Progressive Education Society's

Modern College of Arts, Science and Commerce (Autonomous),

Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus

For

M.Sc. Botany

(Based on NEP 2020 framework)

(To be implemented from the Academic Year 2023-24)

Semester 1 (First Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4+4+2)	23ScBotP111	Major Paper 1 (Theory)	Cryptogamic Botany I	4	4	50	50	100

	23ScBotP112	Major Paper 2 (Theory)	Cell Biology and Evolution	4	4	50	50	100
	23ScBotP113	Major Paper 3 (Practical)	Lab Course on 23ScBotP111	8	4	50	50	100
	23ScBotP114	Major Paper 4 (Practical/)	Lab Course on 23ScBotP112	4	2	25	25	50
Major Electives (4)	23ScBotP121	Major Elective 1 (T)	Plant Metabolism	4	4	50	50	100
	23ScBotP122	Major Elective 2 (T)	Botanical Techniques	4				
RM (4)	23ScBotP131	RM Section 1	Research Methodology Basics and Research in Plant Tissue Culture Techniques	2	4	50	50	100
		RM Section 2		2				
OJT(4),		–	–	–	–	–	–	–
Total				28	22	275	275	550

Semester 2 (First Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4+4+2)	23ScBotP211	Major Paper 1 (Theory)	Cryptogamic Botany II	4	4	50	50	100
	23ScBotP212	Major Paper 2 (Theory)	Biochemistry	4	4	50	50	100
	23ScBotP213	Major Paper 3 (Practical)	Lab Course on 23ScBotP211	8	4	50	50	100
	23ScBotP214	Major Paper 4 (Practical)	Lab Course on 23ScBotP212	4	2	25	25	50
Major Electives (4)	23ScBotP221	Major Elective 1 (T)	BreedingGenetics and Plant	4	4	50	50	100
	23ScBotP222	Major Elective 2 (T)	Molecular Biology	4				
RM (4)		–	–	–	–	–	–	–
		–	–	–				
OJT(4),	23ScBotP241	OJT	On Job Training	8	4	50	50	100
Total				32	22	275	275	550

Semester 3 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours/ Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4+4+2)	23ScBotP311	Major Paper 1 (Theory)	Spermatophytic Botany	4	4	50	50	100
	23ScBotP312	Major Paper 2 (Theory)	Plant Ecology and Phytogeography	4	4	50	50	100
	23ScBotP313	Major Paper 3 (Practical)	Lab Course on 23ScBotP311	8	4	50	50	100
	23ScBotP314	Major Paper 4 (Practical)	Lab Course on 23ScBotP312	4	2	25	25	50
Major Electives (4)	23ScBotP321	Major Elective 1 (T)	Developmental Botany	4	4	50	50	100
	23ScBotP322	Major Elective 2 (T)	Genetic Engineering	4				
RP (4)	23ScBotP352	RP	Research Project I	8	4	50	50	100
OJT(4),								
Total				32	22	275	275	550

Semester 4 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory (4 + 4+4)	23ScBotP411	Major Paper 1 (Theory)	Computational Botany	4	4	50	50	100
	23ScBotP412	Major Paper 2 (Theory)	Industrial Botany	4	4	50	50	100
	23ScBotP413	Major Paper 3 (Practical)	Lab Course on 23ScBotP411	8	4	50	50	100
Major Electives (4)	23ScBotP421	Major Elective 1 (Theory)	Plant Biotechnology	4	4	50	50	100
	23ScBotP422	Major Elective 2 (Theory)	Plant Pathology and Plant Protection	4				

RP (4)	23ScBotP452	RP	Research Project II	12	6	75	75	150
OJT(4),								
Total				32	22	275	275	550

OJT : On Job Training: Internship/Apprenticeship
FP : Field Project
RM: Research Methodology
RP: Research Project

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBotP311 Course Name: Spermatophytic Botany

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of classification of Angiosperms

Course Objectives:

- To study general characteristics of each group with one example each
- To learn evolutionary relationship between the taxa
- To be expertise in field work

Course Outcome:

On completion of the course, student will be able to– •
Identify and classify the biological specimens in nature

- Collect, preserve and have his own start up
- Study of at least 20 locally available families of flowering plants.
- Identification of genus and species of locally available wild plants.
- Identify plants belongings to families studied.
- Preparation of botanical keys at generic level by locating key characters.
- Knowledge of at least 10 medicinal plant species.
- Knowledge of secondary metabolites and its use in taxonomy.

