3. https://www.springer.com › journal
4. https://www.ncbi.nlm.nih.gov › pmc › journals
5. https://www.biologydiscussion.com/plant-physiology-2/notes-plant-physiology/34597

Course Title : **ECOLOGY AND CONSERVATION (THEORY)**

Course Code : **UG-BOT-207**

Credits : **03**

Marks : **75**
Duration : **45 hours**

COURSE OBJECTIVES:

Objective of this paper is to provide introductory knowledge on biotic and abiotic environmental factors, pollution and phytogeography with regards to Government regulations towards environmental management with respect to agriculture and food security.

COURSE OUTCOMES:

Upon successful completion of the course, students will be to:

CLO1: Discuss, explain and review the concept of ecosystem, phytogeography and population ecology.

CLO2: Analyze and evaluate the pollution scenario of the area and relate the theory in the natural environment and work towards conservation of the environment and its legalities.

CLO3: Quantitatively estimate the oxygen and Carbon dioxide from different water samples.

CLO4: Evaluate and determine minimum area of sampling unit (using quadrant) for the study oflocal vegetation.

MODULE 1: CONCEPT OF ECOSYSTEM, PHYTOGEOGRAPHY AND POPULATION ECOLOGY 15 hrs

Concept of Ecosystem, Ecological adaptations of plants belonging to following ecological groups: Hydrophytes, Xerophytes and Halophytes. Shelford's law of tolerance. Introduction to Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation.

Phytogeography – plant distribution, theories on plant distribution; Endemism, Biomes of the world and phytogeographical regions of India.

Population Ecology: Survivorship curves- Type I, Type II, Type III.

Population growth: Population growth curves – Carrying capacity K, Exponential growth (J shaped curve) and Logistic growth (S shaped curve).

MODULE II: ECOLOGICAL FACTORS AND COMMUNITY RELATIONSHSHIPS 15 hrs

Light - quality, duration, absorption, intensity & effects on plants.

Temperature-variation due to altitude effects on plants, thermal constant and stratification. Water-precipitation, moisture & measurement of rainfall, Wind - speed, advantages and damages caused to plants. Soil- Soil profile, texture, classification and organic matter. Community relationships: Biotic interactions, Gaia Hypothesis, Introduction to Optimal foraging theory.

MODULE III: POLLUTION, LAWS AND ORGANISATIONS 15 hrs

Air pollution- polluting gases; ozone depletion, greenhouse effect, global warming, acid rain and smog. Water pollution-eutrophication, sewage, industrial waste, heavy metal Pollution. Soil pollution – chemical pollutants and Bioremediation. Forest conservation act, Indian forest act, Biodiversity act, Western Ghat. Protection act, Kasthurirangan Act, Gadgil committee report, Mining committee reports, wild life act (recent acts to be studied). Organizations (National & International) working for conservation(NEERI, TERI, MSSRF, IUCN, TRAFFIC).

TOTAL 45 hrs

Course Title : **ECOLOGY AND CONSERVATION (PRACTICAL)**

Course Code : **UG-BOT-207**

Credits : Marks : **25**

Duration : **30 hours (15 sessions)**

Sr. No	Topics	Practical Sessions
1.	Study of ecological instruments i.e. lux meter, rain gauge, hygrometer, wet and dry bulb thermometer, maximum and minimum thermometer.	02
2.	To study the physical and chemical characters (moisture, texture and pH) of Sand, Loam and Clay.	02
3.	Analysis of different water samples for oxygen and carbon-dioxide content.	03
4.	Estimation of total carbonates from soil sample	01
5.	Visual interpretation of remotely sensed image for vegetation types (Land use land cover, NDVI)	01
6.	Anatomical study of Hydrophytes (leaf), Xerophytes (succulents) and Halophytes (leaf)	01
7.	Mini project: To determine minimum area of sampling unit (quadrat) for the study of local community and to determine species diversity index (Simpson’s & Shannon-Weiner) of herbaceous vegetation.	05
	Total	**15**

REFERENCES:

1. Ambasht, R.S. (1988). *A Text Book of Plant Ecology*. Varanasi: Students Friends Co.
2. Day A. K., (2002). *Environmental Chemistry*. Fourth Edition. New Delhi:New AgeInternational Publishers.
3. Jogdand, SN, (1995), *Environmental Biotechnology*. Mumbai: Himalaya Publishing House.
4. Moore, P.W. and Chapman, S.B. (1986). *Methods in Plant Ecology*. Blackwell ScientificPublications.
5. Odum E.P. and Barret G.W., (2004) *Fundamental of Ecology*. Fifth edition, Brooks/ColePublishers.
6. P. D. Sharma (2004), *Ecology and environment*. 7th edition, Meerut: Rastogi publications.
7. Piper, C.S. (1950). *Soil and Plant Analysis*. Australia: University of Adelaide,
8. Sangodkar U.M.X and Masur Patil Uma (2018). *Fundamentals in EnvironmentalBiotechnology*,1st Edition, CinnamonTeal Publishers.
9. Santra S.C., (2017). *Environmental Science*. New Delhi: New Central Agency.
10. Sharma B. K., (2001). *Environmental chemistry*. Sixth revised edition. Meerut: Goel publication house.
11. Sharma, P.D. (2017). *Ecology and Environment*. 13th edition. Meerut. RastogiPublishers.
12. Subrahmanyam, N.S.; Sambamurty, A.V.S.S. (2006); *Ecology*; 2nd edition; New Delhi: NarosaPublishing House.

Web links:

1. Science Direct: https://www.sciencedirect.com/topics/agricultural-and-biological- sciences/carrying-capacity.
2. World Wide Fund – India: https://www.wwfindia.org/
3. NEERI: https://www.neeri.res.in/
4. TRAFFIC: https://www.worldwildlife.org/initiatives/traffic-the-wildlife-trade-monitoring- network
5. International Union for conservation of nature: https://www.iucn.org/
6. MSSRF- https://www.mssrf.org/
7. TERI-https://www.teriin.org/

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENYCOURSE CODE: BOT-III.E-2

MARKS: 100 (75 Theory + 25 Practical)

CREDITS: 4 (3 Theory +1 Practical

DURATION: 45 HOURS

PREREQUISITE COURSES: Biology at XIIth preferred.

COURSE OBJECTIVES:

To study the morphology, systematics and phylogeny of flowering plants.

COURSE OUTCOMES:

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

CO1: Define Plant Classification, documentation and nomenclature in Plant Systematics.

CO2: Explain, examine the concept of taxonomic evidences and phylogeny of angiosperms.

CO3: Explain, analyze and interpret the systems of classification, features of families in Systematics of flowering plants.

CO4: Identify plants with help of Floras, taxonomic keys, prepare Herbarium and construct Cladograms.

SR.NO	UNITS, TOPICS AND SUB-TOPICS	HOURS
MODULE I: INTRODUCTION TO PLANT CLASSIFICATION ANDNOMENCLATURE		**15**
1.1	Plant classification, nomenclature & biosystematics	
1.2	Field inventory; Functions of Herbarium; Important herbaria and botanical gardens (India & world), virtual herbarium; e-flora	
1.3	Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access	
1.4	Principles and rules (ICBN); Ranks and names; Typification, author citation, valid publication	
1.5	Rejection of names, principle of priority and its limitations; Names of hybrids	
MODULE II: CONCEPT, TAXONOMIC EVIDENCES AND PHYLOGENY OF ANGIOSPERMS		**15**
2.1	Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; species concept (taxonomic, biological, evolutionary).	
2.2	Evidence from palynology, cytology, phytochemistry and molecular data.	
2.3	Origin & evolution of angiosperms, Co-evolution of angiosperms. Characters; Variations; OTUs, cluster analysis, Phenograms, cladograms (definitions and differences)	
MODULE III: SYSTEMS OF CLASSIFICATION; POSITION AND DIAGNOSTIC FEATURES OF FAMILIES		**15**
3.1	Concepts of evolution and phylogeny	

	reference of Angiosperm Phylogeny group (APG III) Classification.	
3.3	Annonaceae, Capparaceae, Brassicaceae, Grewiaceae, Rutaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Apocyanaceae Asclepiadaceae (sub-family), Solanaceae,Verbenaceae, Zingiberaceae, Commelinaceae, Poaceae	
	TOTAL	**45**
3.2	Major contributions by Linnaeus, Bentham and Hooker, Engler and Prantl; Brief	

COURSE TITLE: SYSTEMATICS OF FLOWERING PLANTS AND PHYLOGENY COURSECODE: BOT-III.E-2
MARKS: 25
CREDITS: 3
COURSE DURATION: 15 SESSIONS (*inclusive of 3 PA*)

SR.NO	MODULE IV: TOPICS	PRACTICAL SESSIONS
1	Plant identification using flora and database	**1**
2	Identification of 10 families mentioned in unit IV (Bentham & Hooker's system) studied in theory from locally available specimens (with floral diagram).	**10**
3	Use of taxonomic keys and construction of dichotomous keys	**1**
5	Taxonomic interpretation using pollen of related species	**1**
6	Construction of Phenogram and Cladogram	**1**
	Mini project: i. Preparation of herbarium	**1**
	TOTAL	**15**

REFERENCES:

1. Singh, G. (1999). *Plant Systematics*: Theory and Practice. New Delhi: Oxford &IBH Pvt. Ltd.
2. Chopra, G. L. (1985). *Angiosperm (Systematics& Life cycles*). Jaladhar, India :Pradeep Publications, pp.339-350.
3. Pandey, B. P. (1969). *Taxonomy of Angiosperms*. New Delhi: S. Chand andcompany Ltd, India, pp.102-105.
4. Subrahmanyam N S (1995). *Modern plant taxonomy*, Vikas publishing house pvt. Ltd.
5. Pandey S.N. (2008). *Taxonomy of angiosperms*, New Delhi: ASE books India.
6. Mondal, A.K. (2009). *Advanced Plant Taxonomy*, New Delhi: New Central Book Agency Ltd.
7. Naik, V.N. (1984). *Taxonomy of Angiosperms*. New Delhi: Tata McGraw Hill.
8. Radford, A.E. (1986). *Fundamentals of Plant Systematics*. New York: Harper and Row.
9. Davis, P.H. and Heywood, V.H. (1963). *Principles of Angiosperm Taxonomy*. London: Oliver and Boyd.
10. Heywood, V.H. and Moore, D.M. (1984). *Current Concepts in Plant Taxonomy*. London: Academic Press.
11. R.S.Rao.(1985). *Flora Of Goa, Diu Daman, Dadra And Nagarhavel* . New Delhi : Director, BotanicalSurvey of India.

