ಮಂಗಳೂರು ವಿಶ್ವವಿದ್ಯಾನಿಲಯ

MANGALORE UNIVERSITY

(Accredited by NAAC Grade)

ಕ್ರಮಾಂಕ/No. : MU/ACC/CR.19/2025-26/A2

ಕುಲಸಚಿವರಕಛೇರಿ
ಮಂಗಳಗಂಗೋತ್ರಿ – 574 199
Office of the Registrar
Mangalagangothri – 574 199
ದಿನಾಂಕ/Date:31.07.2025

NOTIFICATION

Sub: Revised syllabus of M.Sc. in Botany Programme.

Ref: Academic Council approval vide agenda No.:ಎಸಿಸಿ:ಶೈ.ಮ.ಸಾ.ಸ.1:1 (2025-26) dtd 18.07.2025.

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The revised syllabus of M.Sc. in Botany programme which has been approved by the Academic Council at its meeting held on 18.07.2025 is hereby notified for implementation with effect from the academic year 2025-26 and onwards.

Copy of the Syllabus shall be downloaded from the University Website (www.mangaloreuniversity.ac.in)

REGISTRAR

To,

1. The Registrar (Evaluation), Mangalore University.
2. The Chairman, P.G. Board of Studies in Applied Botany, Dept .of Applied Botany, Mangalore University.
3. The Chairman, Dept .of Applied Botany, Mangalore University, Mangalagangothri.
4. The Principals of the College concerned.
5. The Asst. Registrar (ACC), O/o the Registrar, Mangalore University.
6. The Director, DUIMS, Mangalore University – with a request to publish in the website.
7. Guard File.

MANGALORE UNIVERSITY
DEPARTMENT OF APPLIED BOTANY
M.Sc., BOTANY (CBCS)

Program Structure and Scheme of Examination for M.Sc., Botany

PREAMBLE

As per the guidelines of UGC and Higher Education Council, Government of Karnataka, the Board of studies in Botany, Mangalore University has framed a new syllabus according to the regulations governing the choice-based credit system for two year(four semester) M. Sc. Degree Programs in 2022. As per UGC guidelines, syllabus needs to be revised once in three years. Accordingly, now the syllabus has been revised in 2025.

The M. Sc. program in Botany under CBSC scheme has a total of 92 credits consisting of hardcore courses including project work for 58 credits which is equivalent to 63% and soft core courses offered for 28 credits which comes to 30% and open elective courses offered to students for a total of 6 credits which is equivalent to 7%.

In this revised syllabus, more than 20 distinct study areas have been incorporated across 15 courses. Of the total content, 55% of the earlier syllabus(Rev 22) has been retained; 15% has been adopted from soft core courses included in the earlier revised 2022 syllabus but not offered to the students and the remaining 30% comprises entirely new additions which comprise existing new trends in science and technology.

Program Outcomes

Program Outcome 1: To engage the students in a more inclusive and comprehensive curriculum in Botany that integrates foundational and advanced concepts, fostering excellence in competitive examinations and practical competence in areas like plant taxonomy, horticulture, forestry, environment protection, biodiversity conservation, biotechnology, artificial intelligence, bioinformatics and genome editing. The program emphasizes value-based education that contributes to sustainable development and ecological balance.

Program Outcome 2: To equip students with essential soft skills, transferable skills and technical expertise through hands-on practical sessions. Continuous assessment, students-motivated learning's via assignments, effective communication through seminars and presentations preparing the students for successful carriers in research, education, industry or entrepreneurial ventures in plant sciences.

MANGALORE UNIVERSITY
DEPARTMENT OF APPLIED BOTANY

I Semester							
Paper Code	**Title of the Course**	**Instruction hrs./ week**	**Duration of Exam (hrs.)**	**Marks**			**Credits**
				IA	Exam	Total	
Hard Core							
25BOH401	Microbiology and Immunology	4	3	30	70	100	4
25BOH402	Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperm	4	3	30	70	100	4
BOH403	Plant Biochemistry	4	3	30	70	100	4
25BOP404	Microbiology and Immunology: Practical –1	4	3	15	35	50	2
25BOP405	Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperm: Practical–2	4	3	15	35	50	2
BOP406	Plant Biochemistry: Practical–3	4	3	15	35	50	2
Total credits for hard core							**18**
Soft Core							
	Any one soft core course is offered						
25BOS407	Plant Physiology	3	3	30	70	100	3
BOS408	Plant Microbe Interactions	3	3	30	70	100	3
25BOP409	Plant Physiology: Practical-4	4	3	15	35	50	2
BOP410	Plant Microbe Interactions: Practical–5	4	3	15	35	50	2
	Total					**600**	**18 + 5 = 23**

II Semester							
Paper Code	**Title of the Course**	**Instruction hrs./ week**	**Duration of Exam (hrs.)**	**Marks**			**Credits**
				IA	Exam	Total	
Hard Core							
25BOH451	Systematics of Angiosperms	4	3	30	70	100	4
25BOH452	Plant Pathology	4	3	30	70	100	4
25BOP453	Systematics of Angiosperm: Practical –6	4	3	15	35	50	2
25BOP454	Plant Pathology: Practical-7	4	3	15	35	50	2
Total credits for hard core							**12**
Soft Core							
	Any two soft core courses are offered						
25BOS455	Plant Anatomy and Histochemistry	3	3	30	70	100	3
BOS456	Reproductive Biology of Angiosperms and Plant Morphogenesis	3	3	30	70	100	3
25BOS457	Economic Botany	3	3	30	70	100	3
25BOP458	Plant Anatomy and Histochemistry: Practical-8	4	3	15	35	50	2
BOP459	Reproductive Biology of Angiosperms and Plant Morphogenesis: Practical -9	4	3	15	35	50	2
25BOP460	Economic Botany: Practical-10	4	3	15	35	50	2
Open Elective							
BOE461	Medicinal Plants	3	3	30	70	100	3
	Total					700	**12 + 10 + 3 = 25**

III Semester							
Paper Code	**Title of the Course**	**Instruction hrs./ week**	**Duration of Exam (hrs.)**	**Marks**			**Credits**
				IA	Exam	Total	
Hard Core							
25BOH501	Genetics and Evolutionary Biology	4	3	30	70	100	4
25BOH502	Cell and Molecular Biology	4	3	30	70	100	4
25BOP503	Genetics and Evolutionary Biology: Practical– 11	4	3	15	35	50	2
25BOP504	Cell and Molecular Biology: Practical-12	4	3	15	35	50	2
Total credits for hard core							**12**
Soft Core							
	Any two soft core courses are offered						
25BOS505	Plant Propagation, Breeding and Genome Editing.	3	3	30	70	100	3
25BOS506	Ethnobotany and IPR	3	3	30	70	100	3
BOS507	Phytochemical Methods	3	3	30	70	100	3
25BOP508	Plant Propagation, Breeding and Genome Editing: Practical-13	4	3	15	35	50	2
25BOP509	Ethnobotany and IPR: Practical-14	4	3	15	35	50	2
BOP510	Phytochemical Methods: Practical-15	4	3	15	35	50	2
Open Elective							
BOE511	Plant Propagation	3	3	30	70	100	3
	Total					**700**	**12 + 10 + 3 = 25**

IV semester							
Paper Code	**Title of the Course**	**Instruction hrs./ week**	**Duration of Exam(hrs.)**	**Marks**			**Credits**
				IA	Exam	Total	
Hard Core							
25BOH551	Ecology, Biodiversity and Conservation Biology	4	3	30	70	100	4
BOH552	Plant Biotechnology	4	3	30	70	100	4
BOP553	***Project work	4	-	30	70	100	4
25BOP554	Ecology, Biodiversity and Conservation Biology: Practical-16	4	3	15	35	50	2
BOP555	Plant Biotechnology: Practical- 17	4	3	15	35	50	2
Total Credits for Hard Core							**12 + 4 =16**
Soft Core							
	Any one soft core course is offered						
25BOS556	Computational Biology, Bioinformatics, Artificial Intelligence and Biostatistics	3	3	30	70	100	3
25BOS557	Seed Technology	3	3	30	70	100	3
	Total					500	**16 + 3 = 19**

Soft core courses will be offered depending on the expertise available in the Department. IA for theory will be based on two tests and one seminar.
IA for practical will be based on the class records and one practical test.

MANGALORE UNIVERSITY

DEPARTMENT OF BOTANY

Scheme for M.Sc., CBCS Course

Semester	No.of papers	Hardcore				Softcore				Open elective		Total credits
		Theory		Practical		Theory		Practical		Theory		
		Hrs	Credits	Hrs	Credits	Hrs	Credits	Hrs	Credits	Hrs	Credits	
I	4	4	4x3=12	4	2x3=6	3	3x1=3	4	2x1=2	-	-	23
II	5	4	4x2=8	4	2x2=4	3	3x2=6	4	2x2=4	3	3	25
III	5	4	4x2=8	4	2x2=4	3	3x2=6	4	2x2=4	3	3	25
IV	4	4	4x2=8 4x1=4*	4	2x2=4		3x1=3		-	-	-	19

***Project work**

HC credits	-58	60%
SC credits	-28	30%
Open elective	-6	10%

	92	
	====	

Question Paper Pattern for Theory

Reg. No. | | | | | | | | | | | |

BO X 000

_ _ Semester M. Sc. Degree Examination, _____ 2025

(CBCS)

BOTANY

Title of the Course

Time: 3 hrs. **Max. Marks: 70**

I. Answer **any three** of the following (each answer not exceeding **5** pages):

(3 x 10 = 30)

1.
2.
3.
4.
5.

II. Write notes on **any six** of the following (each answer not exceeding **3** pages):

(6 x 5 = 30)

6.
7.
8.
9.
10.
11.
12.
13.

III. Write short notes on **any five** of the following (each answer not exceeding **1** page):

(2 x 5 = 10)

14.
15.
16.
17.
18.
19.
20.

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Question Paper Pattern for Practical

Reg. No. | | | | | | | | | | | |

BOP 000

_ _ Semester M. Sc. Degree Examination, _____ 2025
(CBCS)
BOTANY
Title of the Course

Time: 3 hrs. **Max. Marks: 35**

I. Major Experiments: **12 marks**

II Minor Experiments: **8 marks**

III Comment on: **2 x 5 = 10 marks**

1.
2.
3.
4.
5.

IV Class Record/s **5 marks**

SEMESTER I

25BOH401 **Microbiology and Immunology**

Total Teaching Hours: 64

Learning Objectives:

Students are focused to the new world of microscopic dimensions of life forms, their diversity, pattern of nutrition, reproduction and economic importance. In addition, students are also focused to learn basics, biochemical mechanisms, genetic basis as well as the applied aspects of immunology.

Course Outcome:

It provides immense knowledge about both basic as well as applied aspects of Microbiology and Immunology. Fermentation, mushroom cultivation, clinical aspects of immunology further widen the job opportunities to the students.

Unit I **13 Hrs.**

Introduction to Microbiology, Microbial Diversity and its Significance. Development of Microbiology - Contributions of early microbiologists - Antonie van Leeuwenhoek, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Joseph Lister. Microscopy - Principles and applications; Simple, Compound, Dark field, phase contrast, Fluorescent. Electron Microscopes: SEM, TEM, Principles. Different types of fixation, staining techniques and image processing.

Unit I **13 Hrs.**

Monera- General characteristics of Bacteria- cell structure, size, shape, cell wall, capsule, cytoplasmic inclusions, mesosomes; Bacterial appendages; Chemotaxis, Asexual reproduction in bacteria- Binary fission and endospore formation. Study of Actinomycetes, Rickettsiae, Mycoplasma and Phytoplasmas. Protista- General characteristics. Lifecycle of malarial protozoa Plasmodium. Study of Chrysophytes (Diatoms). **Mycology**- General characteristics and classification. Heterokaryosis and Parasexual cycle. Biology of yeast – reproduction. **Virology**- Baltimore system of Virus classification. Bacteriophages- structure, Viroids, Prions

Unit III **13 Hrs.**

Microbial nutrition: Microbial nutrient requirements – macro and micro-elements, growth factors, sources of nutrients. Bacterial growth curve - Kinetics of Growth. Types of Culture Media. Cultivation of aerobic and anaerobic bacteria; Techniques of pure culture -Batch, Continuous, Synchronous Culture. Nutritional classification of bacteria - Photoautotroph, Photoheterotroph, Chemoautotroph, Chemoheterotroph, Saprophytes and Auxotrophs.

Unit IV **12 Hrs.**

Comparative account on aerobic and anaerobic respiration. Fermentation in yeast and bacteria. Plant microbe interactions: Symbiosis(Mutualism)- Ecto and endomycorrhiza (VAM), Lichens; commensalism; parasitism. Microbial toxins- Bacterial and Mycotoxins, Food poisoning.

Unit V **13 Hrs.**

Immunology: History, detailed and comparative account of classification of immunity. Organs, Cells and molecules of Innate and acquired (adaptive) Immunity. Inflammation, Hypersensitivity, Autoimmunity, Primary and secondary immune response. Antigen, Immunogen and Hapten; Antibody - structure of immune globulins and antibody production. Somatic recombination and antibody and T cell receptors diversity. Antigen-antibody reactions- agglutination, precipitation, complement fixation test. Immunological tests – Immuno diffusion, Immuno electrophoresis, Immun of luorescence. Radio immune assay. Antibody tests - ELISA, Western blotting; Principle, procedure, recent advances in Monoclonal and polyclonal antibody production. A brief introduction to immunity in plants.

25BOH402 **Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms**

Total Teaching Hours: 64

Learning Objectives:

Students are offered to learn about the diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms and their evolutionary relationships. They study the comparative account of ecological adaptation and reproduction in different divisions including economic importance.

Course outcome:

Students are well expertise in identification of different forms of Algae, bryophytes, pteridophytes and gymnosperms. This course will form a foundation to understand further higher level of plant diversity in a more comprehensive way.

Unit I **13 Hrs.**

Algae: Introduction, occurrence, distribution and classifications. Thallus organisation, Life cycle pattern and general reproductive biology of Cyanophyceae, Chlorophyceae, Phaeophyceae, Xanthophyceae, and Rhodophyceae. Fossil algal records; economic importance of algae. Algal blooms.

Unit II **13 Hrs.**

Bryophytes: Introduction, occurrence, distribution and classifications. Life cycle patterns and

reproductive biology of Hepaticae, Anthocerotae and Musci. Evolution of sporophytes in bryophytes. A brief introduction to fossil bryophytes. Ecological and economic importance of Bryophytes.

Unit III **13 Hrs.**

Pteridophytes: Introduction, occurrence, distribution and classifications. Brief account of the classes - Psilophyta, Lycophyta, Sphenophyta and Pterophyta; Strucutre, reproduction and life cycle. Evolution of steles; Heterospory and the origin of seed habit; Economic importance. Evolution of land plants and their affinities. Fossil pteridophytes.

Unit IV **13** Hrs.

Gymnosperms: Introduction, occurrence, distribution and classifications. General account of Cyacadeoidales and Cordaitales.Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Epherdrales, Welwitchiales and Gnetales. Brief account of the families of Pteridospermales Lygenopteridaceae, Medullosaceae, Caytoniaceae, Glossopteridaceae. Economic importance.

Unit V **12 Hrs.**

Paleobotany: Geological time scale; process of plant fossilization; fossil types: petrification, cast & mold, impression, compression, organic origins. Techniques of fossil study; work on fossils in India. Application of Paleobotany.