Course Content

Chapter 1	**Systematics and Classification of Angiosperms**	**4 Lectures**

	1.1 Systematics: A key science, importance, taxonomic structure, taxonomic hierarchy, the species concept, categories and ranks, alpha and omega taxonomy, taxonomy as synthetic discipline.	
Chapter 2	**ICBN**	**5 Lectures**
	2.1 International Code of Botanical Nomenclature: Salient features-principles, important rules and recommendations, provisions for the governance of the code, appendices.	
Chapter 3	**Systems of Classification**	**6 Lectures**
	3.1 Systems of Angiosperm classification: Brief history of pre-Darwinian andpost-Darwinian	
	classification systems, cladestics in taxonomy angiosperm phylogeny group (APG). 3.2 Recent Systems of Classifications: By ArmenL.Takhtajan, AuthurCronquist.	
Chapter 4	**Cronquist`s System**	**10 Lectures**
	4.1 Basic, outline and special features of Cronquist`s system of classification (1998) of flowering plants. 4.2 Salient features of the following subclasses of Magnoliopsida – Magnoliidae, Hamamelidae, Caryophyllidae - Patterns of Relationship within each group. 4.3 Salient features of the following subclasses of Liliopsida, Alismatidae, Commelinidae, Zingiberidae, and Liliidae – Patterns of Relationship within each group.	
Chapter 5	**Phytogeography**	**5 Lectures**
	5.1 Phytogeography: Phytogeographic regions of India, endemism, hotspots and hottest hotspots. Endemism in Western Ghats, plant explorations, invasions and introductions.	
Chapter 6	**Modern Trends In Taxonomy**	**8 Lectures**
	6.1 Synthetic approach to the systematic of angiosperm - Role of Palynology, Embryology, Phytochemistry, Micromorphology, Anatomy in Taxonomy.	
Chapter 7	**Botanical Gardens and Herbaria**	**4 Lectures**
	7.1 Botanical gardens and Herbaria as resource institutes for systematic.	
Chapter 8	**Numerical Taxonomy**	**3 Lectures**
	8.1 Nomenclature and Numerical Taxonomy. 8.2 Application, merits and demerits of numerical taxonomy.	
Chapter 9	**Some Aspects Of Bee – Botany**	**14 Lectures**

	9.1 Interdependence between bees and plants. 9.2 Social organization of a bee colony. 9.3 Foraging behavior of bees in relation to their food plants. a. Foraging for nectars. b. Foraging for pollen grains. 9.4 Physico-Chemical properties of unifloral and multifloral honeys. 9.5 Honeys from poisonous plants. 9.6 Bees as crop pollinators 9.7 Application of Botany to Apiculture	
Chapter 10	**Discussion/guidance of experiential learning through field work**	**1 Lecture**

References:

1. **V N Naik 1984.** Taxonomy of Angiosperms. TATA McGraw Hill Publishing Company Limited New Delhi.
2. **Cronquist, A. 1968.** The Evolution and Classification of Flowering Plants. Thomas Nel and Sons, Ltd. London.
3. **Pande B.P 1997.** Taxonomy of Angiosperms. S.Chand.
4. **Singh V. and D.K Jain, 1981.** Taxonomy of Angiosperms. Rastogi Publication, Meerut.
5. **Swingle D.B. 1946.** A Text book of Systematic Botany. McGraw Hill Book Co. New York.
6. **Santapau H. 1953.** The Flora of Khandala on the Western Ghats of India.
7. **Cliford H.T and W. Stephenson. 1975.** An Introduction to Numerical Taxonomy. Academic Press, N.Y.
9. **Cole A.J (Ed.) 1969.** Numerical Taxonomy. Academic Press,N.Y.

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP312 Course Name: Plant Ecology & Phytogeography

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of plant ecology and phytogeography.

Course Objectives:

- To study general characteristics of each group with one example each
- To learn evolutionary relationship between the taxa
- To be expertise in field work

Course Outcome:

On completion of the course, student will be able to–

- Identify and classify the biological specimens in nature
- Collect, preserve and have his own start up
- The students will understand the basic concepts of general ecology and phytogeography.
- Learn about the analyse and basic principles of ecology.
- Understand the importance of ecology and conservation.
- The students will understand the use of the plant resources to produce valuable products.
- Locate different phytogeographical regions of the world and India and can analyze their floristic wealth.
- Evaluate the ecological, ethnic and economic value of different tracheophytes and summarize their goods and services for human welfare.

Course Content

Chapter 1	**The Environment**	**3 Lectures**
	1.1 Physical environment; biotic environment; biotic and abiotic interactions.	
Chapter 2	**Habitat and Niche**	**5 Lectures**
	2.1 Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.	
Chapter 3	**Population Ecology**	**7 Lectures**
	3.1 Characteristics of a population; population growth curves; population regulation. 3.2 Life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.	
Chapter 4	**Species Interactions**	**7 Lectures**
	4.1Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. 4.2 Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.	
Chapter 5	**Ecosystem Ecology**	**8 Lectures**

	5.1 Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); 5.2 primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).	
Chapter 6	**Biogeography**	**6 Lectures**
	6.1 Major terrestrial biomes; 6.2 Theory of island biogeography; biogeographical zones of India.	
Chapter 7	**Ecology**	**9 Lectures**
	7.1 Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. 7.2 Conservation Biology: Principles of conservation,	
	major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).	
Chapter 8	**Phytogeography**	**6 Lectures**
	8.1Introduction, major plant communities of world, phytogeographic regions of world (vegetation of belts), soil, climate, flora and vegetation of India, floristic (Botanical) regions of India. 8.2Biomes: Classification and components.	
Chapter 9	**Habitat Ecology**	**3 Lectures**
	9.1 Habitat ecology: Fresh water, Marine water, Estuarine ecology, Terrestrial ecology, Dessert ecology.	
Chapter 10	**Endemism**	**3 Lectures**
	10.1 Endemism and EIA 10.2 Succession a. Types; mechanisms; changes involved in succession; b. concept of climax.	
Chapter 11	**Discussion/guidance of experiential learning through field work**	**2 Lectures**

References:

1. **Ambhast, R. S. (1998).** A Text Book of Plant Ecology, 9th edition, Friend and Co.
2. **Barbour, M. G., Pits, W. D. and Burk, J. H. (1967).** Terrestrial Plant Ecology,

Addison-Wesley Publisher.