Course Title: **ENZYMES AND THEIR METABOLIC PATHWAYS (THEORY)**
Course Code: **BOT-III. E-3**
Credits: **3**
Marks: **75**
Course Duration: **45 hours**
Prerequisite Course: **Biology at XII th preferred**

Course Objectives:
The objective of this course is to understand the importance and mechanisms of enzyme action. The course also discusses about enzymatic regulation & metabolic control of biochemical reactions.

Course Outcomes:
Upon successful completion, the students will be able to
CLO1: Classify the different enzymes based on its structure and function.
CLO2: Identify the role of enzymes in various biological processes.

CLO3: Outline the various mechanisms of enzyme action.

CLO4: Identify and apply usage of enzymes in industry.

MODULE I: BASIC CONCEPT AND CATALYSIS OF ENZYMES 15 hrs

Classifications & nomenclature (IUB system). Biological role of enzymes; Concept of holoenzymes, apoenzymes, prosthetic group, iso-enzymes, allosteric enzymes and Active sites. Chemical nature of enzymes, Characteristics of enzymes (Physico-chemical and biological properties), Enzyme activity. Role of co-factors (NAD, NADP+, FMN/FAD, Co-enzyme A, Pyridoxyl phosphate and metal ions).

MODULE II: ENZYME KINETICS 15 hrs

Factors affecting enzyme activity (concentration, substrate, pH, temperature, inhibitors). Michaelis-Menten equation and its significance. Fisher's lock and key model and Koschland (induced fit theory), Arrhenius plot. Enzyme action (competitive, noncompetitive and reversible)

MODULE III: METABOLIC CONCEPTS OF ENZYMES 15 hrs

Glycolysis, Fate of pyruvate (Lactic acid & alcohol fermentation). Citric acid cycle, Glycogen cycle, Respiratory substrate, Respiratory quotient, Mitochondrial Electron transport, Cytochrome, Alternate oxidase pathway. Biosynthesis and degradation of triglycerides. Pathway for amino acid metabolism (Nitrogenase enzyme complex, NIF and Nod genes).

TOTAL 45

Course Title**: ENZYMES AND METABOLIC PATHWAYS (PRACTICALS)**
Course Code**: BOT- III.E-3**
Marks**: 25 MARKS**
Credits**: 1**
Course Duration**: 15 SESSIONS**

Sr. No	TOPICS	PRACTICAL SESSIONS
1	Qualitative and quantitative determination for amylase enzyme in the given plant samples.	3
2	Effect of enzyme concentration, temperature, substrate, inhibitors and pH on the activity of α-amylases	5
3	To extract and determine the activity of catalase , lipase and peroxidase enzymes	3

4	Mini project i. Role of Nitrogen in plants ii. Application of enzymes in industries (dairy/ sugar/ waste management/ food) iii. Anaerobic respiration in germinating seeds.	4
	TOTAL	**15**

REFERENCES:

1. Bennett, T. P. and Frieden E. (1969). *Modern Topics in Biochemistry*. pg. 43-45.London: Macmillan.
2. Breaker, Ronald R. (2000). Making Catalytic DNAs. *Science* 290: 2095–2096.
3. Campbell, N. A., Jane B. R., and Mitchell L. G. (1999). *Biology*, 5th ed. Menlo Park, CA: Benjamin/Cummings.
4. Deeth, R. J. (1997). Chemical Choreography. *New Scientist* 155: 24–27.
5. Harrow, B. and Mazur, A. (1958). *Textbook of Biochemistry*. 109, Philadelphia: Saunders
6. Holum, J. (1968). Elements of General and Biological Chemistry, (2nd ed.) 377. New York: Wiley.
7. Koshland, D. E. (1973). Protein Shape and Biological Control. *Scientific American* 229: 52–64.
8. Madigan, M. R., and Marrs B. L. (1997). Extremophiles. *Scientific American* 276: 82–87.
9. Pfeiffer, J. (1954). *Enzymes, the Physics and Chemistry of Life*. pg 171-173. New York: Simon and Schuster.
10. Price C. N., Lewis S. (1999). *Fundamentals of Enzymology*. UK: Oxford University Press.
11. Berg, J. M., Tymoczko, J. L., Gatto Jr., G. J., & Stryer, L. (2019). *Biochemistry* (9 ed.). New York: WH Freeman.
12. Palmer, T., & Bonner, P. L. (2007). *Enzymes Biochemistry, Biotechnology, Clinical Chemistry* (2 ed.). Cambridge: Woodhead Publishing.
13. Voet, D., & Voet, J. (2010). *Biochemistry* (4 ed.). New Jersey: John Wiley & Sons, Inc.
14. Devasena, T. (2010). *Enzymology*. England: Oxford University Press.
15. Satyanarayana, U. & Chakrapani, U. (2020). Biochemistry (5 ed.). Chennai: Elsevier.
16. Jain, J. L., Jain, S. & Jain, N. (2016). *Fundamentals of biochemistry*. New Delhi: S. Chand Pvt. Ltd.
17. Rodwell, V., Bender, D., Botham, K., Kennelly, P. & Weil, P. A. (2018). Harper's illustrated biochemistry. USA: McGraw Hill Education.

WEBLINKS:

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4692135/

2. https://www.imedpub.com/insights-in-enzyme-research/

3. https://iopscience.iop.org/book/978-0-7503-1302-5/chapter/bk978-0-7503-1302-5ch1

Course Title**: BIORESOURCE MANAGEMENT COURSE**
Course Code**: BOT-III.SEC-1**
Marks**: 100**

Credits**: 4**
Course Duration**: 60 HOURS**

COURSE OBJECTIVES:
Objective of this paper is to provide introductory and practical knowledge on wine preparation, mushroom cultivation and spices and condiments and to develop professional skills in the given areas.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able:
CLO1: Assess the varieties of fruits used for the wine preparation.
CLO2: Outline the basic elements of wine fermentation, responsible organisms and process of wine production.
CLO3: Develop skills and being self-reliable and employable.
CLO4: They are able to work in a mushroom farm / industry and research laboratory.
CLO5: Identify and classify important plants/plant parts.
CLO6: Extract valuable plant products of potential market and economic value.

UNITS, TOPICS AND SUB-TOPICS

MODULE 1: INTRODUCTION TO BIORESOURCES 15

Definition, types, importance and scope of bioresources, sustainable uses, value added products in the market
History and culture of wine,
Classification of wine: Generic classification, varietal classification, Grape variety as criteria for quality wine production
Introduction, history and scope, Edible and non-edible mushrooms (Poisonous). Mushroom classification based on occurrence, habitat,color, morphology, fruit bodies.
General description of spices and condiments

MODULE II: PROCESSING AND PRODUCTION OF WINE 15

Wine preparation: fermentation, microorganisms, racking, tasting and ranking. Preparation of wine using various fruits like apple, chickoo, ginger, guava, grapes, mango, pineapple, pomegranate, carrot, orange, dates,rose, watermelon, jamun, garcinia etc. Organic wines: Organic viticulture and wine-making practices Traditional and commercial wine-making: A comparison of traditional and .new wine-making practices. Barrel aging, clarification, fining, settling, cold stabilization, filtering, blending, bottling, closure systems. Economic importance of winemaking Wine Marketing.

MODULE III – MUSHROOM CULTIVATION 15

Biology and Life cycles of specific mushrooms (any one). Nutritional value and medicinal importance of mushroom, value added products of mushroom.
Cultivation Technology: Mushroom laboratory; infrastructure- facilities and materials; Substrates (locally available - paddy straw, sugarcane trash, maize straw, banana leaves), Mushroom bed preparation (Composting technology, platform, equipment & facilities); pasteurization room & growing rooms. Mushroom spore isolation & spore culture; Culture media (PDA medium, Malt extract agar medium); sterilization, multiplication & storage. Visit/demo/virtual study of button mushroom cultivation.

MODULE IV: MANAGEMENT OF OTHER BIORESOURCES 15

Processing, post-harvest practices and uses of Spices & condiments: chillies, clove, black pepper, cinnamon, turmeric, nutmeg. General description, processing, post-harvest practices and uses of vanilla and coconut and cashew. Marketing of Bioresources (Wines, mushrooms, Spices & condiments, vanilla, coconut, cashew and cashew products).
Visit to farms/processing units/ ICAR.

REFERENCES:

1. Jackson, R.S. 2014. Wine Science: Principles and Applications, 4th Edition. Elsevier AcademicPress, London, UK, ISBN-13: 978-0123814685.
2. Johnson, H. and Robinson, J. 2013. The World Atlas of Wine, 7th Edition. Mitchell Beasley,London, UK, ISBN-13: 978-1845336899.
3. Ribéreau-Gayon, P., Glories, Y., Maujean, A., and Dubourdieu, D. 2006. Handbook of Enology: The Chemistry of Wine Stabilization an Treatments, Volume 2, 2nd Edition. JohnWiley & Sons, Ltd.
4. Marimuthu, T., Krishnamoorthy, A.S., Sivaprakasam, K., & Jayarajan, R. (1991). OysterMushrooms. Coimbatore, TN: Department of Plant Pathology, Tamil Nadu Agricultural University.
5. Swaminathan, M. (1990). Food and Nutrition. Bengaluru: The Bangalore Printing andPublishing Co. Ltd.
6. Subrahmanyam, N. S. and Sammbamurty, A.V.S.S. (2008). *A textbook of Modern economic Botany*. New Delhi: CBS Publishers & Distributors.
7. Pandey, B. P. (2015). *Economic Botany.* New Delhi: S. Chand & Company.

