BOTANY
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.
3. Kokate, C. K. (2008). *Pharmacognosy*. Maharashtra: Nirali Prakashan.
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.
6. Wallis, T. E. (2005). *Textbook of Pharmacognosy*. New Delhi: CBS Publishers & Distributors.

7. Leland, J. C. (2006). *Natural Products from Plants*. New York: Taylor and Francis.
8.Harborne, J. B.(2010). *Phytochemical Methods*. New Delhi: Springer International edition.
8. Mammen, D. (1991). *Methods in Plant Chemistry and Economic Botany*. New Delhi: Kalyani publishers.
9. Kumar, G. S., & Jayaveera, K. N. (2014). *A Textbook of Pharmacognosy and Phytochemistry*.
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.
14. *What is Pharmacognosy*. (2020, February 12). Retrieved from www.pharmacognosy.com:https://pharmacognosy.com/pharmacognosy-consulting-firm/
15. *Pharmacognosy*. (2020, February12). Retrieved from www.phytojournal.com:http://www.phytojournal.com/pharmacognosy
16. *Pharmacognosy Journal*. (2020, February 12). Retrieved from www.scimagojr.com:
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.
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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.
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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/
17. Reddy, J. (2017, February 19). *Organic Agriculture Information Guide*. Retrieved February 13, 2020, from AgriFarming: https://www.agrifarming.in/organic-agriculture.

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.
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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).
11. *Biotechnology*. UK: Cambridge University press.Wilson, K. & Walker, J. (2008).
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Weblinks and Article References:

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

2. https://ndl.iitkgp.ac.in/

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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:

1. https://www.econbot.org › home › education
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.