3. **Begon, M., Townsend, C. R., Harper, J. L. (2005).** Ecology: From Individuals to Ecosystems, 4th edition, Wiley Blackwell.
4. **Canter, L. (1996).** Environmental Impact Assessment, 2nd edition, McGraw Hill Publishing Company.
5. **Coleman, D. C., Crossley, D. A., Handrix, P. F. (2004)**. Fundamentals of Soil Ecology, 2nd edition, Elsevier academic press.
6. **Coller, B. D., Cox, G. W. and Miller, P. C. (1973).** Dynamic Ecology, PrenticeHall, Inc. Englewood Cliffs, New Jersey.
7. **Crawley, M., Crawley, J. And Crawley, M. (1997).** Plant Ecology, 2nd edition,Wiley Blackwell.
8. **De, A. K. (1994)**. Environmental Chemistry, Wiley Eastern publication.
9. **Gurevitch, J., Scheiner, S. M., Fox, G. A. (2006).** The Ecology of Plants, Sinauer Associates.
10. **Hynes, H. B. N. (1978).** Biology of Polluted Water, 1st edition, Liverpool University Press.
11. **Mishra, R. (1968).** The Ecology of Work Book, Oxford and IBH Pub. Co. Kolkata.
12. **Mukherjee, B. (1996).** Environmental Biology, 1st edition, Tata McGraw Hill.
13. **Mukherjee, B. (2000).** Environmental Management: Basic and Applied Aspects of Management of Ecological Environmental System, 1st edition, Vikas Publication.
14. **Odum E. P. (2007).** Fundamentals of Ecology, 5th edition, Thomson Books.
15. **Yadav, P. R. and Mishra, S. R. (2004).** Environmental Biology, Discovery Publication, New Delhi.

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP313 **Course Name: Lab Course on 23ScBotP311**

Teaching Scheme: TH: 8 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Lab Course on 23ScBotP311 (Spermatophytic Botany) (24 Practical's)

1. Study of plant families (at least 20 locally available families, 14 of Dicotyledons & 06 of Monocotyledons). 10 P

2. Identification of genus and species of locally available wild plants (Any08). 04P

3. Preparation of vegetative & reproductive botanical keys of any six plants from different families. 04P

4. Study of endemic, endangered and rare plants in Western Ghats (Any 02 from each category) . 01P

5. Study of unifloral and multifloral honeys. 02P

6. Visit and report preparation of any one local botanical garden and Herbarium. 01P

7. Field trips of at least two days for collection and preparation of field notes and its submission. 02 P

Note: Submission of report of at least 50 plant species from medicinal plants, endemic plants and exotic weeds from local areas.

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP314 Course Name: Lab course on 23ScBotP312

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 02**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Lab Course based on 23**Sc**BotP312 - **Plant Ecology and Phytogeography (12 Practicals)**

1. Allelopathic analysis of the plants 2P

2. Determination of frequency, density, abundance, dominance, IVI and richness of the species among the plant communities 2P

3. Interpretation of satellite imageries and aerial photographs with respective major vegetation/ landforms/ land use patterns etc. 1P

4. Physicochemical analysis of soil (Colour, Texture, Water holding capacity, N, P, K, Mg, Ca, Organic carbon) and water (pH, Turbidity, EC, TDS, Total solids, Hardness, Cl) 3P

5. Biological analysis of water samples (clean and polluted): Phytoplankton, DO, CO_2, BOD and COD 2P

6. Comparison of stomata index, chlorophyll contents and pollution fertility of the plants from polluted and non-polluted area 2P

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020) Course Code :23ScBOTP321 Course Name: Developmental Botany

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite:

- A student should have a basic knowledge of Plant development process.

Course Objectives:

- To understand the process of plant growth
- To study the embryological aspects of plant development

Course Outcome:

On completion of the course, student will be able to–

- Understand the vegetative and reproductive development
- gain knowledge to the new concepts of plant development
- Know about plants anatomical structure, their developmental patterns.

- Plant reproductive parts development of male, female gametophytes and fruits.
- Vascular tissues and its constituents by sections and maceration, wood anatomy, TS, TLS and RLS Mechanical tissues(Collenchyma, Sclerenchyma, Stone cells and Xylem)
- Secretary tissues (Mucilage Canals, resin canals, Nectraies, and oil glands), laticifers(Latex cells and Vessels)
- Normal and abnormal secondary growth etc.
- Understand the importance of developmental botany.