8. V. Verma (2009) Textbook of Economic Botany Published by ANE Books

WEB REFERENCES:

a. https://winefolly.com/deep-dive/how-is-red-wine-made/
b. https://www.winemonthclub.com/the-wine-making-process
c. https://onlinecourses.swayam2.ac.in/nos20_ge07/preview
d. https://nios.ac.in/departmentsunits/vocational-education/stand-alone-courses/oyster-mushroom- production-technology.aspx
e. https://agricoop.nic.in/sites/default/files/ICAR_8.pdf
f. https://kvknorthgoa.icar.gov.in/litpub/Technical%20Folders/Plant%20Protection/Oyster%20Mushr oom%20Cultivation.pdf
g. https://nios.ac.in/media/documents/vocational/mushroom_production_(revised)(618)/Lesson-01.pdf

SEMESTER IV SYLLABUS

Course Title : **CYTOGENETICS (THEORY)**
Course Code : **UG-BOT-205**
Credits : **04**
Marks : **75**
Duration : **45 hours**

COURSE OBJECTIVES:

This course will enable the students to understand fundamentals of genetics and evolution.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CLO1 Restate, apply, analyze and access the fundamentals of Mendelian genetics and linkage.

CLO2 To discuss, explain and interpret extra nuclear inheritance and Sex linked inheritance

CLO3 Identify, explain, compare and contrast various chromosomal abberatior

CLO4 To employ and evaluate Mendelian genetics at a practical level.

MODULE I: Mendelian Genetics, Linkage and Mutation **15**

Mendel's Laws, backcross and test cross. Allelic and non-allelic interactions, Epistatic interactions. Multiple alleles in Drosophila (eye colour), man (blood groups) and plants (self-incompatibility).

Linkage- Coupling and Repulsion Hypothesis Chromosome maps. Mutations and its types. Types of mutagens. Transitions and transversions; frame shift mutations. DNA repair mechanisms, Applications of mutations.

MODULE II: Extranuclear inheritance and Sex linked inheritance **15**

Extranuclear inheritance and maternal influence: Kappa particles in *Paramecium;* CO2 sensitivity in *Drosophila*; cytoplasmic inheritance in mitochondria and plastids; Shell coiling in snails; eye colour in flour moth.

Sex Chromosomes, Mechanisms of sex determination; Genic balance mechanism. Sex-linked inheritance- X linked and Y linked inheritance.

MODULE III: Genetic variation due to chromosome structure and number **15**

Chromosomal aberrations – duplications, deletions, inversions and translocation Variations in chromosome number; auto-and allo-polyploidy - types and effects; artificial induction of polyploidy. Auto and allo-polyploid crop species Aneuploid

segregations in plants- tetrasomics and nullisomics; triploid and tetraploid plants. Applications of polyploidy

TOTAL 45

Course Title : **CYTOGENETICS (PRACTICAL)**
Course Code : **UG-BOT-205**
Credits : **01**
Marks : **25**
Duration : **30 hours (15 sessions)**

Sr. No.	Practical Title	Practical sessions
1.	Study of Mitosis and meiosis using suitable plant material	03
2.	Karyotype analysis and preparation of ideogram	02
3.	Detection of anomalies in cell division using suitable plant material.	02
4.	Study of multiple allelism in blood groups of human beings.	01
5.	Effect of physical and chemical mutagen on seed germination	03
6.	Preparation of chromosome maps from 3-point test cross data and calculation of Interference and coincidence	01
7.	Induction of polyploidy using Colchicine treatment.	02
8.	Study of sex linked inheritance	01
	Total	**15**

List of books recommended for reference:

Mandatory References:

1. Gardner, E.J., Simmons, M.J. and Snustad, D.P. (1991) Principles of Genetics (8th edition). John Wiley & sons, India.
2. Gardner, Eldon J.; Snustad, Peter D.; (1984) Principles of genetics; 7th edition; New York: John Wiley & Sons.
3. Griffiths, A.J.F., Wessler, S.R., Carroll, S. B. and Doebley, J. (2010) Introduction to Genetic Analysis (10th edition). W. H. Freeman and Co., U.S.A.
4. Gupta, P.K. (1990) Genetics. Rastogi Publications .
5. Gupta, P.K.; (2004) Cytogenetics; 1st edition, reprint; Meerut:Rastogi Publications.
6. Gupta, P.K.; Genetics: A textbook for University students; 3rd edition; Meerut: Rastogi Publications (2007).
7. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) Concepts of Genetics, (9 th edition). Benjamin Cummings, U.S.A.
8. Pierce, B. (2008) Genetics : A Conceptual Approach 3rd Edition, Freeman & Co.
9. Shukla, R.S. and Chandel, P.S.; (2007) Cytogenetics, Evolution, Biostatistics and Plant Breeding.
10. Snustad, D.P. and Simmons, M.J. (2010) Principles of Genetics, (5th edition). John Wiley & Sons Inc., India.
11. Snustad, P. and Simmons, M. (2006) Principles of Genetics, 4th Edition, John Wiley and Sons Co.
12. Verma, P.S., Agarwal, V.K. (2009) Genetics, (9th Revised Edition). S. Chand and Co., New Delhi.
13. W. S. Klug, M. R. Cummings, C. A. Spencer. (2006) Concepts of Genetics 8 Edition, Pearson Education International.

Supplementary References:

1. Watson, J. D., Baker, T. A. Bell,S. P. Gann, A. Levine, M. Losick, R. (2004)Molecular Biology of the Gene 5th Edition, Pearson Education.
2. Russell, P. (2006) Genetics 2nd Edition, Pearson International (2006).

Web References:

1. https://ndli.iitkgp.ac.in

Course Title : **PLANT BREEDING AND BIOSTATISTICS (THEORY)**
Course Code : **UG-BOT-206**
Credits : **03**
Marks : **75**
Duration : **45 hours**

COURSE OBJECTIVES:

To enable the students to learn various techniques in plant breeding with regards to crop productivity**.**

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CLO1: Identify and assess the role of various institutions, certification programs and breeders, rights in plant breeding.

CLO2: Describe and compare various techniques in hybridization and mutation breeding

CLO3: Analyze and practice various bio statistical methods.

CLO4: Interpret, analyse and evaluate various experiments in plant breeding and biostatistics.

MODULE I: INTRODUCTION TO PLANT BREEDING, ORGANISATIONS AND CERTIFICATIONS 15 hrs

Introduction, history, objectives, achievements and prospects. Centres of origin of crop plants. Organizations & their mandate – CCARI- ICAR, ICRISAT, IRRI (Indian & International) Plant breeders' & Farmers' Rights, Phytosanitary and Seed Certifications.

MODULE II: HYBRIDISATION, HETEROSIS, INBREEDING DEPRESSION AND MUTATION BREEDING 15 hrs

Pure line and mass selection, Types and Techniques in hybridization. Introduction,

domestication and acclimatization. Heterosis and inbreeding depression.

Varieties developed in India through mutation breeding; Limitations of mutation breeding.

MODULE III: BIOSTATISTICAL METHODS AND GENETICS OF PATHOGENICITY 15 hrs

Introduction to biostatistics: Terms used in biostatistics, types of data, Sampling theories-random sample, sample size determination, precision, data collection, processing and presentation of data: qualitative and quantitative data.

Measures of central tendency: Mean, Median, Mode. Measures of variation: standard deviation, standard error. Concept of correlation between two variables and regression line, Chi square.

Physiological races and types. Genetics of pathogenicity; vertical and horizontal resistance & breeding for various abiotic and biotic stresses in rice/wheat.

TOTAL 45 hrs

List of books recommended for reference:

Mandatory References:

1. Acquaah, G. (2007) Principles of Plant Genetics & Breeding. Blackwell Publishing.
2. Mahajan, B.K.; (1997) Methods in biostatistics; 6th edition; New Delhi:Jaypee Brothers.
3. Shukla, R.S. and Chandel, P.S.; (2007) Cytogenetics, Evolution, Biostatistics and Plant Breeding.
4. Singh, B.D. (2005) Plant Breeding: Principles and Methods (7th edition). Kalyani Publishers, Ludhiana.
5. Singh, B.D.; (2009) A textbook of Plant Breeding; Kalyani Publishers.
6. Zar J H, (1998) Biostatistical analysis 4th ed. Prentice Hall

Supplementary References:

1. Sokal R R and Rahlf H A. (1995) Biometry: the principles and practice of Statistics for Biology. research. 3rd edi W H Freeman and Co.

Web References:

1. https://icar.org.in
2. https://ndli.iitkgp.ac.in

Course Title : **PLANT BREEDING AND BIOSTATISTICS (PRACTICAL)**

Course Code : **UG-BOT-206**
Credits : **01**
Marks : **25**
Duration : **30 hours (15 sessions)**

Sr. No.	Practical Title	Practical sessions
1.	Emasculation and bagging of flowers using suitable plant material and Estimation of fruit and seed set in emasculated flowers	03
2.	Correlation of floral structure with pollination system	01
3.	Estimation of pollen fertility (pollen viability) in locally grown crop species (any two).	02
4.	Study of centres of origin of some important crop plants.	01
5.	Study of soil pH using different soil types & relate it to crops	01
6.	Analysis of data for mean, median & mode, Standard deviation and standard error using suitable plant samples	03
7.	Determination of correlation and regression, Chi square analysis	03
8	Visit to CCARI- ICAR	01
	Total	**15**

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (THEORY)
COURSE CODE: BOT-IV.E-6
MARKS: 100 (75 Theory+ 25 Practical)
CREDITS: 4 (3 Theory+ 1 Practical)
COURSE DURATION: 45 HOURS

COURSE OBJECTIVES:
Objective of the course is to impart knowledge of principle, methodology and application of various techniques & instrumentation.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able:
CO 1: To understand, define and explain the principle, instrumentation and working of microscopy and radiobiology techniques used in Botanical research.
CO2: To understand the principle, working and applications of centrifugation and spectrophotometry in Botanical research.
CO 3: To understand, define the principle, working and applications of chromatography, electrophoresis and molecular techniques.
CO 4: To compare and contrast the techniques used in Research fields.