BOH403 **Plant Biochemistry**

Total Teaching Hours:64

Learning objectives:

This course enables students to understand the structure and function of biomolecules, cellular membranes, and metabolic pathways in plants. It covers enzyme kinetics, bioenergetics, signal transduction, and nitrogen metabolism. Students will learn key biophysical techniques such as spectroscopy, chromatography, and electrophoresis. The course also introduces computational tools for binding site prediction and data mining.

Course outcome:

This course offers a foundational understanding of plant functions and cellular biochemistry, essential for exploring life processes like growth, transport, and stress response. It prepares students for advanced studies in fields such as molecular biology, biotechnology, and microbiology, while also supporting future research and career development in plant and life sciences.

Unit I **13 Hrs.**

Introduction and scope of plant biochemistry. Atomic Structure: chemical bonds- Ionic bond, covalent bond, hydrogen bond; periodic table, Radioactivity, Hydrogen ion concentration(pH),buffers reaction kinetics. Bioenergetics –Laws of thermodynamics, colligative properties, Concepts of enthalpy, entropy and free energy. Exergonic and endergonic reactions. Redox potential. Structure and hydrolysis of high energy compound. Plant enzymes -classification, kinetics and mechanism of action. Enzyme inhibition: competitive, noncompetitive and uncompetitive inhibition. Michaelis–Menten Equation. Units of enzyme activity.

Unit II **13 Hrs.**

Carbohydrates: structures, classification, occurrence and their biological role. Metabolism - Glycolysis and its regulation, HMP pathway, uronic acid pathway, T.C.A. cycle. Mitochondrial structure, Electron Transport System(E.T. S.) and its regulation and oxidative phosphorylation. Factors affecting respiration. Amino acids: classification, structure, properties, biosynthesis and oxidation. Proteins: classification, structures, Ramachandran plot, method of separation and amino acid sequencing.

Unit III **13 Hrs.**

Lipids: structure, classification, functions, properties and biological role. Biosynthesis And oxidation of fatty acids. Vitamins - classification, distribution, structure, production, function. Isolation of selected primary and secondary metabolites: Amino acids, proteins and carbohydrate, phenolics, flavonoids, alkaloids, lipids, oils, terpenes and saponins. Purification techniques for primary and secondary metabolites – solvent-solvent fractionation and chromatography techniques - HPTLC, silica gel column (normal and reverse), ion exchange, size exclusion. Secondary plant products: structure, biosynthesis and distribution of terpenes, phenolics and nitrogen containing compounds.

Unit IV **12 Hrs.**

Signal transduction: Hormones and their Receptors, cell surface receptors, signaling through G-protein coupled receptors, secondary messengers, proteins, phospholipid signaling, role of cyclic nucleotides, calcium - calmodulin cascade, protein kinases and phosphatases. Specific signaling mechanisms in Bacteria and Plants.

Unit V **13 Hrs.**

Biochemical Techniques: Spectroscopy: Basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman, fluorescence spectroscopy. Principles of light scattering, Rayleigh scattering, static light scattering, dynamic light scattering, low angle X-ray scattering. Principles, instrumentation and applications of adsorption chromatography, partition chromatography, molecular exclusion chromatography, affinity chromatography, gel electrophoresis, continuous flow electrophoresis, ultracentrifugation. Binding site identification tools: Cast-P, POCASA, 3D ligand site, Metapocket, Ghecom, QSR. Demonstration of data mining tools: Weka, Rapid miner, Keel.

25BOP404 **Microbiology and Immunology Practical –1**

Total Teaching Hours- 64

Course Outcome:

Students will get thorough training in microbiology lab practices, including sterilization and culture media handling. Hands-on experience in mushroom cultivation with livelihood potential. Practical training in isolation and identification of soil microorganisms. Exposure to essential procedures for handling and studying microorganisms. Laboratory guidelines, design, tools, equipment's and other requirements for studying microorganisms.

1) Sterilization techniques.

2) Measuring the dimensions of microorganisms using Micrometry.

3) Staining methods: simple, negative, Gram's staining, staining of endospore.

4) Preparation of culture media - NA, PDA, Muller Hinton Agar, Sabouraud Dextrose Agar.

5) Pure culturing of bacteria - Streak plate, pour plate, spread plate, serial dilution method.

6) Determination of bacterial motility.

7) Staining of VAM fungi.
8) Mushroom - Spawn production and cultivation.

9) Study of microorganisms in milk and curd.

10) Study of milk sample - Methylene blue reductase test.

11) Isolation of microorganisms - from rhizosphere and non -rhizosphere soil

12) Microflora of mouth and teeth crevices.

13) Observation and Isolation of Rhizobium.

14) Viability and Capsule staining for bacteria.

15) Measurement of conidia by Haemocytometer.

16) Bacterial growth measurement by spectrometric method.

17) Biochemical tests– Amylase, cellulase and casein.

Suggested Readings:

Ahmed M. and Basumatary S. K. 2006. Applied Microbiology, M.J.P. Publishers, Chennai, India.

Alexopoulus C. J., Mims C. W. and Blackwel M. 1996. Introductory Mycology, John Wiley & Sons Inc.

Ananthanarayanan R. and JayaramPaniker C. K. (2017). Textbook of Microbiology, 10th edition. Orient Lomgman.

Black J. C. 2005. Microbiology: Principle and Exploration 6th Ed, John Willey and Sons Inc, USA.

Collee J. G.(1981). Applied Medical Microbiology - 2 edit, Pub: Wiley-Blackwell.

DaCosta M. S., Duarte J. C. and Williams R. A.(1989). Microbiology of extreme environment & its potential for biotechnology. Pub: Springer Dordrecht.

Dubey R. C. and Maheswari D. K. (2005). A text book of Microbiology, Revised Multicolour edition, S Chand Publishers, New Delhi.

Purohit S. S.(2005). Microbiology - fundamentals Applications. Student Edition Publishers, Jodhpur.

Pelezar& Kreig (2006). Microbiology, 5th edition. Tata McGraw Hill, New Delhi

Powar &Daginawala (2005). General Microbiology, Vol. I & II 8th Edition, Himalaya Publishing House, Mumbai.

Salle A. J. (2001). Fundamentals & Principles of Bacteriology, 7th edition. Tata McGraw-Hill.

25BOP405 **Diversity of Algae, Bryophytes, Pteridophytes and Gymnosperms Practical – 2**

Total Teaching Hours: 64

Course outcome:

Introduces the methods of identification of algae and bryophytes using the identification manuals. Students study a detailed anatomical structure of pteridophytes and gymnosperms. This will give them a clear evolutionary trend in vascular structure. The field studies help them to appreciate the diversity and put the theoretical knowledge to practice. Aim is to enable the students to identify the plants independently.

1. Study of Cyanophycean members
2. Study of Chlorophycean and Phaeophycean members
3. Study of Xanthophycean and Rhodophycean members
4. Study of algal blooms
5. Study of Hepaticae
6. Study of Anthocerotae
7. Study of Musci
8. Study of Psilophyta
9. Study of Lycophyta
10. Study of Sphenophyta
11. Study of Pterophyta
12. Study of Cycadales and Ginkgoales
13. Study of Coniferales and Ephedrales
14. Study of Welwitschiales and Gnetales
15. Study of plant fossils (Fossil studies)
16. Field work, specimen collection, processing and identification.

Suggested Readings

Bennet,S.S.R.1979.An Introduction to Plant nomenclature. International Book Distributors.9/3. Rajpur Road, Dehra Dun 248001. India.

BhargavaM.2003.Algae, 1st Ed, Dominant Publisher, New Delhi.

Bhatnagar S. P. and Moitra A. 1997. Gymnosperms. New Age International Pvt. Ltd., New Delhi.

Biswas C.and Johri B. M. 1997. The Gymnosperms, Narosa Publishing House, New Delhi.

Coulter & Chamberlains 1959. Morphology of gymnosperms. Central Book depot. Hyderabad.

Gurucharan Singh 1999. Plant systematics - Theory and practice, Oxford and IBH Publishing Co.,Pvt. Ltd., NewDelhi.

Heywood V. H. 1976.Botanical Systematics, Academic Press London.

Hock C.V.D., Mann D. G. & Jalms H. M. 1993. Algae- an introduction to phycology; Cambridge University Press.

Lawrence H. M.1966. Taxonomy of Vascular Plants. The Mac Millon Company, New York, pp. 823.

Robert Edward Lee 1989. Phycology II End. Cambridge University Press.

Singh S. K. 2006. Text Book of Bryophyta, 1st Edition, Campus Book International Publisher.

Shivarajan V. V. 1991. Introduction to the Principles of Taxonomy, 2nd edition, Cambridge University Press.

BOP406 **Plant Biochemistry Practical – 3**

Total Teaching Hours: 64

Course outcome:

Trains the students in basics of biochemical lab procedures. Students will know to identify basic biochemical compound and certain aspects of enzyme kinetics. It enables the students to isolate, characterize biological compounds that possesses medicinal values, antimicrobial properties.

1. Extraction of phytochemicals using Soxhlet apparatus.
2. Extraction of essential oil using Clevenger apparatus.
3. Reactions of carbohydrates.
4. Reactions of proteins (Precipitation reactions of proteins) & non protein nitrogenous substances.
5. General scheme for identification of unknown carbohydrates, proteins and Non Protein Nitrogenous (NPN) substances.
6. Quantitative estimation of reducing sugar, amino acids & flavonoids.
7. Effect of time and temperature on the rate of reaction of an enzyme.
8. Estimation of total cholesterol (Zlatkis method).
9. Estimation of Starch from plant tissue by iodine method
10. Estimation of phosphatase activity in plant cells.
11. Preparation of standard graph for potassium dichromate by using colorimeter / Verification of Beer Lambert's law by colorimeter.

12. Assay of the enzyme peroxidase, enzyme dehydrogenase.

13. Separation of amino acids by thin layer chromatography(TLC).

14. Separation of Amino acids by paper chromatography.

15. Primary and secondary structure prediction methods: GOR method, PSI-pred, Chou-Fasman method.

16. Protein motif and domain analysis:MEME/MAST, eMotif, InterproScan, ProSite, ProDom,Pfam.

17. Antimicrobial activity of plant extracts.

18. Estimation of Lycopene.

19. Estimation of Crude fibre.

20. Estimation of Saponins.

21. Antioxidant activity of plant extracts.

Suggested Readings:

Buchanan B.B., Gruissem W. and Jones R.L. 2007.Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Dennis D.T., Turpin D.H., Lefebvre, D.D. and Layzell D.B. (eds) 1997.Plant Metabolism. Longman, Essex, England.

Dey P.M. and Harborne J.B., 2000. Plant Biochemistry. Academic press, USA.

Dryer R.L.and Lata G.F.1989. Experimental Biochemistry. Oxford University Press, New York.

Godwin T.W. and E.I. Mercer 1983. Introduction to Plant chemistry. Pergamon press. USA.

HeldtH.W.andHeldtF.2005.PlantBiochemistry,Academic press, California.

Lea P.J. and R.C.Leegood 1993. Plant Biochemistry and Molecular Biology, John Wiley and Sons. USA

Madigan M.T., Martinko T. M. and Parker J. 2000. Brock Biology of Microorganisms, 9thEd, Prentice Hall international, IncUSA.

Moore T.C. 1989. Biochemistry and Physiology of Plant Hormones. Springer- Verlag, New York, USA.

NelsonD.L.andCoxM.M.2008.Lehninger: Principles of Biochemistry 5thEd., W.H. Freeman and Company, New York.

PurichD. L. and AllisonR.D.2002.TheEnzymesreference: Academic Press, New York.

Plummer D.T. 1988. An Introduction to Practical Biochemistry; Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

StryerL.,TymoczkoL.and JandBergJ.M.2006.Biochemistry, 6thEd., W.H. Freeman and Company, New York.

Taiz L. and Zeiger E. 2003.Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts.USA.

Voet D., Voet J. G. and Pratt C.W. 2006. Fundamentals of Biochemistry, 2ndEd, John Wiley and Sons Inc.

Wilson K. and Walker J. 1994.PracticalBiochemistry: Principles and Techniques. Cambridge University Press, Cambridge,UK.

Wilson K. and Goulding K.H. (Eds), 1996.A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, U.K.

25BOS407 **Plant Physiology**

Total Teaching Hours:48

Learning objectives:

This course provides an under laying of physiological processes in plants, including cell differentiation, organ development, and flowering. It covers water and nutrient transport, mineral nutrition, and the role of plant hormones in growth and development. Students will also study photosynthesis, photoreceptors, biological rhythms, and plant responses to environmental stresses such as drought, salinity, and temperature.

Course outcome:

This course focuses on the functional aspects of plants, providing essential knowledge of cellular processes and physiological mechanisms. It serves as a foundational course for understanding how plant cells function, which is crucial for advanced learning in related fields such as molecular biology, biotechnology, and genetics. By building a strong conceptual base, the course also offers significant potential for students pursuing higher studies and research in plant sciences and allied disciplines.

Unit I **9 Hrs**.

Cell differentiation: Internal factors - cytoplasmic, genetic; environmental. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development. Floral meristems and floral development in *Arabidopsis* and *Antirrhinum sp.*

Unit II **10 Hrs.**

Solute transport and photo assimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; mechanisms of loading and unloading of photo assimilates. Water relations: water requirement, Transpiration; mechanism and factors affecting anti transpirants. Mineral Nutrition: Elements found in plants, essential elements, quantitative requirements and tissue analysis, functions, Nutrient deficiency.

Unit III **10 Hrs.**

Photosynthesis: structure of chloroplast and its function, concept of pigment system, Light harvesting complexes; Red drop and Emmersons enhancement effect. Electron transport system, cyclic and noncyclic photophosphorylation, ATP synthesis, photolysis, alternate oxidase; photorespiratory pathway. Photoprotective mechanisms; CO2 fixation-C3, C4 pathways and CAM cycle.

Unit IV **10 Hrs**.

Hormones and growth regulators – biosynthesis, storage, breakdown, transport, physiological effects. Mechanisms of action of auxins, gibberellins, cytokinins, ethylene, abscissic acid; mechanism of flowering, fruit ripening, abscission, senescence hormone receptors. Application of growth hormones and retardants in agriculture and horticulture.

Unit V **09 Hrs**.

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism, vernalization and biological clocks, circadian and other rhythms. plant movements. Stress physiology - water stress, salt stress, temperature stress, environmental radiation, stress tolerance. Special nutrition in plants.

BOS408 **Plant Microbe Interactions**

Total Teaching Hours: 48

Learning objectives:

This course introduces students to plant-microbe interactions, covering both pathogenic and beneficial microbes. It includes the classification, infection mechanisms, and symptoms caused by bacteria, fungi, viruses, and other pathogens, along with plant defense strategies like PTI, ETI, SAR, and ISR. Students will also learn about beneficial microbes such as rhizobia, mycorrhizae, and endophytes, as well as the molecular basis of plant immune responses and tumor formation, providing a foundation for studies in plant pathology and microbial biotechnology.

Course outcome:

This course explores the diverse interactions between microorganisms and plants, encompassing both beneficial and harmful relationships. Students will gain insight into the mechanisms underlying these interactions and how they influence plant health and productivity. A significant focus is placed on plant defense mechanisms that regulate microbial activity, providing a deeper understanding of plant-microbe dynamics. Additionally, the course highlights the practical applications of beneficial bacteria and fungi, such as their use in organic manure production, solid waste management, and bioremediation of heavy metal pollutants. With further study, these areas hold strong potential for sustainable practices and employment generation in environmental and agricultural sectors.