Course Content

Chapter 1	**Plant Development**	**1 Lectures**
	1.1 Concept, definitions and unique features.	
Chapter 2	**Processes of Plant Development**	**6 Lectures**
	2.1 Cell growth, division and differentiation 2.2 Competence, determination, commitment, specification 2.3 Differentiation, redifferentiation and dedifferentiation 2.4 Polarity and symmetry,cell-cell interaction 2.5 Juvenility and transition to adult phase 2.6 Programmed cell death, aging and senescence	
Chapter 3	**Factors for development**	**2Lectures**
	3.1 Intrinsic and extrinsic	
Chapter 4	**Vegetative development**	**2 Lectures**
	4.1 Meristem types and activities of meristem, organization of shoot and root apical meristems 4.2 Leaf development, development of stomata	
Chapter 5	**Phenomenon of development**	**4 Lectures**
	5.1 Organ development, primordium to organ, juvenility – characteristics, transition to adult phase. Coordinated development	
Chapter 6	**Transition from vegetative phase to reproductive phase**	**2Lectures**

	6.1 Morphological and histochemical changes in shoot apex, 6.2Floral meristems and floral development	
Chapter 7	**Development of gametophyte**	**4 Lectures**
	7.1 Development of stamen, anther, sporogenous tissue, tapetum, microsporogenesis, pollen and male gametophyte 7.2 Development of carpel, ovule, placenta, sporogenous tissue, integuments, megasporogenesis, female gametophyte.	
Chapter 8	**Ferlilisation**	**3 Lectures**
	8.1 Interaction between pollen and pistil, pollen tube entry, 8.2.Double fertilization and triple fusion, role of synergids, endosperm development.	
Chapter 9	**Embryo Development**	**3 Lectures**

	9.1 Development of embryo in dicots and monocot 9.2 Unclassified or abnormal embryos, unorganized or reduced embryo	
Chapter 10	**Polyembryony**	**3 Lectures**
	10.1 Concept and classification of polyembryony 10.2Special cases and causes of polyembryony 10.3 Apomixis- concept, categories- agamospermy and vegetative reproduction apospory, parthenogenesis	
Chapter 11	**Light mediated regulation**	**7 Lectures**
	11.1 Light mediated regulation 11.1.1Photoreceptors- phytochromes, cryptochromes, phototropins. 11.1.2 Signal transduction leading to photomorphogenesis and photoperiodic responses. 11.1.3 Circadian rhythms	
Chapter 12	**Floral Induction and Development**	**8Lectures**

	12.1 Photoperiodism and its significance 12.2 Vernalisation and hormonal control 12.3Inflorescence and floral determination. 12.4 Molecular genetics of floral development and floral organ differentiation	
Chapter 13	**Molecular basis of plant development**	**5 Lectures**
	13.1Embryogenesis and seedling development, 13.2 Root, shoot and leaf development, gene expression during transition to flowering and flower development 13.3 Molecular genetics of gametophytes development, expression of cell incompatibility.	
Chapter 14	**Hormonal regulation**	**5 Lectures**
	14.1 Perception, signaling and regulation of gene expression by hormones – 14.1.1Hormone receptors, mutants in hormone signaling, transcription factors involved in hormone signaling. 14.1.2Role of hormones in germination, growth and flowering. Cross-talk between hormone signaling pathways	
Chapter 15	**Hormonal control of seed development**	**4 Lectures**
	15.1Hormonal control of seed development; 15.2 Seed maturation and dormancy; 15.3Hormonal control of seed germination and seedling growth; 15.4 Mobilization of food reserves during seed germination	
Chapter 16	**Discussion/guidance on experiential learning through field work**.	**1 Lectures**

References:

1. Noble P.S. (2009). Physicochemical and Environmental Plant Physiology, 4rth edition, Academic Press, San Diego , USA
2. Salisbury F.B. and Ross C.W. (2009). Plant Physiology, 4rth edition, Australia Cengage Learning.
3. Taiz L and Zeiger E (2014). Plant Physiology, 6th edition, Sinauer Associates, Inc. Publishes, Massachusetts, USA.
4. P.Maheshwari. Embryology of Angiosperms

5. Bhojwani and Bhatnagar. Embryology of Angiosperms.

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020) Course Code :23ScBOTP322 Course Name: Genetic Engineering

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of Genetic Engineering.

Course Objectives:

- To study techniques used in genetic engineering
- To learn its application

Course Outcome:

On completion of the course, student will be able to–

- gain knowledge in techniques used in genetic engineering

Course Content

Chapter 1	**Recombinant DNATechnology**	**7 Lectures**
	1.1 Introduction to recombinant DNA technology. 1.2 Steps involved in construction of recombinant DNA molecule.	
Chapter 2	**Enzymes used in Genetic Engineering**	**3 Lectures**
	2.1 Enzyme used in genetic engineering- • Restriction endonucleases, • Other endonucleases • Exonucleases • Ligases, • Polymerases, • Kinase and • Phosphatase, • DNA methylases, • Topoisomerases • Reverse transcriptase	
Chapter 3	**Vectors in Cloning**	**5 Lectures**