Sr.No	UNITS, TOPICS AND SUB-TOPICS	Hours
MODULE I: MICROSCOPY AND RADIOBIOLOGY (PRINCIPLE, METHODOLOGY AND APPLICATIONS)		**15**
1.1	Light microscopy (compound microscopy and Phase contrast microscopy) Fluorescence microscopy	
1.2	Transmission and Scanning electron microscopy (sample preparation for electron microscopy, cryofixation,)	
1.3	Microscopic measurements (Micrometry & cytometry) and photography (micro and macro)	
1.4	Radioactivity and its measurements (Geiger Muller and Scintillation counter and autoradiography)	
1.5		

MODULE II : CENTRIFUGATION AND SPECTROPHOTOMETRY: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**15**
2.1	Centrifugation: Low speed, high speed, cooling centrifuges and ultracentrifugation Analytical, preparatory and gradient centrifugation	
2.2	UV visual spectrophotometry	
2.3	Fluorescence spectrophotometry	
2.4	Flame (Atomic absorption) spectrophotometry	
2.5	Mass spectrophotometry	

MODULE III: CHROMATOGRAPHY, ELECTROPHORESIS & MOLECULAR TECHNIQUES: PRINCIPLE, METHODOLOGY AND APPLICATIONS		**15**
3.1 3.2 3.3 3.4 3.5	Adsorption and partition chromatography Column chromatography (isocratic and gradient) High Performance Liquid Chromatography& Gas Chromatography Electrophoresis: Agarose Gel Electrophoresis,Sodium Dodecyl Sulphate-Polyacrylamide Gel Electrophoresis , Iso-Electric Focussing and 2-Dimensional Electrophoresis Polymerase Chain Reaction, Real Time PCR	
	TOTAL	**45**

COURSE TITLE: TECHNIQUES & INSTRUMENTATION IN BOTANY (PRACTICAL)
COURSE CODE: BOT-IV.E-6
MARKS: 25
CREDITS: 1

SR.NO	**Module 4- TOPICS**	**PRACTICAL**
1	Preparation of Molar, Normal and ppm solutions	1
2	Determination of Lambda (λ) max of a given solution Verification of Beer's Law	2
3	Micrometric dimensions (cytometry and micrometry)	2
4	Demonstration of SDS- PAGE/ Agarose gel Electrophoresis	2
5	Preparation of TLC plate and Separation of biomolecules	2
6	Visit to Instrumentation Lab (NIO/College/ Goa University)	1
7.	Demonstration of Flame photometry	1
8	Mini project: Comparison of data of ultra and gradient Centrifugation Microscopy: Analysis of different photo micrographs Photography: To submit a report of macro and micro photography Preparation of column for column chromatography.	4
	Total	15

REFERENCES :

1. Karp, G. (1999). *Cell and molecular Biology, Concepts and experiments*. 2nd edition. USA: John Wiley and Sons Inc.
2. Bajpai P. K. (2006). *Biological instrumentation and methodology* . Mumbai: S. Chand and Company. Ltd.
3. Plummer D.T. (2009). *An Introduction to Practical Biochemistry*. 3rd edition. New Delhi: Tata Mc Graw Hill Education Private Ltd.
4. Ghatak K.L (2011). *Techniques and methods in Biology.* NY: Prentice Hall India Learning Private Limited.

5. Davey, H. M., &Kell, D. B. (1996). *Flow cytometry and cell sorting of heterogeneous microbial populations: the importance of single-cell analyses.* Microbiol. Mol. Biol. Rev., 60(4), 641-696.

6. Flegler, S. L., &Flegler, S. L. (1997). *Scanning & Transmission Electron Microscopy*. Oxford University Press.

7. Feist, A. (2018). *Next-generation ultrafast transmission electron microscopy-development and applications* (Doctoral dissertation, Georg-August-UniversitätGöttingen).

8. Kirsch, D. G., Diehn, M., Kesarwala, A. H., Maity, A., Morgan, M. A., Schwarz, J. K., & Haas-Kogan, D. (2018). The future of radiobiology. JNCI: Journal of the National Cancer Institute, 110(4), 329-340.

Weblinks:

1. amrita.olabs.edu.in,. (2013). Paper Chromatography. Retrieved 12 February 2020, from amrita.olabs.edu.in/?brch=8&cnt=1&sim=133&sub=73
2. vlab.amrita.edu,. (2011). Polyacrylamide Gel Electrophoresis. Retrieved 12 February 2020, from vlab.amrita.edu/?sub=3&brch=186&sim=319&cnt=1
3. vlab.amrita.edu,. (2012). Experiment-2 : Differential Protein Expression Analysis. Retrieved 12 February 2020, from vlab.amrita.edu/?sub=3&brch=237&sim=1248&cnt=1
4. vlab.amrita.edu,. (2011). Spectrophotometry. Retrieved 12 February 2020, from vlab.amrita.edu/?sub=2&brch=190&sim=338&cnt=1

Course Title : **PLANT PATHOLOGY (THEORY)**
Course Code : **UG-BOT-203**
Credits : **03**
Marks : **75**
Duration : **45 hours**
Prerequisite : **Biology at XII preferred.**

COURSE OBJECTIVES:

To make the students aware of various plant pathogens and their control.

COURSE OUTCOME:

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

CLO1: Identify various diseases and its causal agents of economically important plants.

CLO2: Explain plant pathogen interaction.

CLO3: Analyze control measures to deal with pathogens.

CLO4: Isolate, observe and culture plant disease causing pathogens.

MODULE I: AN INTRODUCTION AND EPIDEMOLOGY OF PLANTS DISEASES 15 hrs

History, Definitions and Importance of plant pathology.

Concepts and types of diseases in plants.

Infectious agents (nematodes, protozoans, bacteria, fungi & viruses).

Growth, reproduction, survival, multiplication and dispersal of important plant pathogens (*Puccinia*).

Disease triangle.

MODULE II: PLANT DISEASE DEVELOPMENT (PATHOGENESIS) AND MANAGEMENT 15 hrs

Parasitism and pathogenicity. Symptomatology. Host parasite interaction (recognition and infection).

Role of enzymes, toxins & growth regulators in pathogenesis.

Quantitative resistance (Physical, Biological & cultural methods).

Biochemical defense mechanism (oxidative burst; Phenolics, Phytoalexins, PR proteins, antimicrobial substances and plantibodies). Quarantine measures.

MODULE III: GENETICS OF PLANT DISEASE AND STUDY OF PLANT DISEASES IN INDIA 15 hrs

Altered plant metabolism due to pathogens attack. Genetics of resistance ('R' & avr genes, elicitors responses)

Signaling and programmed cell death.

Study of Diseases (Name of disease, pathogen, symptoms and control measures need to be studied).

Important diseases (Any 2 of each) of Paddy, Arecanut, Wheat, Banana, Coconut, Sugarcane, Mango, Amaranth and Radish.

TOTAL 45 hrs

Course Title : **PLANT PATHOLOGY (PRACTICAL)**
Course Code : **UG-BOT-203**
Credits : **01**
Marks : **25**
Duration : **30 hours (15 sessions)**

Sr. No	**Topics**	**Practical Sessions**
1	Isolation and culture of fungal and bacterial pathogens.	02

2.	Demonstration of Koch's postulates	01
3.	Assay for cellulase /pectinase enzyme from diseased plant	02
4.	Study of plant diseases with reference to pathogen & symptomology (Viral, Bacterial & Fungal) (any 10 as per theory)	05
5	Anatomical observations of fungal infected plants (rust, blight, rots)	03
6	Study of antagonistic behavior of bacterial pathogens	01
7.	Mini project: Collection and identification of plant diseases (Any five)	01
	Total	**15**

REFERENCES

1. Agrios, G.N. (2005). *Plant Pathology* (5th ed.). London: Academic Press.
2. Mehrotra, R.S. & Agarwal, A. (2017). *Plant Pathology*: Bangalore: MaGraw Hill Education.
3. Sharma, P.D. (2018). *Plant Pathology*. New Delhi: Rastogi Publishers.
4. Singh, R. S. (2019). Introduction to Principles of Plant Pathology. USA: Medtech.
5. Bilgrami, K.H. & Dube, H.C. (1976). *A textbook of Modern Plant Pathology*. Lucknow: International Book Distributing Co.
6. Mehrotra, R.S. (1980). *Plant Pathology*. New Delhi: TMH
7. Pandey, B.P. (1999). *Plant Pathology, Pathogen and Plant diseases*. New Delhi: S. Chand & Co.
8. Rangaswami, G. (1999). Disease of Crop plants of India. New Delhi: Prentice Hall of India Pvt. Ltd.
9. Ownley, B. H. & Trigiano, R. N. (2017). Plant Pathology, Concepts and Laboratory Exercises. Florida: CRC Press.
10. Gunasekaran, P. (2005). Laboratory manual in Microbiology. New Delhi: New Age International (P) Limited.
11. Aneja, K.R. (2009). Experiments in Microbiology Plant Pathology & Biotechnology. 4th ed. New Delhi: New Age International (P) Limited.

WEBLINKS:
1. https://www.springer.com/journal/42161
2. https://bsppjournals.onlinelibrary.wiley.com/journal/13653059

COURSE TITLE: BASICS IN HORTICULTURE (THEORY)
SKILL ENHANCEMENT COURSE

MARKS: 60

CREDITS: 3

COURSE OBJECTIVES:

Is to provide entrepreneur opportunities.

COURSE OUTCOMES:

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

CO 1: Explain the basics of Horticulture, floriculture and landscaping

CO 2: Outline the requirements for building up nurseries, garden, etc.

CO3: Inculcate the technique of vegetative propagation of plants.

CO 4: Identify and relate the scope of these fields in building up career

Module I: Tools and Techniques in Horticulture, floriculture 15

Theory sessions:

Definition and importance; Pomoculture, Olericulture, Floriculture.

Fertilizers: inorganic, Organic – biofertilizers: vermicomposting, green manure, algal culture, FYM. Knowledge of annual, biennials and perennials with reference to ornamental flowers. Irrigation:- Surface, Sprinkle, Drip and Gravity irrigation Introduction to Green house, Poly house, Moist chamber, Net frame, Introduction to Hydroponics.

Practice sessions:

i) Local visits to nurseries, home gardens to know about different pots and its potting system
ii) Preparation of potting mixture – Potting, repotting
iii) Preparation of organic compost &vermicompost
iv) Familiarizing gardening tools and implements
v) Improving the shelf life of cut flowers using chemicals
vi) Study of Hydroponics
vii) Local visit to an established green house/polyhouse and report making.