Unit I **10 Hrs.**

Plant-associated microbial pathogens

Classification of microbes associated with plant systems: Bacteria, fungi and oomycetes, phytoplasmas and spiroplasmas, protozoa, parasitic algae, viroids and viruses. Generalised scheme of their anatomy, physiology and reproduction Mechanism of infection and symptoms, Plant disease epidemiology Economic losses. **Plant-bacterial interactions:** Quorum sensing Plant penetration (foliar and soil-borne bacteria), attachment Role of cell-wall degrading enzymes (CWDEs), toxins, hormones and extracellular polysaccharides (EPSs) Determinants of host specificity, bacterial *Avirulence*genes (*Avr*),Type III secretion in plant pathogens, Hrp-pili, regulation of *hrp*genes, Secreted proteins, secretion signals. Role of plasmids. Diseases caused by bacterial interaction

Unit II **10 Hrs.**

Plant-fungal interactions: Dispersal of spores, attachment, penetration methods,appressorial development. Cell-wall degrading enzymes (CWDEs) and mycotoxins**,** Necrotrophy and biotrophy. Host barriers, overcoming host barriers (quiescence, detoxification of phytoanticipins, detoxification of phytoalexins, suppression of active oxygen species, avoidance of recognition). Fungal and oomycete genetics [concepts of race structure, *Avirulence*genes (*Avr*)] Diseases

caused by fungal interaction. **Plant-viral interactions:** Structure of plant viruses, RNA viruses, DNA viruses, Transmission of viruses by vectors (insects, nematodes, fungi, seeds and pollens)Movement of plant viruses in plantsViral effects on plants (Alteration in host gene expression, host cell metabolism and suppression of defence responses)Virus-resistance mechanisms in plants, post-transcriptional gene silencing (PTGs).

Unit III **10 Hrs.**

Beneficial microbes: *Rhizobium*-legume symbiosis**,** Nitrogen-fixing bacteria in non-legumes, Epiphytic microbes**,** Rhizosphere bacteria. Mycorrhizae-Endophytes. **Plant tumors:** Viral tumors, Fungal galls, Bacterial tumors, Nematode galls, Galls caused by Mycoplasma and Rickettsia, Insect galls; causes for tumors - Physical factor, chemical factors and Genetic factors.

Unit IV **09 Hrs.**

Plant defense processes:

Preformed defense mechanisms: Inducible defence mechanisms, Recognition of a pathogen [Gene-for-gene resistance, plant *Resistance* (*R*) genes, pathogen *Avr*gene products].*R* gene (leucin-rich repeats, cellular localization of recognition, TIR domains, NBS domain, other *R* gene domains, genetic organisation of *R* genes, mechanism of generation ofnew *R* gene specificities, co-evolution of *R* genes) Pathogen associated molecular patterns (PAMPs), PAMP-triggered immunity (PTI).

Unit V **09 Hrs.**

Effector proteins, effector-triggered immunity (ETI), microbe-induced molecular patterns (MIMPs), Elicitation of defence response and activation of signal transduction (oxidative burst, PAMPs trigger protein kinases, ion fluxes, nitric oxide, activation of transcription factors).Hypersensitive response (HR) and systemic acquired resistance(SAR) {programmed cell death (PCD), signaling molecules of SAR[salicylic acid (SA), jasmonic acid (JA), ethylene],*Pathogenesis- related* protein genes (*PR*), master regulator protein NPR1 (Non-expresser of *PR* genes)}Induced systemic resistance (ISR).

25BOP409 **Plant Physiology Practical – 4**

Total Teaching Hours:64

Course outcome:

Introduces students to some basic experiments in plant physiology. This will help them in appreciating the topics studied in the theory class better. Students will study chromatographic techniques, certain extraction procedures, ecological adaptations in plants etc. along with other experiments.

1. Determination of diffusion pressure deficit.
2. Determination of water potential using Scholander pressure chamber.
3. Determination of stomatal frequency,stomatal indexand the area of stomatal aperture.
4. Separation of plant pigments by column chromatography.
5. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
6. To determine the chlorophyll a /chlorophyll b ratio in C3 and C4 plants.
7. Anatomical characters of C3, C4 and CAM plants.
8. Physiological adaptations in plants - xerophytes, mesophytes, hydrophytes.
9. Estimation of vitamin-C(Ascorbic acid)in plants.
10. Extraction of caffeine.
11. Isolation of intact organelles: Chloroplast and mitochondria.
12. Assay of nitrate/nitrite reductase activity in leaves/algae.
13. Estimation of proline under stress and normal condition.
14. Preliminary screening of phytochemicals: Alkaloids, terpenes, steroids & phenols.
15. Demonstration experiment Warburgh monometer.
16. Isolation of polysaccharide (starch) from plant source.

Suggested Readings:

Buchanan B.B., Gruissem W. and Jones R.L. 2007.Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

BurgessJ.1989. An introduction to plant cell development. Cambridge University Press, Cambridge.

Devlin R. and F.H.Whiteman1986.Plant physiology.CBS publishers and distributors, New Delhi.
HemantaramanA.2007.Environmental Physiology, Scientific Publisher, India.

Hale M.G. and D.M. Orcutt 1987. The physiology of Plants under stress. A wiley - interscience

publication. New York.

Hopkins W.G.2005.Introduction to Plant Physiology. John Wiley & sons, Inc., New York,USA.

Khan N.A. and Singh S. 2008. Abiotic Stress and Plant Responses, I.K. International Publishing House Pvt Ltd, New Delhi.

MooreT.C.1989.BiochemistryandPhysiologyofPlant Hormones Springer-Verlag, New York, USA.

Moore T.C. 1974.Research Experiences in Plant Physiology: A Laboratory Manual: Springer-Verlag, Berlin, New York.

Noggle G.R.andG.J. Fritz1986.Introductoryplant physiology.CBS Publishers and distributors, New Delhi.

ScottP.2008.PhysiologyandBehaviorofPlant,JhonWiley and Sons Ltd, USA.

SrivastavaL.M.2005.PlantGrowthandDevelopmentandEnvironment, Academic Press, California.

Salisbury F.B. and Ross C.W.2001. Plant Physiology. Wadsworth Publishing Co., California, USA.

Taiz L. and Zeiger E.2003. Plant Physiology Sinauer Associates, Inc., Publishers, Massachusetts. USA.

WilkinsM.B.1989.Advancedplantphysiology.Longman Scientific and Technical, England

BOP410 **Plant-Microbe Interactions Practical- 5**

Total Teaching Hours: 64

Course outcome:

Good training in identifying endophytic and arbuscularmycorrhiza will be given. This can be useful in further/higher studies and also canbe used for developing biofertilizer, treating solidwaste etc.

1. Study of Rhizolium nodules
2. Ephiphytic microbes
3. Endophytes

4. Plant tumors
5. Cell wall degrading enzymes
6. Study of plant microbe interaction in phyllosphere
7. Study of plant microbe interaction in Rhisosphre
8. Study of the effect of plant extracts on bacterial growth.
9. **Study of plant microbe interaction enzymes**
10. Determination of activity of Peroxidase in healthy and infected tissues.
11. Determination of activity of Chitinase in healthy and infected tissues.
12. Determination of activity of Nitrogenease in healthy and infected tissues.
13. Determination of activity of Glutamate dehydrogenase in healthy and infected tissues.
14. Determination of activity of Glutamine synthetase in healthy and infected tissues.

Suggested Readings:

Arun Misra 1985. Plant tumors Today and Tomorrow's Printers andPublishers, New Delhi. pp 222

Agrios G. N. (2006). Plant Pathology. Academic Press.

Dickinson M. (2003). Molecular Plant Pathology. BIOS Scientific Publishers.

Gray Stacey, Beth Mullin and Peter M. Gresshoff (1996). Biology ofPlant – Microbe Interactions, Proceedings of the 8th International Symposium on Molecular Plant-Microbe. Interactions, conducted at Knoxville, Tennessee, during July 14-19, 1996. Pub. International Society for Molecular Plant- Microbe Interactions, St. Paul, Minnesota, USA.

Jeng-Sheng H. (2009). Plant pathogenesis and resistance: Biochemistryand Physiology of Plant Microbe Interactions. KluwerAcademic Publishers.

Reed G. (Ed.) (1983). Prescott & Dunn's Industrial Microbiology. 4th Ed., AVI Publishing Co., Connecticut, U.S.A.

Sullia S. B. and Shantharam S. (1998). General Microbiology. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi

SEMESTER-II

25BOH451 Systematics of Angiosperms

Total Teaching Hours: 64

Learning objectives:

To understand the principles of classification, identification and nomenclature of flowering plants. Students will learn to recognize and describe key morphological features of angiosperm families. They will develop skills in using taxonomic keys, herbaria and digital tools to identify plant species.

Course outcome:

Studying angiosperm taxonomy helps in the identification, classification and naming of flowering plants based on their evolutionary relationship. It enhances their understanding of plant diversity and their ecological roles. This knowledge is essential for fields like agriculture, pharmacology and conservation biology. Ultimately, it aids in the preservation of plant biodiversity and the sustainable uses of plant resources.

Unit I **13 Hrs.**

Brief history of development of plant taxonomy: Brief history of taxonomic studies in India. Organization and functioning of the Botanical Survey of India. *Hortus malabaricus*. Taxonomic tools - Herbarium: Methodology and its significance; Floras, Revisionary studies and Monographs: Keys - indented and bracketed keys. Botanical nomenclature: History of nomenclature. Salient features and. provisions of International code of Botanical nomenclature: Principles; Rules and recommendations. Ranks of taxa, Naming of different taxa- Effective and valid publication. Rule of priority, Typification (Topotype, Isotype, Paratype, Syntype, Lectotype; Neotype), Author citation, Valid name, Synonym, Basionym, Homonym, Tautonym, Autonym; naming of cultivated plants. Nomina conservanda.

Unit II **13 Hrs.**

Systems of classification: Development of classification(Pioneer phase/ exploratory phase, consodilation phase, biosystematics phase and encyclopedia phase); Alpha, Beta, Gamma and Omega Taxonomy. Artificial(Linnaeus), Natural (Bentham and Hookers system) and phylogenetic systems of classification (Engler and Prantl system and Taktajan, Cronquist, Dhalghren, Huchinson's–Trans phylogenetic system) and. APG IV system and LAPG. Evidence in Systematics: Morphological, Anatomical, Palenological, Embryological, Chemical, Cytological and Molecular.

Unit III **13 Hrs.**

Salient features and sysytematics of the following families as per Bentham & Hooker's system of classification: Magnoliaceae, Annonaceae, Menispermaceae, Nymphaeaceae, Capparidaceae, Caryophyllaceae, Clusiaceae, Dipterocarpaceae, Oxalidaceae, Balsaminaceae, Meliaceae, Rhamnaceae, Vitaceae, Leeaceae, Sapindaceae, Droseraceae,Melastomataceae, Rhizophoraceae, Combretaceae.

Unit IV **13 Hrs.**

Lythraceae, Passifloraceae, Cactaceae, Verbenaceae Asteraceae, Sapotaceae, Oleaceae, Asclepiadaceae, Loganiaceae, Gentianaceae, Scrophulariaceae, Boraginaceae, Lentibulariaceae, Bignoniaceae, Acanthaceae, Podostemaceae.

Unit V **12 Hrs.**

Euphorbiaceae, Piperaceae, Myristicaceae, Lauraceae, Loranthaceae, Santalaceae, Moraceae, Hydrocharitaceae, Orchidaceae, Musaceae, Zingiberaceae, Liliaceae, Amaryllidaceae, Dioscoreaceae, Commelinaceae, Araceae, Cyperaceae, Poaceae.

25BOH452 **Plant Pathology**

Total Teaching Hours: **64**

Learning objectives:

Learning plant pathology helps students understand the causes and development of plant diseases caused by various pathogens. It enables them to recognize disease symptoms and study host-pathogen interactions. Students gain knowledge of disease diagnosis and management strategies, including prevention and control methods. This understanding is essential for ensuring plant health and improving agricultural productivity.

Course Outcomes:

The course in plant pathology enables students to identify and diagnose various plant diseases accurately. It provides a thorough understanding of disease cycles, pathogen biology, and host interactions. Students learn effective disease management and control techniques to protect crops. This knowledge supports sustainable agriculture and helps minimize crop losses due to diseases.

UNIT I **13 Hrs.**

History: History of plant pathology regarding important diseases of crop plants; Concept and classification of plant diseases; Identification of plant diseases: Koch’s rules. Important Plant diseases: General aspects of plant diseases caused by viruses, mycoplasma, bacteria, fungi, protozoa, nematodes, Parasitic angiosperms - symptoms, etiology, life cycle, transmission. Non-

parasitic diseases. Seed borne pathogens and Diseases of cereals, fruits, vegetables, and plantation crops.

UNIT II **13 Hrs.**

Host-parasite interactions: Pathogenic factors pre-penetration, Mechanism of penetration and establishment - penetration and infection phases; invasiveness - biotrophic and necrotrophic pathogens; - production of enzymes, toxins - specific and nonspecific toxins and polysaccharides. Epidemiology, and Forecasting; Plant disease triangle. Factors affecting plant disease epidemics. Pathogenic effects on growth, physiology, translocation of water and mineral nutrients, organic nutrients, respiration in the host.

UNIT III **13 hrs.**

Host-defence mechanisms: Structural and chemical defence; Inducible defence mechanisms. Recognition of a pathogen (Gene to gene concept, plant resistance (R) genes, pathogen avirulenceAvr gene). Types of elicitors, production and receptor concept. Elicitation of defence response and activation of signal transduction (oxidative burst, PAMPs trigger protein kinases, ion fluxes, nitric oxide). Intra-cellualr and systamatic signal transduction.

UNIT IV **13 Hrs.**

Hypersensitive response (HR), and systemic acquired resistance (SAR) programmed cell death (PCD), Pathogenrelated protein genes (PR). Induced systemic resistance (ISR), structural and chemical defence.Reactive oxygen species (ROS), Lipoxygenases, Phytoalexins Plantibodies, Phenolic compounds, Polyphenol oxidases, and Detoxification of pathogen toxins.

UNIT V **12 Hrs.**

Control of Plan Diseases; Physical, Chemical, Biological and Cultural practices. Quarantine, Integrated pest management; Plant crop certification. Bio pesticides and their mode of action with special reference to induced systemic resistance. Control of plant diseases through transgenic approaches.

25BOP453 **Systematicsof Angiosperms Practical- 6**

Total Teaching Hours: 64

Course outcome:

Students study a detailed anatomical structure of angiosperms. This will give them a clear evolutionary trend in vascular structure. Students are trained in identifying plants using relevant literature. They will be familiar with literature required for plant identification. They will be trained in describing a species and also updating the names of plants. Field studies help them to appreciate the diversity and to put the theoretical knowledge to practice.

Systematics of Angiosperms:

1. Study of morphology of angiosperm plant.
2. Study of Polypetalae
3. Study of Gamopetalae
4. Study of Monochlamydeae
5. Study of Monocotyledonae
6. Botanical descriptions of angiosperms
7. Identification of plants through artificial keys
8. Identification of plants through digital means and confirmation with flora
9. Preparation of key for the indentification of locally availableplants
10. Visit to botanical garden of the university
11. Visit to entire campus to study flora
12. Botanical study tour for 4-5 days
13. Identification of plants pertaining to the families mentioned in the syllabus (Annonaceae,Passifloraceae,Piperaceae,Santalaceae). Construction of dichotomous keys for family, genus and species.
14. Construction of cladogram
15. Herbarium techniques.
16. Economic botany: Study of economically important plant derived products of angiosperms cereals, spices, bio-diesel yielding plants.