	3.1 Use of vector in cloning • Plasmids, • Phages, • Cosmids, • Phagemids, • BACs and • YACs • Vector for marker-free selection • Shuttle vectors, • Expression vectors 3.2 Screening and selection of recombinants (Plasmids and phages)	
Chapter 4	**Isolation of gene and gene libraries**	**3 Lectures**
	4.1Techniques of DNA isolation and purification 4.2 Genomic DNA library. 4.3 Preparation of cDNA. 4.4 cDNA libraries.	
Chapter 5	**Blotting Methods**	**2 Lectures**
	5.1 Southern 5.2 Northern 5.3 Western 5.4 Dot Blot method	
Chapter 6	**Application of Genetic Engineering**	**4 Lectures**
	6.1 Transgenic plants for insect, fungal, bacteria disease resistance. 6.2 Lignin, modification. 6.3 Abiotic stress tolerance. 6.4 Production of useful products.	
Chapter 7	**Techniques of Genetic Engineering**	**9 Lectures**
	7.1 Principles and methods of Genetic Engineering, 7.2 Gene libraries and cDNA libraries, 7.3 Polymerase chain reaction,	
	7.4 DNA fingerprinting, DNA Synthesis, DNA Sequencing, Southern blotting, RAPD, RFLP, Restriction mapping.	
Chapter 8	**Plant Genetic Engineering**	**6 Lectures**
	8.1 Methods of direct and indirect gene transfer in plants- Agrobacterium, Ti and Ri plasmids.	
Chapter 9	**Gene Transfer Methods**	**5 Lectures**
	9.1 Gene Transfer Methods- direct and indirect gene transfer in plants. 9.2 Factor affecting transformation. 9.3 Screening for transformants. 9.4 Handling transformants in subsequent generation.	

Chapter 10	**Genetic Engineering**	**4 Lectures**
	10.1 Introduction to Genomics, Proteomics and Bioinformatics. 10.2 Genome organisation 10.3 Genome mapping	
Chapter 11	**Molecular Genetics**	**5 Lectures**
	11.1 DNA replication 11.2 DNA repair 11.3 Transcription ,Regulation of transcription 11.4 Genetic code 11.5 Protein synthesis 11.6 Mutation	
Chapter 12	**Discussion/guidance of experiential learning through field work**	**1 Lectures**

References:

1. The Hope, Hype & Reality of Genetic Engineering: Remarkable Stories from Agriculture, Industry, Medicine, and the Environment, John C. Avise
2. Give Genetic Engineering Some Breathing Room. Miller, Henry I.; Kershen, Drew L.

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of computational botany.

Course Objectives:

- To study general characteristics of each group with one example each
- To learn evolutionary relationship between the taxa
- To be expertise in field work

Course Outcome:

On completion of the course, student will be able to–

- Identify and classify the biological specimens in nature
- Collect, preserve and have his own start up
- Learn about the computer and imbibe computer skills for biological data management and graphical presentation.
- The students will know the basic principles of biostatistics and computer applications in biology.
- Be enlightened about the need for computer applications, programs and techniques for biology.
- Develop quantitative skills in order to collect, analyze and interpret experimental data.
- Choose an appropriate sampling scheme and/or experimental design for a given biological question.

Course Content

Chapter 1	**Basic Biostatistics**	**9 Lectures**
	1.1Introduction to Statistics. 1.2 Measures of central tendency – mean, mode, median and their properties.	
	1.3 Measures of dispersion – variance, standard deviation, coefficient of variance. 1.4 Symmetry and skewness, measures of skewness, kurtosis. 1.5 Sampling and sampling distributions – concept of sample and population, statistic, standard error, methods of sampling.	
Chapter 2	**Correlation**	**4 Lectures**

	2.1Bivariate correlation, positive correlation, negative correlation. 2.2 Measures of correlation – Scatter diagram, Karl-Pearson's coefficient of correlation, Spearman's rank correlation coefficient.	
Chapter 3	**Regression**	**2 Lectures**
	3.1 Regression – Equations of regression lines using least square method, 3.2 regression estimate and its standard error.	
Chapter 4	**Experimental Statistics**	**8 Lectures**
	4.1 Design of experiments and analysis of variance. 4.2 Principles of design – randomization, replication, local control, treatment group and control group 4.3 Guidelines for designing the experiments, size of plot, number of replications 4.4 Completely randomized design (CDR), randomized block design (RBD) 4.5 Analysis of variance table (ANOVA), standard error, critical difference for pairs of treatments 4.6 Tukey's test for pairwise comparison of treatments 4.7 Dunnet's test for comparison of treatment means with control 4.8 Duncan's multiple range test Mann–Whitney U test	
Chapter 5	**Testing of hypothesis**	**5 Lectures**
	5.1 Hypothesis, statistical hypothesis, critical region, level of significance, p-value, normal distribution 5.2 T-test: t-test for mean, equality of two means, paired t-test, unpaired t-test, chi-square test: chisquare test for goodness of fit, independence of attributes, non-parametric test.	
Chapter 6	**Bioinformatics**	**5 Lectures**
	6.1 Bioinformatics- Introduction to databases and retrieving information from databases: NCBI, EMBEL etc. 6.2 Molecular tools in protein and nucleotide sequence analysis; origin of new genes and Proteins, gene duplication and divergence.	
Chapter 7	**Sequence similarities**	**10 Lectures**
	7.1 Pair wise comparison of DNA and protein	