Module II: Propagation Methods 15

Theory sessions:

Introduction to sexual methods (seed propagation) – Definition, Merits and Demerits, Criteria for selection of seeds.

Asexual (Vegetative) propagation – Definition, and types- Cutting (root, stem, leaf), Layering (simple, air), Grafting (Whip, Approach) and Budding (T, patch), Stock –scion relationship in important horticultural crops.

Use of plant growth regulators in horticulture

Practice sessions:

i) Field work in cutting, grafting, budding, layering
ii) To design experiments for induction of rooting, flowering, fruit set, fruit development and control of fruit crops
iii) To study the cultivation practices of local commercial flowers
iv) Field work in Nursery management; Cut flowers; to improve shelf life of cut flowers.
v) Visit to a local florist for learning different forms of flower- arrangement and live tutorials in classroom on various examples of flower arrangement all around the world.

Module III: Landscaping 15

Theory sessions:

Types of garden: Formal, informal and kitchen garden

Locations in the garden- edges, hedges, fence, lawn, flower beds, Avenue, water garden (with two examples of each). Focal point. Auto CAD in garden designing. Bonsai techniques

Practice session:

i) Visit to local gardens and giving comparative account of types of garden
ii) Listing of plants used for edges, fence, lawn, flower beds, water gardens, etc.
iii) Visit to a botanical gardens/ water garden
iv) To learn different styles of Bonsai techniques
v) Lawn making: type of lawn grasses and maintenance. Plants suitable for hedges. Aftercare: Weeding, top dressing methods of pruning and topiary
vi) Garden designing using (preferably Auto CAD) software

Module 4: Applications of Horticulture, Floriculture and Landscaping 15

Theory sessions: Entrepreneurship skills, Invited lecture by Guests (Spice Farm owner, Ecotourism sector, Organic farmer/ Organic products outlet owner, Nursery manager/ Landscaper, Krishivigyan Kendra, Agriculture dept, Forest Dept, etc) Latest schemes in horticulture, floriculture, agriculture in Goa.

Practice sessions:

Preparation of garden design (area of the campus)

Innovative ideas for beautification of the campus and preparation of the same.

Establishment of vegetable garden using organic compost &vermi-compost

Or Internship at any firm related to Horticulture.

Total 60

REFERENCES:

1. Swarup V. (1997). Ornamental horticulture. MacMillan India Limited, NewDelhi.
2. Randhava, G.S, (1973) – Ornamental horticultural in India Today andTomorrow Printers and Publishers, NewDelhi.
3. Trivedi TP (2007). Ornamental horticultural in India. Indian Council of Agricultural Research NewDelhi.
4. Nayak, K.C. South Indian fruits and their culture P.L. Varadaraj&Co.,&LingichettiStreet,Madras.
5. Edment Senn Andrews (1994) Fundamentals of Horticulture – Tata McGraw Hill Publishing Co., Ltd., Delhi.

Weblink

1. http://agritech.tnau.ac.in/horticulture/horti_index.html

SEMESTER V SYLLABUS

COURSE TITLE: PLANT MOLECULAR BIOLOGY (THEORY)

COURSE: BOT-V.C-7

MARKS: 100 (75 Theory+25 Practicals)

CREDITS: 4 (3 Theory +1 Practical)

COURSE DURATION: 45 HOURS

PREREQUISITE COURSES: Biology at XIIth preferred.

COURSE OBJECTIVE:

At the end of the course students will be able to explain life processes at the sub-cellular and molecular (gene) level and know general principles of gene organization and functions.

COURSE OUTCOMES

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

CO1: Recognize, recall and describe the process of central dogma

CO2: Summarize the molecular basis of life

CO3: Estimate and evaluate methods of quantitation of macromolecules

CO4: Utilize and demonstrate basic molecular techniques of nucleic acid isolation and separation by electrophoresis.

SR.NO	UNITS, TOPICS AND SUB-TOPICS	HOURS
MODULE-I: NATURE OF GENETIC MATERIAL AND DNA REPLICATION		**15**
1.1	Characteristics of genetic material, evidences to prove DNA & RNA as genetic material, Watson and Crick's model of DNA; Polymorphism of DNA.	
1.2	Central dogma of molecular biology, Model organism for studying molecular biology; C-value paradox; Chargoff's Law, Franklin's and Wilkin's work	
1.3	General feature of DNA replication (replication eye, replication forks); Types of DNA replication, mechanism of DNA replication in Prokaryotes & in Eukaryotes (Dispersive, Conservative and Semi- conservative); enzymes of replication –DNA Primase; DNA polymerases	
1.4	DNA Recombination: Holliday model	
MODULE II: DNA DAMAGES AND TRANSCRIPTION		**15**
2.1	Types of DNA damages and repair (direct reversal of damage, excision repair)	
2.2	Structure and functions of mRNA, tRNA and rRNA, RNA polymerases	
2.4	Transcription in prokaryotes & eukaryotes	
2.5	Post transcriptional events (splicing, capping & processing).	
MODULE III: GENE REGULATION, EXPRESSION & TRANSLATION		**15**
3.1	Units of gene (Cistron, recon, muton, enhancers, split genes, overlapping genes; transposons and its role in gene structure, promoters & terminators.	
3.2	Gene regulation in prokaryotes (Lac operon concept/tryptophan) & eukaryotes;	

	Inducible and repressible mechanism.	
3.3	Mechanism & factors involved in the process of Translation.	
3.4	Post translational modifications; Protein targeting	
	TOTAL	**45**

COURSE TITLE: PLANT MOLECULAR BIOLOGY (PRACTICALS)COURSE CODE: BOT-V. C-7

MARKS 25

CREDIT: 1

COURSE DURATION: 15 SESSIONS (*inclusive of 3 PA*)

SR. NO	**MODULE IV: TOPICS**	**PRACTICAL SESSIONS**
1	Isolation of plant genomic-DNA	**3**
2	Quantification of DNA by DPA method.	**2**
3	Isolation and estimation plant RNA from tissue.	**2**
4	Preparation of Agarose gel and running of DNA	**3**
5	Demonstration of DNA amplification by PCR	**3**
6	Mini Project 1. Spooling of DNA from different plant samples	**2**
	TOTAL	**15**

REFERENCES:

1. Gupta P.K. (2018) *Molecular Biology*. Rastogi Publications.
2. Alberts Bruce, Johnson A. Lewis Julian., Raff Martin., Roberts Keith., and Walter Paul (2002). *Molecular Biology of the Cell*. 4thedition. New York: Garland Publishing, Inc.
3. Buchanan B., Gruissem Wilhelm and Jones Russell L. (2015) *Biochemistry and molecular biology of plants*. Wiley Blackwell pub Ltd.
4. Pal, J.K. and Ghaskadabi S.S. (2008) *Fundamentals of Molecular Biology*. Oxford.
5. James D. Watson (2007). *Molecular Biology of the Gene* (6th Edition) by, Tania A. Baker, Stephen P. Bell, and Alexander Gann.
6. Kleinsmith L.J and Kish V.M (1995). *Principles of Cell and Molecular Biology* (2nd Edition). New York: Happer Collins College Publishers.
7. Lehninger (2008). *Principles of Biochemistry* by David L. Nelson and Michael M.
8. Dube, R.C. (2008). *A Text Book of Biotechnology.* New Delhi: S. Chand pub.
9. Lewin B. (2000). *Genes VII*. New York: Oxford University Press.
10. Buchanan B.B, Gruissm W. and Jones R.L (2000). *Biochemistry and Molecular biology*.
11. Johnson Charlotte (2009) *Plant molecular biology*. Oxford Book company.
12. David Freifelder (1983) Jones & Bartlett publishers. *Molecular biology*. 2nd Ed. Reprint 1993. Narosa Publishing House.

WEB REFERENCES:

1. https://www.schoolfinder.com
2. http://www.plantcell.org › content › teaching-tools-plant
3. https://www.cell.com › molecular-plan
4. https://www.freebookcentre.net ›
5. The-Molecular-Biolo…https://nptel.ac.in/courses/10210602

Course Title: **BIOINFORMATICS (THEORY)**
Course Code: **BOT-V.E-9**
Marks: **100 (75 Theory +25 Practical)**
Credits: **4 (3Theory +1 Practical)**
Duration: **45 Hours**
Prerequisite Courses: **Biology at XIIth preferred**.

COURSE OBJECTIVES:
The course will help the students to understand the fundamentals of bioinformatics and tools available.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:
CO1: Introduce, explain and explore biological databases through websites (online) and the need of Bioinformatics.
CO2: Compare and contrast protein information resources and genome information resources, different biological databases and its role in molecular level sequencing
CO3: Relate the theoretical knowledge with practical sessions. Enable data handling and analysis.
CO4: Define the terminologies, types of biological databases, its applications and compare the homology between different biological species

MODULE 1: INTRODUCTION TO BIOINFORMATICS AND INFORMATION NETWORKS 15 hrs

Introduction to bio-informatics, The biological sequence / structure deficit Genome projects, Pattern recognition and prediction, Levels of protein structure, Ramachandran Plot. Role of Chaperons, Sequence analysis. Internet and the facilities available on it, computational biology, What is World Wide Web, Web browsers and Web Addresses. The National Center for Biotechnology Information- NCBI, MMDb The European Molecular Biology Network- EMBnet Bioinformatics programme in India- BTISNet, BPI-2004,

MODULE 2: INTRODUCTION TO BIOLOGICAL DATABASES AND SEQUENCE ALIGNMENT METHODS 15 hrs

Introduction To Biological Database: GenBank, EMBL, SwissProt, PROSITE, EC-ENZYME, PDB, GDB, OMIM, PIR-PSD.

Introduction and comparison of Homology, Analogy, Orthology

And Paralogy. Alignment based methods and Hybrid method. Comparison of Computer Prediction Algorithms. Introduction to pairwise and multiple sequence alignment; Comparison of sequences; Global alignment: The Needleman and Wunsch algorithm; Database interrogation, Alphabet and complexity; Pairwise database searching. BLAST; Databases of Multiple Alignments, Clustal Omega.