Suggested Readings:

Bhattacharya, B., &Johre, B. M. (1998). Flowering plants: Taxonomy and phylogeny. Narosa Publishing House.

Bhojwani, S. S., & Bhatnagar, S. P. (1978). The embryology of angiosperms. Vikas Publishing House.

Davis, P. H., & Heywood, V. H. (1963). Principles of angiosperm taxonomy. Oliver and Boyd Ltd.

Eames, A. J. (1961). Morphology of angiosperms. McGraw Hill Book Co., Inc.

Hutchinson, J. (1973). The families of flowering plants (p. 968). Oxford University Press.

Johri, B. M. (1982). The experimental embryology of vascular plants. Springer-Verlag.

Johri, B. M. (1984). The embryology of angiosperms. Springer-Verlag.

Lawrence, H. M. (1966). Taxonomy of vascular plants. The Macmillan Company.

Maheshwari, P. (1950). An introduction to the embryology of angiosperms. McGraw Hill Book Co., Inc.

Maheshwari, P. (1963). Recent advances in the embryology of angiosperms. International Society of Plant Morphologists.

Sivarajan, V. V. (1985). Introduction to principles of plant taxonomy. Oxford and IBH Publishing.

Singh, G. (1999). Plant systematics. Oxford and IBH Publishing.

Stace, C. A. (1989). Plant taxonomy and biosystematics (2nd ed.). Edward Arnold Ltd.

Swamy, B. G. L., & Krishnamurthy, K. V. (1982). From flower to fruit: The embryology of angiosperms. Tata McGraw Hill Co.

25BOP454 **Plant Pathology Practical -7**

Total Teaching Hours: 64

Course Outcomes:

Understand the symptoms and etiology of plant diseases caused by various groups of pathogens. Identify disease-causing agents based on symptoms and use diagnostic manuals for pathogen identification. Learn methods for isolation and culture of plant pathogens. Gain familiarity with diseases and control measures for local cereal, vegetable, and plantation crops.

1. General cleaning and sterilization of essentials and glassware Microscope and Camera Lucida –parts and their uses and precautions in handling.
2. Calibration and measurement of spores by Haemocytometer.
3. Preparation of mounting slides and stains for temporary and permanent mounts.
4. Collection, preservation and maintenance of plant pathogens.
5. Isolation of fungi from aquatic and infected tissues and Purification of fungal cultures.

6. Study of symptoms of important plant diseases caused by bacteria, fungi, nematodes, viruses and mycoplasma on cereals, vegetables, fruit crops, plantation crops & wild plants - Symptoms etiology and morphology.

7. Preparation of herbarium, field trips, class records and permanent slides.

8. Isolation of pathogens from different plants and their pure culture on different media.

9. Inoculation of pathogens in pure culture to healthy plants to reproduce the disease – Koch Postulate.

10. Study of effect of temperature, pH, salt, pesticides (fungicides) on the growth of plant pathogens in culture.

11. Estimation of Amylase and protease in diseased and healthy plant tissues.

12. Study of Plant disease enzymes: Viscometric and colorimetric methods.

13. Study and production of disease control material (agents). Production of mycotoxins.

Suggested Readings:

Agnihotri V. P., Sarbhay A. K. and Singh, D. V. 1997. Management of threatening plant diseases of National Importance.

Agrios N. 1997. Plant Pathology, Academic Press, New York.

Ainsworth G. C. 1981. Introduction to the history of Plant Pathology.

Bedell P. E. 1998. Seed Science and technology. New Delhi - Allied PP 346.

Callow J. A. (Ed.) 1983. Biochemical plant pathology. John Wiley & Sons.

Chester and Starr K. 1994. Arihant Plant diseases – Jaipur.

Dhingra D. 1993. Basic Plant Pathology methods - Delhi CBS.

Dordrecht 1995. Induced resistance to disease in plants.

John A. Lucas 1998. Fungal pathogenesis in plants and crops. 3rd Ed.

Mahadevan A. 1991. Post infectionaldefence mechanisms - New Delhi (Today & Tomorrow.

Maude R. B. (1996). Seed borne diseases and their control. Wallingford: Cab International, Lowman PP 280.

Paul Neergaard (1988). Seed Pathology Vols. I & II. Published by the Macmillan Press Ltd.

Houndmills. Basingstoke, Hampshire.

Rangaswami and Mahadevan A. 2001. Diseases of crop plants in India. Prentice Hall of India, Pvt. Ltd., New Delhi.
Singh R. S. 1990. Plant diseases - 6th ed. New Delhi. Oxford & IBM.

Vidhyasekaran P. 1997. Fungal Pathogenesis in plants and crops. (Molecular Biology and host Defense mechanisms), Marcel Dekker Inc.

Vidhyasekaran P. - 1990. Basic research for crop diseases Management - Daya Pub., Delhi.

25BOS455 **Plant Anatomy & Histochemistry**

Total Teaching Hours:48

Learning objectives:

Learning anatomy and histochemistry enables students to understand the structure and organization of the plants at both macroscopic and microscopic levels. It helps in identifying tissues and organs based on their cellular composition and histological features. Students gain skills in using microscopes and preparing histological slides for analysis. This foundation is crucial for advanced studies in physiology, pathology, and medical sciences.

Course outcome:

The course in anatomy and histochemistry equips students with a comprehensive understanding of the structural organization of the plants and its tissues. It enables them to identify and differentiate various cells, tissues, and organs through microscopic examination. Students develop practical skills in histological techniques and slide interpretation. This knowledge forms the basis for studying ontogeny of different organs and their differentiation and also to trace biochemical basis of differentiation.

Unit I **10 Hrs.**

Primary vegetative body of the plant: Stem: Arrangement of tissues, epidermis, cortical bundles, medullary bundles, steles of various types: Leaf-Structure of foliage leaves, petiole and node of dicot leaves. Vascular system of monocotleaves, stem-leaf junction of monocots, structure of fern and gymnosperm leaves: Structure of modified leaves-Kranz anatomy and C4 photosynthesis. Xerophytic and submerged foliageleaves, cataphylls, hypsophylls: Root-Structure of primary root, mucigel, epidermis, exodermis, dimorphic roots, root nodules.

Unit II **10 Hrs.**

Ultra-structure of the cell wall and differentiation. Ultra-structure and differentiation of xylem and phloem: tracheary elements and their differentiation, sieve elements and their differentiation.

Meristems: Apical meristems, shoot apex of Pteridophytes, gymnosperms and angiosperms, root apex and intercalary meristems.

Unit III **10 Hrs.**

Secondary growth of the plant body: Periderm, variations in wood structure. Anomalous secondary growth in climbers and monocots. Floral anatomy: Flower, flower parts and their arrangement, vascular system, floral meristem, origin and development of floral parts. Pathological Anatomy.

Unit IV **09 Hrs.**

Study of the instruments, their principles and uses (a) Camera lucida, (b)Micrometry (c) Microtomes –sledge Rocking, Rotary. Staining techniques –Principles of histochemical stains, Killing, fixing & staining of plant tissues.

Unit V **09 Hrs.**

Important reagents& chemicals needed in the fixatives; FAA, Carnoy's fluid, Navashins solution, fleminge; Dehydrating agents, mounting media, Double staining, Saffranin, Fast green. Embedding: TBA method, embedding for electron microscope, Sectioning, Whole mounts maceration. Histochemical-PAS Test, Sudan black lip.

BOS456 **Reproductive Biology of Angiosperms and Plant Morphogenesis**

Total Teaching Hours: 48

Learning objectives:

The study of reproductive biology in angiosperms focuses on understanding the processes of flower development, pollination, fertilization, and seed formation that ensure successful reproduction. It explores the mechanisms of sexual reproduction, including the structure and function of male and female gametes, and the role of pollinators. Plant morphogenesis examines how plants develop their shape and structure from cells to tissues, highlighting the genetic and environmental factors influencing growth patterns. Together, these topics aim to provide a comprehensive understanding of how angiosperms reproduce and develop, which is essential for applications in agriculture, horticulture, and plant breeding.

Course outcome:

Upon completing this course, students will be able to explain the key concepts and mechanisms involved in the reproductive biology of angiosperms, including flower development, pollination, fertilization, and seed formation. They will gain insights into the molecular, cellular, and

anatomical aspects of plant reproduction and their evolutionary significance. Students will also understand the principles of plant morphogenesis, including how genetic and environmental factors influence plant growth and form. Overall, the course will equip learners with the knowledge required to analyze and apply concepts in plant development, breeding, and biotechnology.

Unit I **10 Hrs.**

An introduction to Reproductive Biology of Angiosperms- A brief historical account on developmental biology of plants. Concept of male germ unit and its significance. Male gametophyte development; anther wall layers and functions; Tapetum-types, Pollen morphological features; Unusual features: pollen development in Cyperaceae, pollen embryosac; structure and growth of pollen tube and expression of genes.

Unit II **10Hrs.**

Concept of female germ unit and its significance –Female gametophyte development; Ovular structure & types; Development of monosporic, bisporic, tetrasporic & special types of embryo sacs; Ultrastructure & nutrition of female gametophyte.

Unit III **10 Hrs.**

Fertilization-A general account; double fertilization; single fertilization; heterofertilization & polyspermy; Endosperm-Types; haustorial variations; ruminate & composite endosperm. Embryo-Structure; Development of monocot, dicot & grass embryo; significance of embryonal suspensor; Invitro fertilization and its significance, gene expression during embryogenesis and mutant embryos

Unit IV **09 Hrs.**

Plant Morphogenesis: Historical developments; Models of morphogenesis, Plant morphogenetic pathways: Embryo, *Arabidopsis thaliana* and *Anthirrium*. Concepts-Cell fate/fate maps, gradients, stem cells in plants and their significance in development. Polarity (Acellular: Dictyostelium, Unicellular: Fucus egg and Equisetum spore, Multicellular: Colonial-Volvox), and Willow tree symmetry, totipotency of cell types, pleuropotency, plasticity, differentiation, redifferentiation, dedifferentiation and regeneration in Acetabularia.

Unit V **09 Hrs.**

Plant Growth and Development: Types, shoot apical meristems, root meristems; control of cell division in meristems; Quiescent center and meresteme de attente; Arabidopsis-vascular patterning and leaf development, abnormal growth; Cellular basis of growth- maintenance of cell shape; Cytoskeletal elements; Photomorphogenesis- definition, history, Hartmann's technique. ABCDE model of flower development

25BOS457 **Economic Botany**

Total Teaching Hours: 48

Learning objectives:

Learning economic botany helps students understand the importance of plants in everyday life, focusing on their economic uses such as food, medicine, and industry. It enables the identification and classification of commercially valuable plants and their products. Students study the cultivation, processing, and sustainable use of plant resources. This knowledge supports the development of agriculture, horticulture, and natural resource management.

Course outcome:

The course in economic botany equips students with knowledge about the economic significance and uses of various plants. It enables them to identify and classify plants with commercial and medicinal value. Students gain an understanding of the cultivation, harvesting, and processing of economically important plants. This prepares them for careers in agriculture, pharmaceuticals, forestry, and related industries.

Unit I **09 Hrs.**

Food Plants: Agroclimatic regions, diversity, nutritional and neutraceuticals properties, components of cereals, millets, legumes and nuts. Vegetables - root, stem, herbage and fruit vegetables. Fruits of tropical and temperate. Important spices and condiments of India.

Unit II **09 Hrs.**

Fibre and fibre yielding plants - textile fibres, uses ofcotton; soft or bast fibres, jute industry, coir industry. brush fibres, filling fibres. Vegetables sponges, artificial fibres.

Unit III **09Hrs.**

Wood and Cork: Diagnostic features of wood, mechanical properties of wood, seasoning of wood; veneers, plywood, lamina boards, cork and uses of cork. Important timber yielding plants of India.

Unit IV **10 Hrs.**

Tannins, dyes, gums and resinsTannins from bark, wood, leaves and fruits - uses of tannins. Dyes – sources and uses. Classification of Indian gums and resins, important plant sources for gums and resins.

Unit V **10 Hrs.**

Medicinal plants, Drugs from roots, stems, bark, leaves andflowers. Important medicinal plants of India. Threatenedmedicinal plants.Fumitories and masticatories - Tobacco, arecanut, betel, catechu, opium, cocaine, hemp.

25BOP458 **Plant Anatomy & Histochemistry Practical – 8**

Total Teaching Hours:48

Course outcome:

Gives basic tissue organization in plants. Practicalhelp them differentiate these tissues. Also this will train them in various methods of staining. They will also be trained in microtomy.

1) Staining of xylem and phloem tissues.

2) Anatomy of roots in: Ficus, Musa, Dieffenbachia, Orchid.

3) Anamalous secondary growth in the following examples: Stems ofAristolochia, Nyctanthes, Pyrostegia, Peperomia, Tinospora,Achyranthes.

4) Ecological anatomy.

5) Pathological anatomy.

6) Vasculature in floral organs.

7) Double staining technique.

8) Embedding: TBA method, embedding for electron microscope, Sectioning, Microtomes,Whole mounts maceration. Histochemical-PAS Test, Sudan black lipids, Feulgen reaction –N acids

Suggested Readings:

Abraham F. 1982. Plant Anatomy. 3rdedn.,Pergaon Press, Oxford.

Cariquist S. 1967. Comparative Plant Anatomy-Holt Reinert and Winston, NY.

Cutter D. G. 1971. Plant Anatomy- Part 1, Cell and Tissues,Edward Arnold London.

Cutter D. G. 1971. Plant Anatomy-Part 11, Cell and Tissues, Edward Arnold London.

Eames and McDaniel 1947. II edn., "Plant Anatomy" McGrawHill, N.Y.

Esau K. 1965, Plant Anatomy, Joh Wiley and Sons, N.Y.

James D. Mauseth 1998. Plant anatomy The Benzamin/ Cummins Publishing Co.Inc.

Katherine Esau 1979, Anatomy of seed plants-first Wileyeastern reprint. New Delhi.

Krishnamurthy K. V. 1988. Methods in Plant Histochemistry. S.Viswanathan (Printers and Publishers) Pvt. Ltd. Madras.

BOP459 **Reproductive Biology of Angiosperms and Plant Morphogenesis Practical-9**

Total Teaching Hours: 64

Course outcome:
Contains basic experiments in reproductive biology and Morphogenesis. Gives the various stages of the development of reproductive structures in plants. The various experiments help them to better understand other courses like tissue culture, biotechnology etc.

Reproductive Biology of Angiosperms:

1) Microsporangium: Slides: Wall layers; tapetal types; two - celled & three-celled pollen; pollen tetrads
2) Pollen germination: *Balsam, Delonix, Hibiscus* and *Peltaphorum*
3) Megasporangium: Slides Female gametophyte development in Penstemon, Xyris pauciflora;2, 4, 8-nucleate stages; mature embryo sac.
4) Endosperm mounting: *Cucumis sativus, Grevellia robusta* &*Croton sparsiflorus*
5) Embryo: Slides: Monocot, dicot & grass embryo
6) Embryo mounting: *Crotalaria*

Plant Morphogenesis:

7) Study of stem cells in plants: SAM, RAM
8) Regeneration abilities of shoot apical meristems of dicots on media with combinations of growth regulators.
9) Study of totipotency in cell types: stomata, epidermal cells, stem and leaf explants on a tissue culture media
10) Polarity in stem cuttings: *Pothos*spp.
11) Study of regeneration in succulents *Kalanchoe*, *Byrophyllum*
12) Study of leaf galls of plants: *Pongamia pinnata* &*Achyranthesaspera*: Morphological observations and histology.