	sequences, dynamic programming algorithms, FASTA and BLAST. 7.2 Multiple sequence alignments, progressive methods, iterative methods, localized alignments. 7.3 Determining phylogenetic relationships using DNA and protein sequences. 7.4 Protein structure prediction, motifs and domains.	
Chapter 8	**Biomathematics**	**5 Lectures**
	8.1 Types of measurement and their units. 8.2 Making solutions – moles and molarity, stock solutions and dilutions, making media and reaction mixtures. 8.3 Ions and electrical potentials – Nerst and Goldman equations.	
Chapter 9		**7 Lectures**
	9.1 Osmolarity and osmotic pressure measurements. 9.2 Quantification of chemical reactions – equilibrium constant, reaction rates. 9.3 pH measurements and preparation of buffers. 9.4 Measuring concentrations using spectrophotometry. 9.5 Measurement of enzyme activity. 9.6 Specific activity of radioisotopes, making radioisotope solutions. 9.7 Cell counting using serial dilutions, haemocytometry.	
Chapter 10	**Discussion/guidance of experiential learning through field work**	**1 Lectures**

References:

1. Lab Math – Adams, D.S. I.K. InternationsPvt Ltd. New Delhi, 2004.
2. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989.
3. Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983.
4. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H. , John Wiley, New York, 2001.
5. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003.
6. Bioinformatics – Sequence and genome analysis. D.W. Mount, CBS Publishers, New Delhi, 2003.
7. Bioinformatics and Molecular Evolution – Higgs PG and Attwood, TK

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP412 Course Name: Industrial Botany

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of Industrial Botany.

Course Objectives:

- To study fermentation and algal technology
- To learn biofuel technology

Course Outcome:

On completion of the course, student will be able to– •
gain knowledge about industrial techniques

- understand the scope and application of various techniques

Course Content

Chapter 1	**Introduction to Algal Technology**	**2 Lectures**
	1.1Resource potential of algae . 1.2 Commercial utility of algae- food and feed, pigments, pharmaceuticals and neutraceuticals, fine chemicals, fuel and biofertilizers, seaweeds extracts as biofertilizers. 1.2 Distribution of economically important algae in India.	
Chapter 2	**Algal Products**	**5 Lectures**

	2.1 SCP- Spirulina mass cultivation and its applications. 2.2 Biodiesel from algae. 2.3 Advantages over other sources of biodiesel. 2.4 Cultivation and extraction methods,. 2.5 Liquid seaweed fertilizers – method of preparation and application	

Chapter 3	**Biopesticide Technology**	**8 Lectures**
	3.1Concept and significance of bio-pesticide. 3.2Types of biopesticides and their applications. 3.2.1Herbal- Azadiractine, rotenone and pyrethrins. 3.2.2Insect predators/parasites- Lady bird beetle, Trichrograma 3.3Fungal- Trichoderma, its isolation, mass multiplication and applications 3.4Bacterial- Bacillus thurengenesis 3.5Viral- Nuclear Polyhydrosis Virus (NPV), Helicoverpa Nuclear Polyhydrosis Virus (HNPV).	
Chapter 4	**Biofuel Technology**	**3 Lectures**
	4.1 Environmental implications of fossil fuel. 4.2 Concept of biofuel. 4.3 Alternatives for fossil fuels – ethanol, vegetable oil, biodiesel	
Chapter 5	**Bioethanol Technology**	**5 Lectures**
	5.1 Sources for bioethanol production- sugar crops, starch crops, cellulosic feed stock. 5.2 Bioethanol production- sugar-to-ethanol process, starch-to-ethanol process, cellulose-to ethanol process, bio-ethanol form lignocelluloses, distillation to dehydration process. 5.3 Technology applications of bioethanol, spark ignition engines, compression ignition engines, fuel cells, standardization of bioethanol.	
Chapter 6	**Lipid Derived Biofuels**	**3 Lectures**
	6.1 Sources - oil seed crops, microalgae, animal fats, waste oils. 6.2 Fuel productions- oil extractions, oil refining, transesterification. 6.3 Properties and use of lipid biofuels, economy of lipid biofuels.	
Chapter 7	**Bio-hydrogen and Methanogenesis**	**4 Lectures**
	7.1 Bio-hydrogen- Application and future prospects . 7.2 Methanogenesis from agro industrial residues.	