MODULE 3: PROTEIN AND GENOME INFORMATION RESOURCE

15

Introduction to Protein information resources, Primary Sequence Databases, Composite protein sequence databases, Secondary databases, Composite protein pattern databases Structure classification databases Introduction to genome information resources, DNA sequence databases, Specialised genomic resources, ORF (Open Reading Frame Finder), TIGR Genome Resources Genome comparison, Genome Annotation, Microarray image analysis

Course Title: BIOINFORMATICS (Practical)
Course Code: BOT-V.E-9
Marks: 25
Credits: 1
Duration: 15 Hours

SR. NO	Module 4- TOPICS	PRACTICAL
1.	Biological databases and exploring various websites- NCBI, PUBMED and GenBank databases	3
2.	To explore EBI server and searching EMBL	2
3.	Exploring and querying UniProt KB	1
4.	Pairwise global alignment of protein and DNA using Needleman-Wunsh algorithm	2

5.	Obtaining sequences for Pairwise alignment and to interpret the results to study the homology between the sequences	2
6.	Database searching using different versions of BLAST and FASTA and Derivation of relationships of query sequences	2
7.	Use of Clustal Omega for multiple sequence alignment	1
8.	**MINI PROJECTS** Drug designing Construction of phylogenetic trees/cladogram (comparison between different organisms**)**	
	TOTAL	45

REFERENCES:

1. Attwood, D. J., Parry Smith D.J. and Phukan, S. (2011). Introduction to Bioinformatics. Pearson education.
2. Ignacimuthu, S. (2005). Basic Bioinformatics. Narosa PublishingHouse
3. Khan, I. A. and Khanum, A. (2003). Fundamentals of Bioinformatics –Ukaaz publications.
4. Mani, K. and Vijayaraj, K.A. (2002). Bioinformatics for Beginners. Aparnaa Publication.
5. Murthy, C. S. V. (2004). Bioinformatics. Himalaya Publishing House.

Web References:

1. http://genes.mit.edu/GENSCAN.html
2. http://vmoc.museophile.org Computer History
3. http://www.clcbio.com/index
4. http://www.genome.jp
5. http://www.genome.jp/dbget/LinkDB
6. http://www.ncbi.nlm.nih.gov/Structure/CN3D/cn3d.shtml
7. http://www.softberry.com/berry
8. http://www.studentworkzone.com/
9. www.ebi.ac.uk
10. www.fgcu.edu/support/office2000
11. www.learnthenet.com WebPrimer
12. www.clustawomega.org
13. www.embl.org Research

Article:

1. Antre R.V et al., Computer aided Drug Design: An Innovative Tool for Modeling, Open Journal of Medicinal Chemistry, 2012,2,pp139-148
2. Surabhi et al, Computer aided drug designs: An overview, Journal of Drug Delivery and Therapeutics, 2018; 8(5);pp504-509. Available at http://jddtonline.info

Drug Design Softwares:

1. ArgusLab- https://www.arguslab.com

2. Schrodinger- https://www.schrodinger.com/
3. VlifeMDSTM- https://vlifesciences.com/
4. Accelrys 5. SYBYL 6. AutoDock- https://autodock.scripps.edu/ 7. FlexX- https://www.biosolveit.de/FlexX 8. Vakser Lab 9. Ligplot: https://www.ebi.ac.uk/thornton-srv.software/LIGPLOT/ 10. LiganScout- https:/www.intelligand.com

COURSE TITLE: PLANT DRUG TECHNOLOGY AND PHARMACOGNOSY(THEORY)
COURSE CODE: BOT-V.E-11
MARKS: 100(75 Theory+ 25 Practicals)
CREDITS: 4 (3 Theory+ 1 Practical)
DURATION: 45 HOURS
PREREQUISITE COURSES: Biology at XIIth preferred.

COURSE OBJECTIVES:
To enable the students to learn and understand the fundamental knowledge, techniques & skillsin plant drug industry, drug discovery and development.

COURSE OUTCOMES:
Upon successful completion of the course, students will be able to:
CO 1: Explain, discuss and classify medicinal plants, plant drug and technology
CO 2: Explain and illustrate, biosynthetic pathways, bioassays and working of instrumentsCO 3: Discuss and compare methods of extraction and analysis of phytochemicals.
CO4: Apply fundamental knowledge, techniques and skills in plant drug industry, drug discovery

SR.NO	UNITS, TOPICS AND SUB-TOPICS	HOURS
MODULE I: INTRODUCTION		**15**
1.1	Introduction to plant drug technology and Pharmacognosy	
1.2	Classification of drugs: morphological, chemical and pharmacological.	
1.3	Identification of marker compounds in the formulations.	
1.4	Bioassays, Fingerprint and identification of plant drugs.	
1.5	Biosynthesis of alkaloids. Metabolic pathways of selected plants (from *Ocimumsanctum* and *Rauwolfia*).	
MODULE II: CULTIVATION, COLLECTION AND CONSTITUENTS		**15**
2.1	ROOTS/ RHIZOME: *Rauwolfia* and *Curcuma*	
2.2	LEAVES: *Adathoda* and *Ocimum*	
2.3	SEEDS: Fenugreek and Nutmeg	
2.4	FRUITS: Coriander and Senna pod	
2.5	FLOWERS: Clove and Rose	
MODULE III: PHYTOCHEMICALS (EXTRACTION AND ANALYSIS)		**15**
3.1	Extraction methods and principles. Traditional and modern techniques	

3.2	Methods of Characterization: NMR,MS,UV-Vis, GC-MS, LC- MS	
3.3	Analysis of Pigments, Phenolics, Flavonoids and Alkaloids.	
	TOTAL	**45**

COURSE TITLE: PLANT DRUG TECHNOLOGYAND PHARMACOGNOSY (PRACTICAL)COURSE CODE: BOT-V. E-11

MARKS: 25

CREDITS: 1

COURSE DURATION: 15 SESSIONS (*inclusive of 3 PA*)

SR. NO.	**MODULE IV: TOPICS**	**PRACTICAL SESSIONS**
1.	Isolation of alkaloids and Phenolics	**2**
2.	Test for alkaloids: Mayer's, Wagner's, Dragendorffs' reagent	**1**
3.	Disc diffusion for antimicrobial assay	**2**
4.	MIC evaluation for antimicrobial assay	**2**
5.	Anatomical study of *Nux vomica* seeds, Ginger, Citronella leaf, Senna leaf & its medicinal properties	**4**
6.	Histochemical tests for Oils and Fats –Castor seed/ *Eucalyptus* Citrus	**1**
7.	Microchemical test of Arum / *Colocasia* leaves for observation of Calcium oxalate crystals.	**1**
8.	Mini project Adulteration of crude drugs	**2**
	TOTAL	**15**

REFERENCES:

1. Gokhale, S.B.& Kokate, C.K. (2009). *Pharmacognosy*. Maharashtra: Nirali Prakashan.
2. Khandelwal, K. R. (2008). *Practical Pharmacognosy*. Maharashtra: Nirali Prakashan.
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4. Qadry, J.S. (2014). *A Textbook of Pharmacognosy, Theory and Practicals*. New Delhi:CBS Publishers& Distributors.
5. Trease, G.E. & Evans, W.C., (2002). *Pharmacognosy*. USA: Elsevier Science Publishers.
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8.Harborne, J. B.(2010). *Phytochemical Methods*. New Delhi: Springer International edition.
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10. New Delhi: S. Chand & Company Pvt. Ltd.
11. McCreath, S. B., & Delgoda, R. (2017). *Pharmacognosy: Fundamentals, Applications and Strategies.*
Amsterdam: Mica Haley.
12. Shah, B., & Seth, A. (2010). *Textbook of Pharmacognosy and Phytochemistry.*
13. New Delhi: Elsevier Health Sciences.
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https://www.scimagojr.com/journalsearch.php?q=19700175096&tip=sid
(2020, February 12). Retrieved from www.medicinalplants-pharmacognosy.com:https://www.medicinalplants-pharmacognosy.com/

WEB REFERENCES:

1. www.britannica.com
2. www.pharmacyguideline.com
3. https://www.springer.com
4. https://www.biologydiscussion.com
5. amrita.edu/course/herbal-drug-technology-theory
6. pharmacyinfoline.com/herbal-drug-technology

Course Title**: ORGANIC FARMING (THEORY)**
Course Code**: BOT-V.E-12**
Marks: **100 (75 Theory +25 Practical)**
Credits: **4 (3Theory +1 Practical)**
Course Duration**: 45 HOURS**

COURSE OBJECTIVES:
The course provides knowledge of principles and practices of organic agriculture and its role in sustainable crop production.

COURSE OUTCOMES:

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

CLO1: To understand the need and basics of Organic Farming, create awareness of the social, economic and environmental context for current and future organic agricultural production and management.

CLO2: Assess the importance of organic foods in today's World.

CLO3: Analyse and interpret the given problem in components of Organic Farming.

CLO4: Apply the knowledge in becoming an entrepreneur in Organic Farming to create own business plan.

MODULE 1: Concept of Organic farming, compost, manures and its application. **15**

Introduction: Farming, organic farming, concept and development of organic farming. Principles of organic farming, Types of organic farming. Needs and benefits of organic farming. Agencies and institutions related to organic agriculture. Farm components for an organic farm. Manure application: Composted vs. uncomposted manure. Composting- principles, stages, types and factors Composting methods, Vermicomposting. Bio-fertilizers, M.I., F.I.M., Neem cake, Mulching, Elley farming, Bioinoculation.

MODULE II: Soils, Soil Fertility Management and fertilizers **15**

Soil types and Soil tillage. Factors affecting soil fertility and productivity Land, preparation. Water management for good soil, Commercial fertilizers, composition Residual effects and fertilizer use efficiency. Foliar application and its concept.