Suggested Readings:
Aloni R. 1987. Differentiation of vascular tissues. Annu. Rev. Plant Physiol. 38:179-219.

Bhojwani S. S. & Bhatnagar S. P. 1978. The embryology of Angiosperms. Vikas Publishing House, New Delhi.

Chasan R. 1994. Tracing tracheary element development. The Plant Cell6:917-919.

Eames 1961. Morphology of Angiosperms. McGraw Hill book Co., Inc., NY.

Johri B. M. 1984. The embryology of Angiosperms. Springer Verlag.

Johri B. M. 1982. The experimental embryology of vascular plants. Springer Verlag NY.

Lyndon R. F. 1990. Plant Development: The Cellular basis. Unwin Hyman, London.

Maheshwari P. 1963. Recent advances in the embryology of angiosperms. Edited by the International Society of Plant Morphologists, New Delhi.

Maheshwari P. 1950. An introduction to the embryology of Angiosperms. McGraw Hill book Co., Inc., NY.

Mohr H. 1972. Lectures in photomorphogenesis. Springler- Vohrleg, Berlin, Germany.

Raman A. 2007. Insect induced plant galls of India; unresolved questions. Curr. Sci. 92 (6): 748-757.

Sinnot E. W. 1960. Plant Morphogenesis. Mc Graw-Hill Book Co. Inc. New York, USA.

Smith H. 1975. Phytochrome and Photomorphogenesis-an introduction to the photocontrol of plant development. McGraw-Hill Book Co. (UK), Ltd.

Steeves T. A. & Sussex I. M. 1989. Patterns in Plant development. 2nd edition, Cambridge University Press.

Swamy B. G. L. & Krishnamurthy, K. V. 1982. From flower to fruit: The embryology of angiosperms. Tata McGraw Hill Co.

Turing A. M. 1952. The chemical basis of morphogenesis. Phil. Trans. R. Soc. Lond. B. 237: 37-72.

25BOP460 **Economic Botany Practical – 10**

Total Teaching Hours: 64

Course outcome:

Field studies will introduce them to many of the economically important plants. They will also come to know a large number of various plant products of economic use.

1. Field survey for collection of economically important plants.

2. Study of important medicinal plants and their uses.

3. Economics of establishing one hectare of Areca plantation.

4. Study of Timber yielding plants.

5. Study of Fiber yielding plants.

6. Study of Oil yielding plants.

7. Study of Fodder yielding plants.

8. Economics of paddy cultivation in one hectare of land.

9. Economics of one hectare of coffee plantation.

10. Economics of establishing one hectare of coconut plantation.

11. Economics of establishing one hectare of mulberry garden.

12. Economics of producing organic manure from vegetable wastes.

Suggested Readings:

Anonymous 1952. The Wealth of India Series, CSIR, New Delhi.

Hill A.F. 1952. Economic Botany, Tata MacGrawHill, Cp Ltd, NewDelhi.

Kocchar H.L. 1998. Economic Botany of the tropics, 2nd Edn.MacMilln India Ltd. India.

Pandy B.P. 2000. Economic Botany, S. Chand and Company Pvt.Ltd., New Delhi.

Pandy S.N. and Chandha A. 1999. Economic Botany, VikasPublishing House Lvt. Ltd., New Delhi.

Open Elective

BOE461 **Medicinal Plants**

Total Teaching Hours: 48

Learning objectives:

Learning about medicinal plants helps students understand the identification and classification of plants with therapeutic properties. It enables them to study the chemical compounds responsible for medicinal effects and their modes of action. Students gain knowledge of traditional and modern uses of medicinal plants in healthcare. This foundation supports research and sustainable use of plant-based medicines.

Course outcome:

The course on medicinal plants equips students with the ability to identify and classify plants used in traditional and modern medicine. It provides knowledge of the chemical constituents responsible for their therapeutic effects. Students learn about cultivation, extraction methods, and sustainable harvesting practices. This prepares them for careers in herbal medicine, pharmacology, and related research fields.

Unit I **09 Hrs.**

Plant classification – Broad outline of groups and ranks of taxa, Plant Nomenclature- Common names, Bionomial nomenclature, IUBN- brief outline of methods in nomenclature; Typification. Herbarium- Methods of collection, processing of herbarium specimens; Herbaria of the world. Botanical Survey of India- brief outline of its organization and its role and significance.

Unit II **09 Hrs.**

Medicinal plants – system of herbal medicine, threatened medicinal plants- Threats. Conservation of Medicinal Plants *in-situ* and *ex-situ;* MPCA, Biosphere reserves, National parks, Sacred grooves, CITES, IUCN categories of plant, Brief account of Biodiversity Act.

Unit III **10 Hrs.**

Ethnobotany: Concept, scope and objectives; ethnic groups and ethnobotany and minor ethnic groups of India. Methodologies of ethnobotanical studies (a) Field work –documenting the information; questionnaire, interviews, video recording, identification and herbarium. Role of ethnobotanyin modern medicine with examples. Ethnobotanical uses of *Withania somnifera*, *Phyllanthus amarus*, *Bacopa monnieri*,*Artemisia annua*, *Rauwolfia serpentina*.

Unit IV **10 Hrs.**

Plants as medicine: Drugs of botanical origin. Medicinal properties of important local plants. Neutraceuticals Bioprospecting, Biopiracy. Intellectual property Rights: Forms of protection, Patents, Trademarks, Trade secrets, Designs, Geographical indications, Plant variety protection.

Unit V **10 Hrs.**

Cultivation potential of important medicinal plants. Agro climatic requirements, propagation, Transplanting and after care of the following medicinal plants.

Acorus calamus, Andrographis paniculala, Asparagus racemosus, Azadirachta indicaCentella asiatica, Piper longum, Rauwolfiaserpentina, Zingiber officinale, Vinca rosea, Emblica officinalis, Cinnamomum suphuratum.

Suggested Readings:

Agarwal S.S.M. and Paridhavi (2007). Herbal Drug Technology, University press, Hyderabad.

Bennet S.S.R. 1979. An Introduction to Plant nomenclature. International Book Distributors. 9/3. Rajpur Road, Dehra Dun248001. India.

Davis P.H. and V.H. Heywood 1963. Principles of AngiospermTaxonomy. Oliver and Boyd Ltd., Tweeddale Court, Edinburgh.

Heywood V.H. 1976. Botanical Systematics, Academic PressLondon.

Stace C.A. 1989. Plant Taxonomy and Biosystematics (2nd Edition). Edward Arnold Ltd., London.

Sumy, Ved & Krishnan (2000). Tropical Medicinal Plants, FRLHT,Bangalore.

SEMESTER III

25BOH501 Genetics and Evolutionary Biology

Total Teaching Hours:64

Learning objectives:

Learning genetic and evolutionary biology helps understand the mechanisms of heredity, variation, and the molecular basis of gene function. It enables students to analyze how evolutionary processes shape genetic diversity within and between populations. The subject fosters skills in interpreting genetic data and understanding evolutionary relationships among organisms. Overall, it prepares students to apply genetic and evolutionary principles in research, medicine, and conservation.

Course outcome:

The course in genetic and evolutionary biology enables students to explain the principles of inheritance, gene structure, and function. It helps them understand the mechanisms driving evolution, such as mutation, natural selection, genetic drift, and gene flow. Students will gain the ability to analyse genetic data and interpret evolutionary patterns. This knowledge equips them for advanced studies and careers in genetics, biotechnology, evolutionary research, and related fields.

Unit I **13 Hrs.**

Mendelian Genetics; Extensions of Mendelian's principles. Penetrance and expressivity, phenocopy, Quantitative and qualitative inheritance: Polygenic inheritance, heritability and its measurements, QTL mapping. Extra nuclear inheritance, Linkage and crossing over, Sex determination in plants, sex linkage, sex limited and sex influenced character, Tetrad analysis and mitotic recombination; construction of linkage maps.

Unit II **13 Hrs.**

Gene, Alleles, Pseudoalleles, one mutant one metabolic block, one gene one enzyme concept, one gene one polypeptide concept, complementation test, cistron, muton, recon, Intragenic mapping.Molecular basis of gene mutation: Physical mutagens and mechanism of mutation induction, Types of chemical mutagensandtheir mechanism of mutation induction: DNA repair – NER in prokaryotes and eukaryotes, BER, MMR, SOS and recombination repair.

Unit III **13 Hrs.**

Epigenetic inheritance- Introduction, dosage compensation, types, molecular basis of dosage compensation in Drosophila, man and Coenorhabditis, properties of inactive x chromosome. Genome imprinting in xci, stability, applications of xci, genome imprinting, consequences and mechanism, life cycle of imprint, imprinting and diseases and regulation, evolution.

Unit IV **`13 Hrs.**

Evolutionary Biology: Nature of Evolution: - Theories of origin of Universe, origin of Earth and origin of life; Development of Evolutionary Thoughts: Before Darwin, Charles Darwin, Darwin's Evolutionary Theory.Evolutionary Theories after Darwin, Modern Synthesis. Evidences for the theory of organic evolution: Paleontology, Biogeography, Taxonomy, Comparative Anatomy and Embryology, Comparative Physiology and Biochemistry, Plant and Animal Breeding.

Unit V **12 Hrs.**

Variations: Concept of evolution of gene and Gene Mutation-Chromosomal mutations-Architectural changes in the chromosomes. Speciation and origin of higher categories: Natural Selection- Selective forces, Types of Natural Selection, Selection models, Sexual Selection, Selection and nonadaptive characters. Isolating Mechanism and Species formation.Polyploidy: Autotetraploidy, Allotetraploidy and Polyploidy, Molecular basis of evolution and Neo-Darwinian evolution.Population genetics, future of genetics.

25BOH502 **Cell and Molecular Biology**

Total Teaching Hours: 64

Learning objectives:

The course Cell and Molecular Biology aims to provide students with a comprehensive understanding of cellular structures and the molecular mechanisms that govern key processes such as DNA replication, transcription, translation, and cell signaling. Students will learn how cells communicate, regulate their growth and division, and maintain homeostasis through complex molecular interactions. The course also develops students' abilities to apply laboratory techniques and interpret experimental data relevant to molecular and cellular functions. Overall, it lays a strong foundation for further studies or careers in biomedical research, biotechnology, and health sciences.

Course outcome:

Upon completing the Molecular Cell Biology course, students will be able to explain the structure and function of cellular organelles and understand the molecular basis of key cellular processes such as gene expression, cell signaling, and cell division. They will demonstrate the ability to apply fundamental laboratory techniques and analyze data from molecular and cellular experiments. Students will also develop critical thinking skills to connect molecular events with cellular function and human disease. This course prepares them for advanced studies or careers in research, biotechnology, and healthcare.

Unit I **12 Hrs.**

History and scope of molecular biology. Central dogma of Molecular biology; Nucleus: Nuclear

envelop, nuclear pore complex and composition of nuclear matrix. Structure and function of endoplasmic reticulum and Golgi bodies. Chromosome structure, organization and types. Chromosome banding techniques.

Unit II **13Hrs.**

DNA - discovery, structure, types, properties. RNA structure, types and factors affecting its stability. Concept of genome and genotype;Genome sequences and gene numbers, clusters and repeats, multigene families and evolution of globin gene cluster. Phylogenetic tree: Properties, construction and applications. Dot matric techniques and computer software used to determine divergence of DNA sequence. C value paradox, Cot and Rot values and its significance. *in situ* hybridization, chromosome microdissection, chromosome walking, DNA finger printing.

Unit III **13 Hrs.**

Gene expression in prokaryotes and their regulation: Transcriptionunit, *cis* acting elements andtrans-acting factors, prokaryotic RNA polymerase structure and functions of different units.Transcription initiation, elongation and termination. Genetic code and its universality and flexibility. Structure and activation of tRNA. Translation initiation, elongation and termination. Operon, *lac*, and *trp*operon organization, function and regulation. Mechanism of regulation of Lambda and cro repressor proteins.

Unit IV **13 Hrs.**

Gene expression in Eukaryotic cell system and their regulation: Transcription unit, Transcription factors, Types and functions of eukaryotic RNA polymerases. Transcription initiation, 5' capping, elongation and spliceosome mediated splicing, splicing of group I and group II introns, ribozyme technology and termination and polyadenylation. RNA transport.Translation initiation, elongation and termination. Protein trafficking and sorting.Regulation of gene expression:DNA binding domains, Chromatin remodeling complexes, histone tail modifications, enhancers, silencer, insulators, *gal* system in yeast.

Unit V **13 Hrs.**

DNA replication: Replicon, mechanism of DNA replication and their regulation in pro and eukaryotic cell system, cell cycle and its regulation. Cancer- Classification, Theories, 43roto-oncogenes, oncogenes, tumor suppressor genes, recent advances in cancer treatment. Transposons- types, mechanism of transposition, organization of important transposons in different model organism. Regulatory RNA's – types, synthesis, gene silencing and recent advances.Recombination and gene mapping in Bacteria and Viruses: Transformation, Conjugation and Transduction. Interpretation of genetic map of E. coli.

25BOP503 **Genetics and Evolutionary Biology Practical –11**

Total Teaching hours: 64

Course outcome

Demonstrate proficiency in basic techniques of classical and molecular genetics, including Mendelian crosses.

Conduct experiments to observe genetic variation and mutation in model organisms or systems.

1. Mendelian Genetics: Problems related to Dihybrid and monohybrid cross.
2. Problems related to Non-mendelian inheritance: Co-dominance, epistasis- dominant and recessive.
3. B-chromosome squash preparation in *Trigonella* root.
4. Polytene chromosome squash preparation.
5. Study of genetics in *Neurospora crassa*
6. Study of genetics in *Saccharomyces cerevisiae*.
7. Study of genetics in *Sordariafimicola*.
8. Calculation of chiasma frequency.
9. Study of the Hardy-Weinberg principle.
10. Study on the effect of selection on allelic frequency.
11. Sorting and determination of seed coat color allelic frequency in *Eleusine coracana* and *Macrotyloma uniflorum*.
12. Linkage problems- 3 point test cross, tetrad analysis.
13. Contributions of Evolutionary Scientists
14. Models and Photographs related to evolution.
15. Study of genetics of important hybrid crop plants.
16. Identification and description of genetic variations in mutant crop plants.

Suggested Readings:

Atherly A. G., Girton J. R. and Donald J. R. 1999. The Science of Genetics. Saunders College Publishers. Fortworth.

Brooker R. J. 1999. Genetics –analysis and principles. Addison Wesley Longman Inc. California.

Brown T. A. 1989. Genetics a molecular approach. Van Nostrand Reinhold (intn) Co., Ltd. London.

Dodson E. O. and Dodson P. 1976. Evolution: Process and Product. 2nd Ed., D. Van Nostrand Company, 450 West 33rd Street, New York, N.Y. 10001

Fairbanks D. J. and Anderson W. R. 1999. Genetics the continuity of life. Brooks's/Cole publishing company. California.

Futuyma and Douglas J. 2005. Evolution. Sinauer Associates, Inc., 23 Plumtree Road, Sunderland, MA 01375, United States of America.

Griffit A. J. F., Gelbart W. M., Muller J. H. and Lewintin R. C. 1999. Modern Genetic analysis. W. H. Freeman and co. N.Y.
Hartl D. 1991. Basic Genetics. II edn. Jones and Barlett Publishers Inc. Boston.

Snustad D. P., Simmons M. J. and Jenkins J. R. 1997. Principles of Genetics. Hohn Wiley & son's inc. N.Y.