Chapter 8	**Fermentation Technology**	**5 Lectures**
	8.1 Introduction , History. 8.2 Fermentation process, fermenters- design and construction, basic functions. 8.3 Types of fermenters, operation, aseptic operation and use of computer in fermenters, maintenance, types of fermentation process, batch fermentation, fed-batch fermentation, continuous fermentation, scale up of fermentations. 8.4 Industrial processes- upstream and down-stream processes, strain improvement of microbes .	
Chapter 9	**Alcohol and Beverage Industry**	**2 Lectures**
	9.1Sources and methods of production of alcohol, beer and wine.	
Chapter 10	**Organic Acid Industry**	**1 Lectures**
	10.1 Sources and methods of production of vinegar, and citric acid.	
Chapter 11	**Antibiotic Industry**	**2 Lectures**
	11.1Sources and methods of production of Penicillin, Cephalosporins, and Griseofulvins.	
Chapter 12	**Food Industry**	**5 Lectures**
	12.1SCP - advantages and disadvantages. 12.2Production of yeast biomass. 12.3 Production of mycoproteins, traditional fungal foods (*Shoyu*, Miso, Sake, Tempeh), production of Button mushroom, (*Agaricus*) Paddy straw mushroom (*Volvariella*) and Dhingri mushroom (*Pleurotus*).	
Chapter 13	**Herbal Technology**	**5 Lectures**
	13.1 Introduction, concepts and prospects 13.2 Phyto-technology- value addition to biodiversity through chemo prospection.	
Chapter 14	**Medicinal Plants**	**10 Lectures**
	13.1 Medicinal plants mentioned in Atharva-Veda with their application. 13.2 Medicinal mushrooms for healthy life. 13.3Natural dyes for cotton and silk industry – *Tecomella* leaves, *Katha* and *Ravenchi* wood,Seeds of *Bixa*, *Babul* flowers. 13.4 Medicinal herbs for dying hair and in cosmetics. 13.5 Aromatic plants as important sources of essence.	
Chapter 14	**Discussion/guidance of experiential learning through field work**	**1 Lectures**

References:

1. Biofuel Technologies- Recent Developments, Gupta, Vijay Kumar, Tuohy, Maria G. (Eds) Springer publication .
2. Biofuel technology Handbook, Dominik Rutz, Rainer Janseen, WIP Renewable Energies, Germany.
3. Biopesticides for sustainable agriculture: prospects and constraints, Editor(s): Nutan Kaushik.
4. A Text Book of Microbiology, Dube and Maheshwari.
5. A Text Book of Biotechnology. R C Dube.
6. Insecticide control act 1985 Gazette of India.
7. Fertilizer control act 1985 Gazette of India

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP413 Course Name: Lab course on 23ScBotP411

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Practical based on P401 Computational Botany

Biostatistics (eight practicals) -

1. Measurement of central tendency (mean, mode and median), variance, standard deviation, coefficient of variance and standard error from the given grouped and ungrouped data. 1P 2. Measures of skewness and measures of Kurtosis (grouped and ungrouped data). 1P

3. Determination of regression lines and calculation of correlation coefficient – grouped and ungrouped data.
1P

4. Examples based on t – test
1P

5. Drawing a simple random sample with the help of table of random numbers.
1P

6. Chi-square test for goodness of fit and independent attributes.
   1P
7. Analysis of variance on the given data (ANOVA)
   2P
8. Tukey's test for pairwise comparison of treatments
   1P
9. Dunnet's test for comparison of treatment means with control
   1P
10. Duncan's multiple range test for comparing treatment means 1P
11. Determination of Karl-Pearson's coefficient of correlation from the given grouped and ungrouped data.
2P
12. Determination of Spearman's rank correlation coefficient from the given grouped and ungrouped data. 1P

Note: Any four practicals from practical number 1 to 6 and any four practicals from practical number 7 to 12

Bioinformatics (any 2 practicals)

1. Databases and database searching and DNA and protein sequence comparisons 2P
2. Pairwise comparison of DNA and protein sequences – BLAST 2P
3. Multiple sequence alignments, progressive methods, CLUSTAL 2P
4. Determining phylogenetic relationships using DNA and protein sequences 2P

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP421 Course Name: Plant Biotechnology

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite:

- A student should have a basic knowledge of Plant Biotechnology.

Course Objectives:

- To understand the interaction between the environment and plant growth
- To study the metabolic and physiological processes in plants

Course Outcome:

On completion of the course, student will be able to–

- Understanding interrelationship between plant metabolism and development • understand several major areas of active investigation in contemporary plant biology
- Know about Equipment's required in Tissue culture Lab.
- Media preparation techniques for different plants. Explain the synthesis of various metabolites.
- Sterilization techniques for media as well as for explants.
- Explant Culture- Anther culture, Pollen culture, Micropropagation. Embryo rescue technique.
- Somaclonal variation. In-vitro mutation. Isolation of plant protoplasts and viability testing.
- Protoplast fusion techniques.

Course Content

Chapter 1	**Plant Tissue Culture**	**5Lectures**
	1.1 History, 1.2 Laboratory organization, 1.3 Sterilization methods, Media preparation, 1.4 Plant Growth Regulators, 1.5 Micro propagation, 1.6 Callus culture, Cell Culture, Protoplast Culture and Fusion, Organogenesis and Somatic embryogenesis.	
Chapter 2	**Application of Tissue Culture**	**5 Lectures**
	2.1 Application of tissue culture for crop improvement in agriculture, horticulture and forestry 2.2 Seed Storage proteins 2.3 Methods for plant Conservation	
Chapter 3	**Haploid Production**	**5 Lectures**
	3.1 Anther, Pollen, Embryo and ovule culture and their applications. 3.2 Somaclonal variations.	
Chapter 4	**Tools for understanding gene expression**	**5 Lectures**