MODULE III: Organic plant protection, Seed Certification and Entrepreneurship Development **15**

Plant protection- cultural and mechanical. Plant protection- bio pesticide and bio control agents. Allelopathic methods of weed control. Certification of organically produces seeds. Entrepreneurship – Concept, characteristics, approaches, need for entrepreneurship in Organic farming. Popularization of organic farming. Marketing of organic produce. National and international scenario of organic farming. **Total 45**

COURSE TITLE: ORGANIC FARMING (PRACTICAL) COURSE
CODE: BOT-V.E-12
MARKS: 25
CREDITS: 1
PRACTICAL SESSIONS: 15

Sr. No	Module IV- Topics	Practical sessions
1	Comparative analysis of pH, EC, organic C, total N, available N, P, K and S from organic and inorganic data (obtained data).	01
2	Survey of weeds in crop fields (Organic v/s inorganic farming)	01
3	Study of soil types.	01
4	Observation of Mycorrhizae	01
5	Study of bio pesticide (Neem cake)	01
6	Study of Mulching	01
7	Study of nitrogen fixing bacteria in leguminous plants	01
8	Visit to an organic farm	02
9	Mini project: Preparation of Compost/ vermi-compost Effect of various manures on plant growth. Study of recycling of farm waste.	06
	Total	15

REFERENCES:

1. Chakraverty, A. (1991). Post-*harvest technology of cereal, pulses and oil seeds*. Oxford: IBH Publishing Co. Pvt Ltd.
2. Deshmukh, S.N. (2012). Organic Farming: Principles, Prospects and Problems, India: Agrobios Publishers.
3. Gehlot, D. (2010). *Organic Farming: Components and Management*, India: Agrobios Publishers.
4. Gupta, O.P. (2010). *Modern weed management*. Agrobios Publishers.
5. Israelsen, O.W. and Hansen, V.E. (2015). *Irrigation Principles and Practices*. John Wiley & Sons Inc.
6. Kanwar, J.S. (1978). *Soil Fertility, Theory and Practice*. Indian Council of Agricultural Research Publication.
7. Palaniappan, S.P. and Annadurai, K.A. (2010). *Organic Farming: Theory and Practice*. Indian Council of Agricultural Research, Scientific Publishers Journals Dept.
8. Rao, V.S. (2000). *Principles of Weed science*. Taylor & Francis Publishers.
9. Reddy, T.Y. and SankarReddi, G. H. (2015). *Principles of Agronomy*. Kalyan Publishers.
10. Sadhu, A.N. and Singh, A. (2014). *Fundamentals of Agricultural Economics*. Himalaya Publishing House.
11. Saraswat, V.N., Bhan, V. M. and Yaduraju, N.T. (2003). *Weed management* -

(ICAR), Indian Council of Agricultural Research Publication.
12. Sharma, A.K. (2002). *A hand book of Organic Farming*. Agrobios Publishers.
13. Singh, B. D. (2006). *Plant Breeding Principles and Methods*. Kalyani Publishers.
14. Tisdale, S.L., Nelson, W.L., Beaton, J.D. and Havlin, J. L. (2013). *Soil fertility and fertilizers*. Pearson Publishers.
15. Yawalkar, K. S., Agrawal, J.P. and Bokde, S. (1962). *Manures and Fertilizers*. Agri-Horticulture Publishing House.
16. *Introduction to Organic Farming*. (n.d.). Retrieved February 13, 2020,from http://agritech.tnau.ac.in/: http://agritech.tnau.ac.in/
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SEMESTER VI SYLLABUS

COURSE TITLE: PLANT GENETIC

ENGINEERING COURSECODE: BOT- VI.C8

MARKS: 100 (75 Theory +25 Practical)

CREDITS: 4 (3Theory +1

Practical)COURSE

DURATION: 45 HOURS

COURSE OBJECTIVES: This course is to develop fundamental knowledge and skills invarious aspects of Genetic engineering.

COURSE OUTCOME: Upon successful completion of the course, students will be ableto:

CO1: Understand, associate and apply the basic knowledge of tools in plant geneticengineering.
CO2: Interpret, analyze and understand the techniques in plant genetic engineering. CO3: Apply the knowledge of plant genetic engineering in variousfields.
CO4: State the Biosafety regulations and assess its procedure and importance.

Sr.No	TOPICS	Hours
	Module 1: Tools in Recombinant DNA technology	**15**
1.1	Introduction to Recombinant DNA technology, DNA cloning- cell based and cell free.	
1. 2	Enzymes- Importance in plant genetic engineering, Nucleases: Exo and endonucleases; Types I, II, III and Nomenclature. DNA ligases. DNA modifying enzymes, Factors affecting enzyme activation.	
1.3	DNA ligation, transformation, selection of transformed bacteria- antibiotic selection.	
1.4	Vectors- Key features, advantages and disadvantages. Prokaryotic vectors - plasmids, cosmids, Lambda phage. Eukaryotic vectors-	
1.5	Bacterial Artificial Chromosome, Yeast Artificial Chromosome. DNA Isolation and sequencing (Sanger & Coulson, Maxam &	

	Gilbert).	

Module 2 : Techniques in Recombinant DNA technology		15
2.1	Methods of Gene transfer: Indirect and Direct methods of gene transfer. Indirect method: Agrobacterium mediated gene transfer- T-DNA, Ti plasmid and Ri plasmid derived vector systems. T-DNA transfer.	
2.2	Direct methods of gene transfer: Physical and Chemical.	
2.3	Selection of transformants; selectable marker (Antibiotic resistant markers, herbicide resistant markers) and reporter genes (Luciferase, GUS, GFP).	
2.4	Gene Cloning: Construction of genomic and cDNA libraries, screening of DNA libraries; complementation, colony hybridization; Southern, Northern and Western blotting; ELISA, CRISPR-Cas9.	
2.5	Polymerase Chain Reaction, Techniques of DNA fingerprinting (RFLP, RAPD, AFLP)	

Module 3: Gene transfer methods in plants, Biosafety and Applications of Genetic Engineering		**15**
3.1 **3.2** **3.3** **3.4** **3.5**	Applications in Agriculture: Transgenic crops with improved quality traits: FLAVR SAVR Tomato, Golden rice, Bt cotton, herbicide resistant plants. Applications in Environment: Role of transgenics in bioremediation Mycoremediation, Phytoremediation, and Waste management(UASB reactor), Remediation of Xenobiotic compounds Molecular techniques in Phytoremediation Applications in Industries: Edible vaccines; Industrial enzymes (Protease, Lipase); Genetically Engineered Products – Human Growth Hormone; Humulin; Superweeds Bioethics and Biosafety: Intellectual Property Rights, Genetic engineering and Public issues. Biosafety regulations	
	Total	**45**

COURSE TITLE: PLANT GENETIC ENGINEERING (PRACTICAL) COURSE CODE: BOT-VI.C-8
MARKS: 25

CREDITS: 1
Pracical Sessions: 15

Sr. No	**Module4: Topics**	**Practical**
1	DNA isolation by CTAB/(any other) method	02
2.	Estimation of DNA	02
3.	Agarose Gel Electrophoresis	02
4.	Restriction digestionof DNA	02
5	Sequence reading – Sanger method/Maxam Gilbert method – problem	02
6	*Agrobacterium tumefaciens*-mediated plant transformation. (Virtual Library)	01
7	Small scale plasmid preparation from *E. coli*	03

8	Visit to a leading biotechnology institute and Report making.	01
	Total	**15**

REFERENCES:

1. Brown, T. A., (2006). *Gene cloning and DNA analysis An Introduction*. UK: Blackwellscientific publishers.
2. Chawla, H.S. (2000). *Introduction to Plant Biotechnology*. New Delhi: CRC Press.
3. Dovstekel (2005). *Microarray Bioinformatics*. UK: Cambridge University press.
4. Dubey, R.C. (2014). *Introduction to Plant Biotechnology*. New Delhi: S. Chand & Co.
5. Ignacimuthu, S. (1997). *Plant Biotechnology*. New Hampshire: Science Publishers.
6. Purohit, S.S. (2003). *Agricultural Biotechnology*. New Delhi: Agrobios.
7. Sobti, R.C & Pachauri, S.S. (2009). *Essentials of Biotechnology*. New Delhi: AneBooks.
8. Gupta, P. K. (1996). *Elements of Biotechnology*. Meerut: Rastogi Publications.
9. Lewin, B. (2004). *Genes VIII*. UK: Oxford University Press.
10. Primrose, S. B, Twyman, R. M. & Old R. W. (2001). *Principles of gene manipulation: An Introduction to genetic engineering*, 6 ed. UK: Blackwellscientific publishers. Smith, J.E. (2005).
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12. *Principles and Techniques of Biochemistry an Molecular Biology*. UK: Cambridge University Press.

Weblinks and Article References:

1. Thomson, J. (2011). Genetic Engineering Of Plants. https://www.semanticscholar.org/paper/GENETIC-ENGINEERING-OF-PLANTS-Thomson/e34c54c3c16d50c5180df80dd6b8993fc23851c6.

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5. Mathur, R. (2018). Genetic engineering and biosafety in the use of genetically modified foods. IJASRM, 2018(I), 76-82.

6. Cahoon, E. B. (2003). Genetic enhancement of soybean oil for industrial uses: prospects and challenges. AgBioForum, 6(1&2): 11-13.

Course Title : **ECONOMIC BOTANY (THEORY)**
Course Code : BOT-VI. E-15
Credits : **03**
Marks : **75**
Duration : **45 hours**
Prerequisite : **Biology at XII preferred.**

COURSE OBJECTIVES:

This course facilitate knowledge on the value of plants with scientific information and critical thinking to strengthen knowledge on economic botany.

COURSE OUTCOMES:

Upon successful completion of the course, students will be able:

CLO1: Identify and categorize economically important plants/plant parts.

CLO2: State, describe and explain the use plants as an alternative to synthetic and chemical products.

CLO3: State, describe and explain the uses of natural plant products.

CLO4: Develop skills in extracting valuable plant products of potential market and economic value.

MODULE I: ORIGIN OF CULTIVATED PLANTS (CENTRES OF ORIGIN, CEREALS & LEGUMES) 15 hrs

Centres of origin: Concept, Vavilov's work, examples of major plant introduction; evolution of new crops/ varieties; crop domestication.

Organizations and their mandates – NRRI, CFTRI, SBRI.

Importance of germplasm, threats to genetic diversity.