Strickberger and Monroe W. 2000. Evolution. 3rd Ed., Jones & Bartlett Publishers, Inc. 40 Tall PineDrive Sudbury, MA 01776, United States of America.

Tamarin 1985. Principles of Genetics. V. edn. WC Brown publ. Co.

Winchester A. M. 1969. Genetics. III edn. Oxford and IBH, New Delhi.

25BOP504 **Cell and Molecular Biology Practical – 12**

Total Teaching Hours: 64

Course outcome:

Upon completing the Molecular Cell Biology Practical, students will gain hands-on experience with essential laboratory techniques such as DNA isolation, gel electrophoresis, PCR, and microscopy. They will develop the ability to accurately perform experiments, record observations, and analyze molecular and cellular data. The practical will enhance their

understanding of theoretical concepts through real-world application and foster problem-solving and critical thinking skills. This experience prepares students for research roles, advanced laboratory work, and further studies in molecular biology and related fields.

1) Pollen viability studies using different techniques.

2) Study of multiple translocations in *Rheo.*

3) Isolation of DNA plant source.

4) Isolation of DNA Microbial source.

5) Quantification of DNA - Plant source.

6) Quantification of DNA - Microbial source.

7) Quantification of RNA - Plant source.

8) Quantification of RNA - Microbial source.

9 and 10) Sequence analysis – Demonstration and problems.

11) DNA isolation and restriction digestion and separation and analysis by submarine electrophoresis.

12) Prediction of amino acid sequence from DNA sequence.

13) Dot matrix method for sequence homology determination.

14) Method of phylogenetic tree construction.

15) Study of the antibiotics which target DNA polymerase enzyme.

16) Study of the antibiotics which target RNA polymerase enzyme.

17) Study of chemotherapy formulation and their mechanism of action.

Suggested Readings:

Alberts B., Bray D., Lewis J., Raff M., Roberts K., and Watson J.D. 1999. Molecular Biology of the Cell. Garland Publishing Inc., New York.

Baxevanis A. D. and Francis Ouellellette B. F.(2009). Bioinformatics- a Practical Guide to the Analysis of Genes and Proteins by Wiley India Pvt Ltd.

Buchanan B.B., Gruissem W. and Jones R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA.

Cooper G.M. and Hausman R.E., 2004. The Cell: A Molecular Approach 3rd Ed, Sinaur Associates, IncSunderland, Massachusetts.
David W. Mount (2001). Bioinformatics: Sequence and Genome Analysis: University of Arizona, Tucson.

Gardner E.J., Simmons M.J. and Snustad D.P. 2003. Principles of Genetics, 8th Ed, John Wiley and Sons. Inc., New York.

Glick B.R. and Pasternak 1998. Molecular Biotechnology: Principal and Application of Recombinant DNA, 2nd Ed, ASM Press, Washington D.C.

Gunning B.E.S. and Steer M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.

Hartl D.L. and Jones E.W. 2002. Essential Genetics: A Genomic Perspective, 3rd Ed, Jones and Bartlett Publishers, Sudbury, Massachusetts.

Hughes M.A.1999. Plant Molecular Genetics, Addison Wesely Longman Limited, England.

Karp G. 2008. Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons Inc., New York.

Lewin B., Lingappa V.R. and Plopper G., 2007. Cells, Jones and Bartlett Publishers, Sudbury, Massachusetts.

Lewin B. 2017. Genes XII. Jones and Bartlett publishers,Sudburry, Massachusetts.

Lodish H., Berk A., Zipursky S.L., Matsudaira P., Baltimore D. and Darnell J. 2000. Molecular Cell biology, 4th edition, W.H. Freeman and Co., New York, USA.

Malacinski G.M., 2003. Essentials of Molecular Biology, 4th Ed, Jones and Bartlett Publishers, Inc Sudbury, Massachusetts.

25BOS505 **Plant Propagation, Breeding and Genome Editing**

Total Teaching Hours: 48

Learning objectives:

The course on Plant Breeding and Genome Editing aims to equip students with a comprehensive understanding of crop improvement techniques. It covers the principles and methods of plant

breeding, along with various sexual and asexual propagation techniques used in agriculture and horticulture. Students will also learn about modern genome editing tools such as CRISPR-Cas and their applications in enhancing desirable traits in plants. Through this course, learners will develop practical skills and scientific knowledge essential for advancing sustainable agriculture and plant biotechnology.

Course outcome:

Upon completing the course Plant Breeding and Genome Editing, students will understand the key principles of crop improvement and propagation techniques. They will be able to apply appropriate breeding and propagation methods for different plant species. The course also provides foundational knowledge of genome editing tools like CRISPR-Cas and their applications in trait enhancement. Students will be equipped to contribute to sustainable agriculture through modern plant biotechnology, considering ethical and regulatory aspects.

Unit I **10 Hrs.**

History, objectives, present status and future prospectus of plant breeding, plant breeding as both an art and science. Modes of reproduction and their implications in plant breeding: Amphimixis, apomixes, asexual and vegetative. Polyembryony, grafting techniques and layering. Determination of mode of reproduction and pollination in a species. Plant propagation: Definition, need and potentialities for plant multiplication. Propagation facilities. Morphological contrivances promoting allogamy and autogamy, Techniques of emasculation, and its exploitation in plant breeding.

Unit II **09 Hrs.**

Nature of gene action and components of genetic variance; genotype and environment interaction and adaptation. Methods of selection: Pureline selection, mass selection, disruptive selection, clonal selection. Population improvement: Recurrent and reciprocal recurrent schemes; composite population and synthetic population developments, hybrids and synthetic varieties. Breeding for nutritional quality. Mutation breeding.

Unit III **09 Hrs.**

Breeding in self-pollinated crops: Hybridization - history and objectives, types, procedure, consequences and achievements. Pure lines - origin of variation, pure line theory, effect of self-pollination on the genotype and achievements in self-pollinated crops. Heterosis-homozygous and heterozygous balance. Wide crosses and their uses in plant breeding.

Unit IV **10 Hrs.**

Breeding for disease resistance- History, mechanism of variability in pathogens, methods of breeding for vertical, horizontal and combined resistance. Breedingfor pest resistance; Polyploidy-aneuploids and euploids; inductionof polyploids-haploids, triploids, tetraploids, amphidiploids: Applications and limitations.Breeding for wide adaptation. Exploitation of

physiological efficiency of plants - as a new parameter for human selection.

Unit V **10 Hrs.**

Introduction to Genome Editing**.** Genome Editing Technologies CRISPR-Cas9 System: Mechanism, components, and applications. Other Genome Editing Tools: ZFNs, TALENs, and other technologies**.** Delivery Method. Applications in Crop Improvement. Ethical Issues**.** Case Studies and Future Directions. Examples of Genome-Edited Crops: Highlighting successful applications in various crops. Emerging Technologies: Exploring new advancements in genome editing and their potential. Challenges and Opportunities: Discussing the limitations and future prospects of genome editing in crop improvement.

25BOS506 **Ethnobotany and Intellectual Property Rights**

Total Teaching Hours: 48

Learning objectives:

The learning objectives of Ethnobotany and Intellectual Property Rights (IPR) include understanding the relationship between indigenous communities and their use of plants for medicinal, cultural, and economic purposes. Students will explore traditional knowledge systems and the significance of biodiversity in sustaining cultural heritage. The course also aims to provide insights into the legal frameworks that protect traditional knowledge through IPR, such as patents, trademarks, and geographical indications. Additionally, learners will develop a critical awareness of ethical issues related to biopiracy and the equitable sharing of benefits arising from the use of traditional resources.

Course outcome:

Upon completing the course on Ethnobotany and Intellectual Property Rights (IPR), students will be able to recognize and appreciate the value of traditional plant knowledge held by indigenous communities. They will gain the ability to analyze the cultural, ecological, and economic significance of ethnobotanical practices. The course will enable them to understand national and international IPR laws that safeguard traditional knowledge and promote fair benefit-sharing. Furthermore, students will be equipped to address ethical concerns related to bioprospecting, biopiracy, and conservation of biodiversity.

Unit I **10 Hrs.**

Ethnobotany: Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context. Ethnic groups and Ethnobotany: Major and minor ethnic groups or Tribals of India, and their life styles. Forest Vs. ethnic groups; Plants in Tribal life with reference to Magico-religious rituals and social customs. Sacred groves.

Unit II **09 Hrs.**

Methodology of Ethnobotanical studies: a) Field work- documenting the information-questionnaire, vedeo recording, interviews b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places f) Protocols.

Unit III **09 Hrs.**

Role of ethnobotany in modern Medicine with special examples; Medico-ethnobotanical sources in India with special reference to Karnataka. Tribals Vs. Agriculture: Shifting, Podu and Jhum cultivation. Role of ethnic groups on surrounding environment. Crop Genetic sources. Endangered taxa and forest management (participatory forest management).

Unit IV **10 Hrs.**

Ethnobotany and legal aspects. Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Ethnobotany as a source (recent) of already known drugs: a) Withania as an antioxidant and relaxant b) Sarpagandha in brain ailments c) Becopa and Centella in epilepsy and memory development in children d) *Phyllanthus fraternus* in diabetic and viral jaundice e) Artemisia as a powerful cerebral antimalarial agent and its possible use in tuberculosis.

Unit V **10 Hrs.**

Bioprospecting: Definition, scope, biodiversity potential practices and phases. Fields of Bioprospecting: Pharmaceutical, Agricultural and Environmental remedies. Biopiracy: Definition, history, global capitalism, international treaties. Study of Intellectual Property Rights – patents, trademark, geographical indication, copyright; IPR and Traditional Knowledge; Bio-piracy of traditional knowledge; Ethno botany and legal aspects; National and international organizations and treaty related to traditional knowledge – WIPO, TKDL, TRIPS, CBD, Nagoya protocol etc.

BOS507 **Phytochemical Methods**

Total Teaching Hours – 48

Learning objectives:

The learning objectives of phytochemical methods include understanding the principles and techniques used to identify and analyze bioactive compounds in plants. Students learn how to perform qualitative and quantitative analysis of phytochemicals such as alkaloids, flavonoids, tannins, and saponins. These methods also help in evaluating the medicinal potential of plant extracts through various biochemical assays. Overall, learners gain practical skills in laboratory techniques essential for natural product research and drug discovery.

Course outcome:

The course outcome of phytochemical methods enables students to proficiently identify, extract, and analyze various phytochemicals present in medicinal plants. Learners develop the ability to apply standard laboratory techniques for the qualitative and quantitative evaluation of plant constituents. The course also enhances understanding of the role of phytochemicals in therapeutic applications and drug development. Ultimately, students are equipped with practical and analytical skills essential for careers in pharmacognosy, herbal medicine, and natural product research.

Unit I **09 Hrs.**

Phytochemistry: Definition,scopeand importance. Plants as source of chemical compounds, Primary and secondary metabolites. Important source of alkaloids, Phenylpropanoids, flavonoids, steroids, cardiac glycosides, triterpenoids, volatile oils, tannins, resins, glycosides, iridoids,terpenoids and napthaquinones.

Unit II **10 Hrs.**

Selection of plant samples, processing and storage of samplesfor extraction.Extraction methods- infusion, decoction, digestion,maceration, percolation, solvent extraction, fluid extraction,ultrasound, microwave assisted extraction, advantage anddisadvantage involved in each method.Isolation of selected primary and secondary metabolites –amino acids, proteins and carbohydrate. Phenolics, flavonoids,alkaloids, lipids, oils, terpenes and saponins.Purification techniques for primary and secondary metabolites– solvent-solvent fractionation and chromatography techniques- HPTLC, silica gel column (normal and reverse), ion exchange,size exclusion.

Unit III **10 Hrs.**

Preliminary, qualitative and quantitative techniques – paperchromatography, thin layer chromatography, ColumnChromatography – HPLC, GC (qualitative and quantitative)Colour reactions for amino acids, sugars, phenolics,flavonoids, alkaloids, terpenes, saponins, oils, lipids.Spectroscopic estimations/gravimetric determination of totalsugars, amino acids, proteins, phenolics, flavonoids,alkaloids, terpenes, saponins, oils, lipids.Characterisation using spectroscopic techniques - UV/VIS,FTIR, DSC (differential scanning calorimeter), NMR, MS, MALDI.XRD – single crystal and powder.

Unit IV **09 Hrs.**

Evaluation of phytochemicals for bioactive potential *in vivoin vitro*. Evaluation of phytochemcials for antimicrobial,antioxidant,antidiabetic, anti-inflammatory, anti-pyretic,diuresis, anti-thyroid, anticancer, hepatoprotectiveactivities and nutritional values.Toxicity study, route ofadministration, analysis. Ethical guidelines and clearance.

Unit V **10Hrs.**

Quality determination of herbal drugs. Role of processingmethods and storage conditions on

quality of drugs.Standardistation parameters- impurity limit, ash content,extractable matter, moisture content, other phytocemicals,microbial contaminants, pesticides.Validation of drug – guidelines, limit of detection andquantification of impurities, organoleptic properties,physical, chemical, biological characteristics, stabilitytesting, storage conditions and packing system/unit.

25BOP508 **Plant Propagation, Breeding and Genome Editing Practical – 13**

Total Teaching Hour-64

Course outcome:

Upon completing the practical in Plant Propagation, Breeding, and Genome Editing, students will gain hands-on experience in techniques such as grafting, layering, hybridization, and tissue culture. They will learn to perform controlled pollination, selection, and evaluation of breeding populations for desirable traits. The practical component also introduces students to basic genome editing protocols and molecular marker-assisted selection methods. These skills prepare students for applied research, crop improvement programs, and professional roles in plant biotechnology and agriculture.

1. Study of floral biology and pollination mechanism.

2. Demonstration of mode of pollination by bagging.

3. Preparation of land.

4. Preparation of nursery bed for seedlings or saplings.

5. Transplantation of paddy and ragi seedlings.

6. Demonstration of bud selfing in gametophytic self-incompatibility plant system.

7. Demonstration of bud selfing in sporophytic self-incompatibility crop systems.

8. Demonstration of bud grafting.

9. Demonstration of whip grafting.

10. Demonstration of splice grafting.

11. Demonstration of approach grafting.

12. Demonstration of air layering.

13. Demonstration of ground layering.

14. Induction of polyploidy using colchicine.

15. Techniques in Hybridization: Emasculation, bagging and labelling.

16. Demonstration of uses of breeding implements.

Suggested Readings:

Bhojwani S.S. and Razdan M.K. 2004. Plant tissue culture, Panima Publishing Corporation, Delhi.

Chawla H.S. 2009. Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

GustafsonJ.P. 2000. Genomes, Kluwer Academic plenum press, Newyork.

Ignacimuthu S.J. 1997. Plant Biotechnology, Oxford& IBH Publishing Co. Pvt.Ltd. New Delhi.

Old R.W. and Primrose S.B. 1989. Principles of Gene Manipulation, Blackwell Scientific Publications, Oxford UK.

Primrose S.B. 1995. Principles of Genome Analysis.Blackwell Science Ltd., Oxford, UK.

Purohit S.S. 2000. Bio-fundamentals and applications, Agrobios, Jodhpur.

Purohit S.S.1999. Agricultural Biotechnology, Agro Botanical Publ. Bikaner.

Reinert J. 1982. Plant Cell and Tissue Culture: A Laboratory Manual. Narosa Publishing House. New Delhi.

Scheppler J.A., Cassin E.P. and Gambier R.M. 2000. Biotechnology explorations, ASM press, Washington. DC.

Smith E. 1996. Biotechnology, Cambridge press, U.K.

Smith R.M. 2000.Plant tissue culture, Techniques and experiments, Academic press, New York.

Stewart N. 2016. Plant Biotechnology and Genetics: Principles, Techniques, and Applications Edited by C Jr. University of Tennessee Knoxville, Tennessee. John Wiley & Sons, Inc., Hoboken, New Jersey.

Treshan, 1990. Biotechnology, Wiley Eastern, New Delhi.

25BOP509 **Ethnobotany and Intellectual Property Rights Practical– 14**

Total Teaching Hours: 64

Course outcome:

Visit to tribal area and data collection will familiarize them with the field conditions. They will learn about the identification of crude drugs from the experienced practitioners. Students will have a field knowledge of the diversity of medicinal plants.

1) Survey and collection of important ethno-botanical plants by using questionnaire and interview.

2) Preliminary phyto- chemical analysis of medicinal plants.

3) Study of biological functional properties of crude drugs – Anti microbial activity.

4) Study of methods of in-situ or ex-situ conservation of important medicinal plants.

5) Study of techniques used in Pharmacognosy – organoleptic, anatomy and chemical methods.

6) A visit to a Tribal area to conduct field work and collect ethno-botanical information / data.

7) Listing of Crude drugs in Pansari shops (local crude drugs shops) and their identification (little known drugs only).

8) Visit to nearby Western Ghats and Sacred Groves.

Suggested Readings:

Colton C.M. 1997. Ethnobotany –Principles and applications. John Wiley and sons –Chichester.

Faulks P.J. 1958. An introduction to Ethnobotany, Moredale pub. Ltd. London.

Jain S. K. (1995). Manual of Ethnobotany, Scientific Publishers, Jodhpur.

Jain S. K. 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
Jain S. K. (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

Jain S. K. (ed.)(1981). Glimpses of Indian. Ethno-botany, Oxford and I B H, New Delhi.
Lone et al., 2020. Palaeoethnobotany. eBook ISBN, 9781003079453.

Rajiv K. Sinha 1996. Ethnobotany The Renaissance of Traditional Herbal Medicine –INA– SHREE Publishers, Jaipur.
Rama Rao N. and Henry A. N.1996. The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah.

BOP510 **Phytochemical Methods Practical-15**

Total Teaching Hours – 48

Course outcome:
They work on the estimation and identification of variousPhytochemicals. This will stand them in good stead in getting jobs in biochemical based companies.

1. Estimation of Phenols.

2. Estimation of Flavonoids.

3. Estimation of Starch.

4. Extraction of essential oils.

5. Estimation of total sugars by Anthrone method.

6. Phytochemical screening of secondary metabolites.

7. Estimation of alkaloids.

8. Estimation of Caffeine.

9. Extraction of secondary metabolites through Soxhlet apparatus.

10-12. Isolation and quantification of compounds having medicinal properties.

Suggested Readings:
Bourne U.K.,Kokate, Purohit C.K. and Gokhale S.B. (1983).Pharmacognosy. Nivali Prakashan Publication.

Braithwaite A. and Smith F. J. (1996). Chromatographic Methods(5th edition), Blackie Academic & Professional London.

Harborne J.B. (1973). Phytochemical methods a guide to moderntechniques of plants analysis. Chapman and Hall, London Ltd.

Sadasivam S. and Manickam A. (2005). Bio Chemical methods 2nd edition, New AgeInternational Limited, New Delhi.

OPEN ELECTIVE

BOE511**Plant Propagation**

Total Teaching Hours:48

Learning objectives:
The learning objectives of plant propagation are to understand the various methods used to reproduce plants both sexually and asexually. Students will learn how to select appropriate propagation techniques to produce healthy and true-to-type plants. They will also gain skills in managing environmental factors to optimize propagation success. Additionally, learners will appreciate the importance of propagation in agriculture, horticulture, and conservation.

Course outcome:
The course on plant propagation equips students with the ability to apply different propagation techniques to multiply plants efficiently. Learners will develop practical skills in both sexual and asexual methods, ensuring the production of healthy and genetically stable plants. They will also understand how to manage propagation environments to maximize success rates. Ultimately, students will be prepared to contribute effectively to agriculture, horticulture, and plant conservation through improved propagation practices.

Unit I **10 Hrs.**
Definition,History,scope and importance of plant propagation. Propagationstructures: green house and its equipment -Cold frames, hot beds, poly tunnels/net houses, mist chambers,micropropagation chambers,rooting chambers, glass houses, phytotrons nursery. Propagation media- Organic media, inorganic media, rockwool hydroponics. Tools and implements.Modern plant propagation industry.

Unit II **10 Hrs.**
Biology and Environmental factors: Temperature, humidity, soil pH.Genetic control inpropagation - sexual versus asexual, hormonal control of plantgrowth and development. Microclimatic and edaphic factors.Biotic factors - Pathogen and pest management. Postpropagation care.

Unit III **10 Hrs.**
Seed propagation: Formation of fruit, seed and embryo,polyembrony and apomixes, hormones and seed development. Seedtesting, seed storage, seed germination - types. Nurserytechniques for transplant production.

Unit IV **09 Hrs.**
Vegetative propagation: Cuttings - advantages, types, sourceof cutting materials, rooting media.Grafting - History, terminology, types - detached sciongrafting, approach grafting, repair

grafting.Bud grafting. Layering - patch, ring and chip budding.Layering - simple, tip, mound, air and trench layering.

Unit V **09 Hrs.**

Micropropagation: Introduction, Culture techniques –Initiation, Multiplication, Rooting, Acclimatization/Hardening. Culture Media Components- Macro andmicronutrients, carbon source,growth regulators. Media Preparation and Sterilization. Generallaboratory facilities and procedures. Hardening technique.Propagation methods for Banana, Orchid, Anthurium, Gladiolus.

Suggested Readings:

Abbott A.J. and Atkin R.K.(9eds.)1987. Improving vegetativelypropagated crops. Academic press, NewYork.

Bose T.K., Sadhu M.K.& DasP.1986. Propagation of Tropicaland Subtropical Horticultural crops, Navya Prakash, Calcutta.

Hartmann, H. T., Kester, D. E., Davis, F. T., & Geneve, R. L. (1997). Plant propagation: Principles and practices. Prentice Hall of India Private Limited.

Krishnamurthy, H. M. (1982). Plant growth substances including application in agriculture. McGraw-Hill.

MacDonald, B. (1987). Practical woody plant propagation for nursery growers. Timber Press.

Pierik, L. M. (1987). In vitro culture of higher plants. Martinus Nijhoff Publishers.

Razdan, M. K. (1994). An introduction to plant tissue culture. Oxford & IBH Publishing Co. Pvt. Ltd.

Sadhu, M. K. (1989). Plant propagation. Wiley Eastern Ltd.

SEMESTER IV

25BOH551**Plant Ecology and Conservation Biology**

Total Teaching Hours: 64

Learning objectives:
The course on Ecology, Conservation Biology aims to provide students with a broad understanding of the interactions between organisms and their environments, and the importance of biodiversity for ecosystem health. Students will learn about the principles and methods of conservation biology to protect endangered species and habitats. The course also covers the distribution patterns of plants across geographical regions and the factors influencing these patterns. Through this, students will develop the knowledge and skills necessary to address environmental challenges and promote sustainable management of natural resources.

Course outcome:
Upon completing the course on Ecology, Conservation Biology, students will be able to analyze ecological relationships and understand the significance of biodiversity in maintaining ecosystem stability. They will demonstrate knowledge of conservation strategies aimed at protecting endangered species and habitats. Students will also be able to explain the distribution of plant species across different geographical regions and the environmental factors influencing these patterns. This course equips students with the skills to contribute to environmental management, conservation efforts, and
sustainable development initiatives.

Unit I **13 Hrs.**

Introduction to modern ecology, concept and scope: The Environment: Physical environment, biotic environment; biotic and abiotic interactions. Ecosystems: Introduction, trophic levels, Food webs, Energy flow, Primary and secondary production, nutrient cycles: C, N,P and S.Soil: Classification, types of soil, soil profile. Ecological succession: Causes of succession, Primary and secondary succession; Types – Hydrosere, Xerosere, Psamosere. climax community: Characteristics of climax, theories about climax; Unit of vegetation - Formation, Association, Consocies, Island Biogeography.

Unit II **13Hrs.**

Autecology: Phenology. Genecology. Synecology (Community ecology): Methods of study of community: Population ecology: Abiotic factors that affect species distribution patterns, characteristics of population - density, natality, mortality, age distribution, biotic potential, growth forms, fluctuations and dispersal. Population structure - dispersal, aggregation, intraspecific interactions in populations; population growth - life tables, deterministic models, stochastic models, causes of population change - key factor analysis, density dependence. Global warming: Green-house effect - causes and consequences. Climate change. Solid and liquid waste

management. Radioactive pollution: Ionising radiation, disposal of radioactive waste, nuclear accidents.

Unit III **13 Hrs.**

Definition and brief history, plant communities: Tropical forest, Temperate forest, Deserts, Grassland, Taiga, Tundra. characters used in the study of community structure - analytical and synthetic characters.

Diversity indices - Simpson's index, Shannon-Weiner's index, alpha, beta and gamma diversity, Jaccard's index, Sorenson's similarity index. Biodiversity and its conservation: Biodiversity: Definition, types of biodiversity - habitat diversity, species diversity and genetic diversity, SDG's in biodiversity conservation. Values of Biodiversity – Economic and aesthetic value, Medicinal and timber yielding plants. NTFP. Threats to biodiversity. Concept of Biodiversity Hotspots, Biodiversity hot spots of India. Concept of endemism and endemic species. ICUN plant categories with special reference to Karnataka/ Western Ghats.

Unit IV **13 Hrs.**

Biodiversity Conservation-Indian Forest conservation act, Biodiversity bill (2002). Conservation methods – In-situ and ex-situ methods. In-situ methods –Biosphere reserves, National parks, Sanctuaries, Sacred grooves. Ex-situ methods-Botanical gardens, Seed bank, Gene banks, Pollen banks, Culture - collections, Cryopreservation. Ramsar convention, Stockholm convention, CITES, Convention on biological diversity(CBD), United Nations Framework Convention on Climate Change (UNFCCC), Basel Convention, The Forest (Conservation) Act – 1980,National Action Plan on Climate Change (NAPCC) – 2008

Unit V **12 Hrs.**

Biogeography of the world, India and Karnataka. Climatic zones, tectonics, continental movements Types of plant distribution – discontinuous distribution - land bridge theory, continental drift; continuous distribution-cosmopolitan, circumpolar, circumboreal, circumneutral, pantropical.

Distribution of plants - islands; Phytochorea of the world, India; Plant dispersal, migrations and isolation**.** Endemic plants of Western Ghats and Eastern Himalayas. Origin, distribution and acclimatization of coffee, cardamom, sugarcane, cashew, ragi, maize, wheat, rice and cotton. Remote sensing and GPS, study of vegetation by GIS (Geographical Information system).

25BOP554 **Ecology, Biodiversity and Conservation Biology Practical – 16**

Total Teaching Hours: 64

Course outcome:

Upon completing the practical in Ecology, Biodiversity and Conservation Biology, students will gain hands-on experience in field survey techniques, species identification, and habitat assessment. They will learn to collect and analyze ecological data to evaluate biodiversity and monitor conservation status. Practical sessions will also involve mapping plant distributions and studying environmental factors affecting phytogeographical patterns. These experiences will enhance their ability to apply theoretical knowledge to real-world environmental and conservation challenges.

1. Morphology and Anatomy of plants in relation to habitats - xerophytes, mesophytes, hydrophytes, halophytes and psammophytes.

2. Preparation of ombrothermic diagrams.

3. Calculation of Evapotranspiration.

4. Population studies by transects and quadrats.

5. Soil analysis: Soil grading, Soil moisture, water holding capacity, porosity, pH and bulk density.

6. Estimation of organic carbon, sulphate, phosphate, nitrogen, calcium, sodium, potassium.

7. Water analysis: Salinity, alkalinity, Hardness, Chlorine demand, Residual Chlorine.

8. Determination of dissolved oxygen and CO2 in different water samples.

9. Determination of primary production as GPP and NPP by light and dark bottle technique and its importance in biodiversity conservation.

10. Determination of biomass accumulation CO2 sequestration and tree cover.

11. Determine the required size of the quadrant to the study the vegetation by species area curve method.

12. Analyzethe vegetation by line transect method(Quadrat method)

13. Analyze the vegetation by belt transect method (Quadrat method)

14. Forest biomass calculation by allometric method.

15. Determination of carbon stock of woody plant species.
16. Field survey in University campus for studying plant biodiversity.
17. Ex-situ conservation of plant species using in-vitro technique.
18. Floristic regions of world – India and Karnataka.
19. Study of endemic plants of India.
20. Origin, acclimatization and distribution of Coffee, Cardamom, Sugarcane, Cashew, Ragi, Maize, Wheat, Rice and Cotton.
21. Field work/ Study tour.

Suggested Readings:

Cain, S. A. (1944). Foundations of plant geography.

Croizat, L. (1952). Manual of phytogeography.

Edgar, A. (1972). Plants, man and life.

Good, R. D. (1974). Geography of the flowering plants.

Harold, W., & Hocker, Jr. (1979). Introduction to forest biology. John Wiley and Sons, Toronto.

Hunter, M. L., Jr. (1999). Maintaining biodiversity in forest ecosystems. Cambridge University Press.

James, H. B. (1998). Biogeography.

Kormondy, E. J. (1996). Concepts of ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.

Ludwig, J. A., & Reynolds, J. F. (1988). Statistical ecology. Wiley, New York.

Narasaiah, M. L. (2005). Biodiversity and sustainable development. Discovery Publishing House, New Delhi.

Odum, E. P. (1971). Fundamentals of ecology. Saunders, Philadelphia.

Odum, E. P. (1983). Basic ecology. Saunders, Philadelphia.

Peter, D. S. (1992). Introductory ecology. Prentice Hall, Englewood Cliffs, NJ.

Polunin, N. (1961). Introduction to plant geography.

Robert, S. B., Ronald, A., Gecsey, D. S. G., & Sayler, G. (1988). Technique in microbial ecology. Oxford University Press, New York.

Sinha, R. K. (2008). Biodiversity: Global concerns. Commonwealth Publishers, New Delhi.

Smith, R. L. (1990, 1996). Ecology and field biology. Harper Collins, New York.

Tandon, P., Abrol, Y. P., &Kumaria, S. (2007). Biodiversity and its significance. I. K. International, New Delhi.

Tewari, D. N. (1995). Western Ghats ecosystem. International Book Distributor, Dehra Dun.

Thorogood, C. (2024). Pathless forest: The quest to save the world's largest flowers. Allen Lane.

Valentine, D. H. (1972). Taxonomy, phytogeography & evolution.

BOH552 **Plant Biotechnology**

Total Teaching hours: 64

Learning objectives:
Learning plant biotechnology enables students to understand genetic manipulation techniques for improving plant traits. It helps them develop skills in applying molecular biology methods in plant research. This knowledge supports innovations in crop improvement, disease management, and sustainable agriculture.

Course outcome:
The course in plant biotechnology equips students with the ability to apply genetic engineering techniques for plant improvement. Students gain practical skills in molecular markers and genome mapping. This prepares them for careers in research, agriculture, and biotechnology industries.

Unit I **12 Hrs.**

Introduction to biotechnology, types, scope of biotechnology, recent developments in biotechnology.