Classification, description and economic importance of Cereals and Legumes: Wheat, Rice (local varieties) and Millets (any one), Chick pea, Cow pea and one fodder legumes.

MODULE II: SOURCES OF SUGARS & STARCH, OILS & FATS, DRUGS & NATURAL RUBBER 15 hrs

Sugar & Starch sources: Sugarcane; Potato & Dioscorea.

Fat and Oil sources: Groundnut, Coconut, Soybean.

Extraction and applications of essential oils: Eucalyptus and mustard oils.

Therapeutic and habit-forming drugs: Cinchona, Cannabis, Tobacco (Morphology, processing, uses and health hazards).

Tapping, processing and uses of *Hevea brasiliensis*.

MODULE III: CLASSIFICATION, GENERAL DESCRIPTION AND USES OF SPICES, BEVERAGES, FRUIT AND NUTS, FIBERS AND TIMBER PLANTS

15 hrs

Spices & condiments: Clove, Black pepper, cinnamon, turmeric

Beverages: Tea & Coffee

Fruits: Mango, Cashew & Jackfruit

Fibers: Coconut, cotton & Jute.

General account of Timber Plants: Teak and Matti.

TOTAL 45 hrs

Course Title : **ECONOMIC BOTANY (PRACTICAL)**
Course Code : **UG-BOT-202**
Credits : **01**
Marks : **25**
Duration : **30 hours (15 sessions)**

Sr. No	TOPICS	Practical Sessions
1	Morphological and Anatomical study of cereal and legumes seeds (rice and groundnut).	04
2	Study of essential oil yielding plant parts (Coconut (dry copra), *Eucalyptus* (leaf), Citrus (rind))	02
3	Mini Projects: i. Extraction of essential oil from plant sources (Distillation method) ii. Analysis of starch content from plant sources (fruits, rhizome, tubers) iii. Phytochemical analysis of plants for drugs, alkaloids and dyes iv. Study of Fibers from plants v. Study of local fruits and spices	07
4	Field Visit to Farm/ Rubber Plantation	02
	Total	**15**

REFERENCES:

1. Pandey, B. P. (2015). *Economic Botany.* New Delhi: S. Chand & Company.

2. Kochhar, S.L. (2012). *Economic Botany in Tropics*. New Delhi: MacMillan & Co.
3. Wickens, G.E. (2001). *Economic Botany: Principles & Practices*. Netherlands: Kluwer Academic Publishers.
4. Subrahmanyam, N. S. and Sammbamurty, A.V.S.S. (2008). *A textbook of Moderneconomic Botany*. New Delhi: CBS Publishers & Distributors.

Weblinks:

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2. https://www.loc.gov › scitech › tracer-bullets › economic.
3. https://www.kew.org › science › collections › economic.

COURSE TITLE: APPLIED MYCOLOGY (THEORY)

COURSE CODE: BOT-VI.E-16

MARKS: 100 (75 Theory +25 Practical)

CREDITS: 4 (3 Theory +1 Practical)

COURSE OBJECTIVES:

This paper provides knowledge on culture techniques and the applicative aspects of fungi.

COURSE OUTCOMES: The students be able to:

CO 1: Describe fungal cultures

CO2: Restate Media formulations

CO3: Identify the role of fungi in Industry.

CO4: Identify the role of fungi in Agriculture.

Sr.No.	TOPICS	Hours
Module 1: Introduction and Fungal Culture studies		**15**
INTRODUCTION		
1.1	General account of fungi. Microscopic structure, Chemical composition and understanding of fungal cell wall	
1.2	Environmental factors influencing fungal growth	

STUDIES OF FUNGAL CULTURE		
1.3	Introduction to culture collections, Culture Media formulations and types of media used in mycology. Culture databases.	
1.4	Various techniques for pure culture isolation and maximum recovery from different habitats (Soil, Litter, Water, Dung) Baiting, moist-chamber and particle-plating techniques	
1.5	Isolation of pure cultures and maintenance.	
1.6	Study of colony characters and growth patterns	
1.7	Fungal gene banks- Culture Collection Centres.	
Module 2: Industrial Mycology		
INDUSTRIAL MYCOLOGY		**15**
2.1	Role of fungi in biotechnology	
2.2	Applications of fungi in food industry • Flavour and texture	
	• Fermentation and baking • Organic acids (Preferably Citric acid) • Enzymes (Preferably Cellulases and Pectinases) Mycoproteins– SCP (Yeast)	
2.3	Endophytic fungi and its industrial applications.	
Module 3: Fungi in Agriculture, medicine and recent mycological advances.		**15**
FUNGI IN AGRICULTURE		
3.1	Fungi as biofertilizers (Preferably *Trichoderma*) Fungi as biocontrol agents- Mycofungicides, Mycoherbicides, Mycoinsecticides	
3.2	Mycorrhizae and its role	
3.3	Medical mycology - Secondary metabolites- Pharmaceutical preparations from fungi, antibiotics from fungi. (Preferably *Penicillium* and *Ganoderma*)	
MUSHROOM CULTIVATION & RECENT ADVANCES IN MYCOTECHNOLOGY		
3.4	Mushroom cultivation techniques: Oyster and Button mushrooms.	

3.5	Applications of PCR and other molecular techniques in mycology, Mycoinformatics, Mycoremediation	
		TOTAL: 45 Hours

COURSE TITLE: APPLIED MYCOLOGY (PRACTICAL)

COURSE CODE: BOT- VI.E-16

PRACTICAL SESSIONS: 15 CREDITS: 1

Sr. No.	**MODULE 4: TOPICS**	**Practicals**
1.	Isolation and preparation of pure culture from a mixed culture plate on solid medium.	02
2.	Preparation of moist chamber and incubation of fungi	01
3.	Particle dilution plating for fungi	01
4.	Isolation of endophytic fungi from plant leaves	01
5.	Study of effect of incubation temperatures and pH on fungal growth	02
6.	Colorimetric estimation of cellulase and amylase produced by fungi	02
7.	Production of Citric acid (using *Aspergillus*) in broth and testing for its presence.	02
8.	Mushroom cultivation- Oyster mushrooms and its protein estimation	03
9.	Understanding structures of fungal enzymes using Bioinformatics tools.	01
	TOTAL	15

REFERENCES:

1. Aneja, K. R. (2007). *Experiments in Microbiology Plant Pathology & Biotechnology*. (5th ed.) New Delhi: New Age International Publishers.
2. Bhat, D. J. (2010). *Fascinating Microfungi (Hyphomycetes) of Western Ghats – India.* First edition., Goa: Broadway Book Centre.
3. Powar, C.B. and Daginawala, H.F. (1982). *General Microbiology–Volume II*. Mumbai: Himalaya Publishing house.
4. Prescott, L. M. (2005). Microbiology. 6th ed., New Delhi: Mc Graw-Hill.
5. Shivkumar, P.K., Joe, M.M. & Sukesh K. (2010). *An Introduction to Industrial Microbiology.* (1st ed.). New Delhi: S. Chand& Company Pvt. Ltd.
6. Trivedi, P.S. and Pandey, S.N. (2009). *A Textbook of Botany*. Volume I. New Delhi: Vikas Publishing House Pvt Limited.

COURSE TITLE: PLANT TISSUE CULTURE COURSE CODE:

BOT-VI.E-13

MARKS: 100 (75 Theory +25 Practical)

CREDITS: 4 (3Theory +1

Practical)COURSE

DURATION: 45 HOURS

COURSE OBJECTIVES: To develop the plant tissue culture skills.

COURSE OUTCOME: **Upon successful completion, the students will be able to:**

CO 1: Explain and discuss the general theoretical backgrounds and practical techniques

CO 2: Describe, define, explain/ discuss, compare, concept of differentiation and culture types. CO 3: Define, describe, explain/ discuss, techniques in PTC in media preparation, sterilisation, callus culture and organogenesis

CO 4: Describe, explain, discuss applications in forestry, agriculture etc.

Sr.No	TOPICS	Hours
	MODULE – I: INTRODUCTION AND DIFFERENTIATION	**15**
1.1	Scope and history of plant tissue culture, Laboratory organization.	
1.2	Culture techniques – Sterilization methods of glasswares, explant preparation, sterilization, media composition and preparation.	
1.3	Cellular differentiation and totipotency; effect of growth regulators on differentiation.	
	MODULE – II: CULTURE TYPES AND TECHNIQUES IN TISSUE	**15**
2.1	Cell culture types- callus, single cell and suspension culture Organogenesis and embryogenesis; Somaclonal variation; meristem	
2.2	Micropropagation, Germplasm conservation; Isolation and regeneration of protoplasm; Somatic hybridization, Synthetic seeds, Cryopreservation, secondary metabolite production.	
	MODULE- III: APPLICATION OF PLANT TISSUE CULTURE	**15**
3.1	Horticulture	

3.2	Agriculture	
3.3	Forestry	

TOTAL	

COURSE TITLE: PLANT TISSUE CULTURE (Practical)

COURSE CODE: BOT-VI.E-13 MARKS: 25

CREDITS: 1

COURSE DURATION: 15 SESSIONS

Sr. No	MODULE 4: Topics	Practical sessions
1	Preparation of MS Medium; Sterilization techniques	**03**
2	Embryo culture of maize	**02**
3	Callus induction and its morphological studies	**04**
4	Sub-culturing callus for rooting and shooting	**03**
5	Enzymatic Isolation of plant protoplast	**01**
6	Synthetic seed production	**01**
7	Visit to Plant tissue culture unit	**01**
	TOTAL	**15**

REFERENCES:

1. Bhojwani, S.S. (1990). *Plant Tissue Culture: Applications and Limitations*. USA: Elsevier Science Publishers.
2. Kumar, U. (1999). *Methods in Plant Tissue Culture*. Jodhpur: Agrobios.
3. Razdan, M. K. (2002). *Introduction to Plant Tissue Culture.* New Delhi: Oxford &IBH Publishing Co. Pvt. Ltd.
4. Satyanarayana U. (2013). *Biotechnology.* New Delhi: Books and allied (P) Ltd.
5. Vasil, I.K. and Thorpe, T.A. 1994. *Plant Cell and Tissue Culture*. Netherlands: Kluwer Academic Publishers.