Laboratory organization, basic principles of cell and tissue culture. Culture media: types and composition of media, preparation, sterilization,Role of macronutrients, micronutrients, organic nutrients, growth regulators and gelling agents, undefined supplements, different carbon sources used in tissue culture media. Micropropagation of Plants; Plasticity and totipotency. Explant selection, induction of callus, meristem culture, embryo culture, applications and limitations.

Unit 1I **13 Hrs.**

Cell suspension culture: Isolation of cells, types, synchronization, assessment of growth and viability; techniques and factors affecting single cell culture;Haploids and triploids production techniques. Protoplasts isolation, culture techniques, fusion, selection, characterization of somatic hybrids, cybrids. Applications and limitations of somatic hybridization. Root cultures, Shoot tip and Meristem culture. Embryo culture, Microspore culture. Plant regeneration-Somatic embryogenesis, Organogenesis. Applications of plant tissue culture. Synthetic seeds and their applications.

Unit III **13 Hrs.**

Principles and Methodology of genetic engineering; Isolation and characterization of Genomic DNA. Gel electrophoresis – agarose, polyacrylamide, Blotting techniques – Southern, northern and western; dot blot technique, autoradiography, PCR, (qPCR and RT PCR). Transformation techniques. Gene cloning: Vectors(cloning, shuttle and expression), DNA modifying enzymes, isolation of gene of interest, molecular cloning, identification of cloned genes, chain termination DNA sequencing. Morphological markers, biochemical markers and molecular markers (RFLP, RAPD, AFLP, SSR, SPAR, STMs, SCARs and CAPS), marker assisted selection. Fluorescent *in situ* hybridization. Gene testing using transformation and complementation test. Applications of genetic engineering; transgenic plants and microbes and their applications. Germplasm Storage: Plant germplasm storage by Cryopreservation, Advantages of cryopreservation. Molecular maps of Plant genomes: Plant genome sequencing and data utilization. RFLP Genetic maps in plants for conservation.

Unit IV **13 Hrs.**

Biofertilizers: Preparation and applications of biofertilizers such as *Rhizobium*, *Azotobacter*, *Azospirillium*, Blue Green Algae, VAM and *Azolla*. Single Cell proteins (SCP): Health benefits and advantages of single cell proteins- *Spirulina*, *Chlorella*, *Scenedesmus*; Yeast as SCP. Mycoproteins. Biofuels: Bio-fuels production; Ethanol, Biogas, Hydrogen and their applications. Biofuel production from plants. Healthcare Products from Plants: Anticancer agents from higher Plants. Pharmaceuticals from Fungi. Plant Secondary metabolites and their pharmaceutical applications. Plant vaccines.

Unit V **13 Hrs.**

Biological waste treatment and reuse of wastes: Waste treatment, Steps, Reuse of wastes; Conversion of wastes in biogas; Ethanol and compost. Seaweeds and Marine biotechnology: Exploring seaweeds for food, fodder, pharmaceuticals and therapeutic agents. Bioremediation: Cleaning environment; In-situ bioremediation. Phytoremediation. Biodegradation: Xenobiotics; Biodegrading agents; Treatment of Toxic pollutants, Advantages of Biodegradation. Biotechnology of medicinal and aromatic plants: Cultivation and exploitation of medicinal and aromatic plants for human welfare.

BOP555 **Plant Biotechnology Practical–17**

Total Teaching hours: 64

Course outcome:

Upon completing the Plant Biotechnology Practical**,** students will gain hands-on experience in essential laboratory techniques such as tissue culture, DNA isolation, and PCR. The course enhances students' ability to apply experimental approaches for solving biological problems. It also fosters critical thinking, data interpretation skills, and provides a strong foundation for research or advanced studies in plant biotechnology.

1. Biotechnology lab design organization, sterilization techniques, nutrition medium.
2. Preparation of culture media.
3. Micropropagation of Plants through shoot tip culture and anther culture.
4. Callus induction, organogenesis – shooting, rooting, hardening from different explant sources.
5. Embryo culture.
6. Laboratory scale production of wine.
7. Hemocytometer cell counting- percent cell viability in suspension.
8. Industrial production of ethanol from sugar and its estimation alcohol meter.
9. Preparation of biofertilizers such as Rhizobium and seed testing.
10. Single cell protein production-Shake flask culture- Spirulina and Chlamydomonas and its quantification by Lowry's method.
11. Biogas production from waste from anaerobic digester.
12. Detection of secondary metabolites in callus.
13. Study of DNA integrity of *Allium cepa* root cells under the influence of xenobiotics.
14. Isolation of starch and its morphological characterization using SEM.
15. Isolation of pectin and its confirmation using FT–IR.
16. Preparation of Synthetic seeds
17. Isolation and separation of nucleic acid.

Suggested Readings:

Adrian Slater, Nigel Scott and Mark Flower (2000). Plant Biotechnology -The Genetic Manipulation of Plants, Oxford University Press.

Bhojwani S. S. and Razdan M. K. 2004. Plant Tissue Culture: Theory and practice. Elsevier Science Publishers, New York, USA.

Chawla H. S. 2009. Plant Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.

Chrispeels M. J. and Sadava D. E. 1994. Plants, Genes and Agriculture, Jones and Bartlett Publishers, Boston, USA.

Collins H. A. and Edwards S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.

Das H. K. (2004). Text Book of Biotechnology: (ed). Wiley India Pvt. Ltd., New Delhi.

Draperet J. *et al.*, (1988). Plant Genetic Transformation and Gene Expression: Blackwell Scientific Publications, Oxford.

Evans D. E., Coleman J. O. D. and Kearns A. 2008. Plant cell culture. Bio Scientific Publ. London

Giri C. C. and Giri A. 2007. Plant Biotechnology Practical Manual, I K International Publishing House Pvt Ltd.

Hammond J. H., McgarveyP.and Yusibov V.(eds)(2000). Plant Biotechnology: Springer Verlag, Heidelberg.

Khanna V. K. 2003. Plant Tissue Culture Practicals, Kalyani, 2nd Ed, U.P.

Mount D. (2004). Sequence and Genome Analysis: Cold Spring Harbor Laboratory Press, New York. 2004

PUROHIT S. D. 2012. Introduction To Plant Cell Tissue and Organ Culture PHI Learning Pvt. Ltd., New Delhi.

Roberta H. Smith, 2012. Plant Tissue Culture: Techniques and Experiments, 3 edition. Academic Press; US.

Slater N. Scott and Fowler M. (2003). Plant Biotechnology: The genetic manipulation of plants. Oxford University Press, Oxford.

25BOS556 **COMPUTATIONAL BIOLOGY, BIOINFORMATICS, ARTIFICIAL INTELLIGENCE(AI) AND BIOSTATISTICS**

Total Teaching Hours:48

Learning objectives:

The course on Computational Biology, Bioinformatics, Artificial Intelligence, and Biostatistics aims to equip students with the skills to analyze and interpret complex biological data using computational tools and statistical methods. Students will learn to apply bioinformatics techniques for sequence analysis, genome annotation, and data mining. The course also introduces artificial intelligence approaches, such as machine learning, to solve biological problems and enhance predictive modeling. Overall, students will develop a strong foundation in integrating computational and statistical methods to advance research in biology and biotechnology.

Course outcome:

Upon completing the course on Computational Biology, Bioinformatics, Artificial Intelligence, and Biostatistics, students will be able to utilize computational tools and statistical techniques to analyze and interpret biological datasets effectively. They will demonstrate proficiency in applying bioinformatics methods for genome analysis, protein structure prediction, and data visualization. Students will also be capable of employing artificial intelligence and machine learning algorithms to address complex biological questions and improve predictive accuracy. This course prepares students for advanced research and careers that require integration of computational and quantitative approaches in life sciences.

Unit I **09 Hrs.**

Overview of computational Biology: History, Definition, applications-Research trajectory. Database alignment-Overview of BLAST suits of programs-Computational approach –Statistical significance. Pairwise alignment-concept of homology-scoring models, with gaps and affine gaps-global (Needleman and Wunsch) and local alignment (Smith-waterman) algorithms, -PAM and BLOSUM scoring matrices, dot plot and its relevance.

Unit II **09 Hrs.**

Sequence analysis- Compositions, codon usage analysis, pattern finding, alignment, motifs analysis. Remote sensing and its applications in forest resource management Land use land cover mapping (LULC), Normalized difference vegetative index (NDVI), vegetation mapping and change detection, wild life habitat assessment. GIS for the collection storage and spatial analysis of geo referenced forest resources data and information for the development of information/decision support systems for forest management.

Unit III **10 hrs.**

Definition of concept of Bioinformatics-biological data, databases and sources-Database searching using Boolean operators. Amino acid sequence analysis-Secondary structure

prediction method-Protein Structure-Basis of homology modelling.RNA sequence and structure analysis: IncRNA, mRNA, SiRNA. Phylogenetics tree construction.Genome/Transcriptome data –high throughput sequencing (NGS Platform)-Assembly and mapping of reads, annotation with functional features and Visualization of data-Practice use of script for NGS data analysis.Molecular Docking, Protein-ligand and protein-protein interactions. Online tools,Data generations and analysis.

Unit IV **10 Hrs.**

Foundations of AI in Plant Sciences, Basics of AI: Machine Learning, Deep Learning, Computer Vision. Tools: Tensor Flow, Scikit-learn, Open CV, NLP in botany. AI for Plant Identification &Taxonomy. Image-based recognition (e.g., Plant Net, Leaf Snap).Neural networks for species classification. AI in Plant Health & Physiology: Disease/stress detection via computer vision, Remote sensing & phenol typing using ML. AI in Agriculture & Crop Management: Precision agriculture & yield prediction. Smart irrigation, nutrient modeling. AI in Ecological and Genetic Data Analysis: Large dataset handling & pattern recognition. Predictive modeling for biodiversity & climate. Case Studies & Applications: AI in herbarium digitization Invasive species tracking. Greenhouse automation.

Unit V **10 Hrs.**

Definition of Statistics, its usages.Tabulation and graphical representation of data; Histogram, frequency polygon, pie diagram. Construction of frequency tables. Frequency graphs and their uses. Measures of Central tendency mean, median and mode. Measures of dispersion standard deviation, normal distribution, binomial, Poisson, probability. Coefficient of variation. Population versus sample Need and objectives of sampling. Methods of simple random sampling, stratified sampling, cluster sampling and sub sampling and their application in field research. Non-parametric tests Sign test, Wilcoxon test, Mann-Whitney test, Kruskel and Wallies test. Statistical inference-need and meaning in biological research. Normal, t, Chi-square and F-test. Basic introduction to Multivariate statistics.

Suggested Readings:

The machine learning approach by Pierre Baldi, Søren Brunak. MIT Press.2001

Wunschiers R. (2013). Computational biology: A practical introduction to BioData processing and analysis with Linux, MySQL, and R. Springer.

Remote Sensing and its Application: Reference Books

Reddy A. M. 2014. Text book of remote sensing and geographic information system, 4th edition, BS publication, Hyderabad.

Remote sensing and image interpretation 7th edition by Ralph W. Kiefer and Thomas Lillesand.

Baljeeth Singh (2023). Genome editing for Crop improvement. Nova science publishers.

"Genome Editing: Current Technology Advances and Applications by Springer

"Genome Editing Tools in Plants" (NIH)

"CRISPR/Cas9 Technology and Its Utility for Crop Improvement" (NIH):

"The CRISPR/Cas Genome-Editing Tool: Application in Improvement of Crops" (Frontiers): by Dr. S. H. J. Wang

"Genome-edited crops for improved food security of smallholder farmers" (Nature):

"Application of CRISPR/Cas9 in Crop Quality Improvement" (NIH):

"CRISPR/Cas9 in plant biotechnology: applications and challenges.

Bioinformatics-Reference Book

Teresa K. Attwood, and David J. Parry-Smith (1999). Introduction to Bioinformatics, Pearson Education.

Artificial Intelligence: Reference Books

Mario Cananataro*et al.*,(2022). Artificial Intelligence in Bioinformatics. Pub: Elsevier Inc.

Marco Antonio A. F. (2019). Artificial intelligence: Applications in Medicine and Biology. Pub.: IntechOpen.(Still more books are exploring from all sources)

Pradeep Kumar, Rani Gulati, Ritu Bhatia. (2022).Plant disease diagnosis using bioinformatics and artificial intelligence. Pub: Springer Nature.

Chetan W Patil. (2021). Artificial Intelligence in Agriculture: Principles and Applications. CRC Press

Megh R. Goyal, R.P. Singh. (2020). Artificial intelligence for Sustainable agriculture: Emerging Research and Opportunities. Apple Academic Press.

Biostatistics- Reference Books

Das N. G. (2009). Statistical Methods (Volume 1 and 2) (1st Ed.), Tata McGraw-Hill.

2. Bernard Rosner and Thomson Brooks (2003). Fundamentals of Biostatistics (6th Ed.), Satellite data collection.

25BOS557 **Seed Technology**

Total Teaching Hours:48

Course Outcome:

The course covers fundamental concepts related to seed structure and germination, providing students with a strong foundation in seed science. It introduces methods of seed quality assessment and seed health testing, enabling students to evaluate the viability and integrity of seeds effectively. Practical applications of various seed processing methods are included, equipping students with the skills needed to handle and process seeds efficiently. Additionally, the course familiarizes students with seed certification, production, and marketing procedures, highlighting the essential requirements for successful seed production. This comprehensive knowledge prepares students for employment opportunities in seed production companies. Furthermore, with the skills acquired, students can also establish their own seed production units, thereby contributing to self-employment and job creation in the agricultural sector.

Unit I **09Hrs.**

Significance of Seed Technology Seed germination: Structure of monocot and dicot seeds; factors affecting germination; Seed dormancy- types, 50 significance, mechanism, endogenous and exogenous factors regulating dormancy, Orthodox and recalcitrant seed

Unit II **10 Hrs.**

Seed processing: seed drying – methods, types of driers, seed cleaning and upgrading- equipment and their functions; functions of scalper, debearder, scarifier, huller, seed cleaner and grader. Screen cleaners, specific gravity separator, indented cylinder, velvet-spiral-disc separators. Seed treatments- methods of seed treatment, seed treating formulations and equipment, seed disinfestations, identification of treated seeds. Seed Packaging and labelling,

Unit III **10 Hrs.**

Seed quality and health Testing: Implications of seed health testing, ISTA and its role in seed testing. seed sampling, purity analysis, moisture determination, viability, vigour, incubation tests, bioassays and biochemical procedures, factors affecting incubation test results

Unit IV **10Hrs.**

Seed certification- objectives of seed certification; seed certification agency/organization and staff requirement; quarantine regulations- import and export, Field Inspection- principles, phasesand procedures; reporting and evaluation of observations; pre and post-harvest control tests for genetic purity evaluation (grow-out tests), seed inspection, seed legislation- Seed Act, Seed Rules, seed law enforcement, seed quality regulation in India.

Unit V **09 Hrs.**

Seed production and Marketing: Management of seed production: general principles of seed production, location of seed production, cropping, selection of cultivars, cultural practices,

Longevity and storage of seeds, impact of storage fungi on seeds, transgenic seeds, hybrid seeds. Seed marketing management.

Suggested Readings

Agarwal, R. L. (1997). *Seed technology*. Oxford & IBH Publishing.

Agrawal, P. K., & Dadlani, M. (1992). *Techniques in seed science and technology* (2nd ed.). South Asian Publishers.

Agrawal, P. K. (Ed.). (1993). *Handbook of seed testing*. Ministry of Agriculture, Government of India.

Agarwal, P. K. (2015). *Principles of seed technology*. Indian Council of Agricultural Research.

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