	4.1Techniques used to study gene expression at transcription level: 4.1.1 Northern hybridization, 4.1.2 Reverse Northern hybridization, 4.1.3Differential screeningand subtractive hybridization, 4.1.4 Differential display of mRNA, ESTs, SAGE,cDNA-AFLP, 4.1.5 DNA microarrays	
Chapter 5	**Gene synthesis**	**3 Lectures**
	5.1 Gene synthesis machines 5.2 Gene-tagging and plasmid rescue, 5.3 Promoter and enhancer traps.	
Chapter 6	**Alterations in gene expression**	**4 Lectures**
	6.1 Site-directed mutagenesis, 6.2 Insertional mutagenesis, 6.3 Knock out mutants, targeting induced local lesions in genomes (TILLING)	
Chapter 7	**Gene silencing**	**3 Lectures**
	7.1 Gene inhibition at RNA level - antisense, 7.2 Co-suppression, 7.3 miRNAs and siRNAs, silencing mechanisms	
Chapter 8	**Agriculture Biotechnology**	**8 Lectures**
	8.1 Herbicide resistance (phosphoinothricine glyphosate, Sulphonyl urea, astrazin) 8.2 Insect resistance (Bt gene, non Bt like protease inhibitor) 8.3 Virus resistance (Coat protein mediated nucleocapsid gene) 8.4 Disease resistance (Chitinase, 1-3 beta glucanase, RIP) 8.5 Nematode resistance	
Chapter 9	**Stress tolerance**	**3 Lectures**

	9.1 Abiotic stress tolerance - Salt tolerant 9.2 Abiotic stress tolerance - Drought stress resistance.	
Chapter 10	**Post-harvest losses**	**4 Lectures**
	10.1 Post-harvest losses - Long shelf life of fruits. 10.2 Post-harvest losses - Long shelf life of flowers	
Chapter 11	**Secondary Metabolite Production**	**3 Lectures**
	11.1Scope and applications of *in vitro* secondary metabolite production. 11.2Types of culture systems used for secondary metabolite production	
Chapter 12	**Improving secondary metabolite production**	**7 Lectures**
	12.1 Improving secondary metabolite production in culture a. Regulation of secondary metabolite pathways and compartmentalization b. Manipulation of nutrient media, precursor additions c. Immobilization of cells d. Elicitation using biotic and abiotic elicitors e. Biotransformation f. Screening and selection of high secondary metabolite producing cell	
	lines.	
Chapter 13	**Bioreactors and Pathway engineering**	**5 Lecture**
	13.1Types of bioreactors, growth, product analysis and scaling up 13.2Enhancing secondary metabolite production through genetic manipulation of biosynthetic pathways	
Chapter 14	**Discussion/guidance on experiential learning through field work**.	**1 Lectures**

References:

6. **Noble P.S. (2009)**. Physicochemical and Environmental Plant Physiology, 4rth edition, Academic Press, San Diego , USA
7. **Salisbury F.B. and Ross C.W. (2009)**. Plant Physiology, 4rth edition, Australia Cengage Learning.
8. **Taiz L and Zeiger E (2014)**. Plant Physiology, 6th edition, Sinauer Associates, Inc. Publishes, Massachusetts, USA.
9. **Verma S.K. and Verma Mohit (2007**). ATextbook of Plant Physiology, Biochemistry and Biotechnology, S. Chand Publications.

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PG Part 2 / M.Sc. (Botany) (2023 Course under NEP 2020)

Course Code :23ScBOTP422 Course Name: Plant Pathology and Plant Protection

Teaching Scheme: TH: 4 (Hours/Week) **Credit: 04**

Examination Scheme: CIA: 50 Marks **End-Sem: 50 Marks**

Prerequisite Courses:

- Student should have basic knowledge of plant pathology and plant protection.

Course Objectives:

- To study general characteristics of each group with one example each
- To learn evolutionary relationship between the taxa
- To be expertise in field work

Course Outcome:

On completion of the course, student will be able to–

- Identify and classify the biological specimens in nature
- Collect, preserve and have his own start up
- Understand the basic principles of plant pathology, plant disease development and defense mechanisms.
- Learn about organisms and casual factors responsible for plant diseases & methods of studying plant diseases.

- Recognize the symptoms of plant diseases.
- Identify some common plant diseases.
- Employ methods to diagnose and manage a wide range of plant diseases.
- Gain knowledge on host parasite interaction process.

Course Content

Chapter 1	**Introduction to Plant Pathology**	**3 Lectures**
	1.1Plant Pathology- Milestones in plant pathology. 1.2Plant pathology and its objectives.	
Chapter 2	**Plant Diseases**	**12 Lectures**
	2.1Causes of plant diseases, symptoms of plant diseases, disease cycle. 2.2Bacterial and mollicutes diseases of plants. 2.3 Viral diseases of plants Diseases caused by viruses. 2.4 Nematodal diseases of plants. 2.5 Plant disease epidemiology and forecasting of plant disease epidemics. 2.6 Effect of plant diseases on human affairs.	
Chapter 3	**Pathogenesis**	**8 Lectures**
	3.3 Pathogenesis:Penetration,infection and spread of diseases. 3.4 Effect of pathogen on plant physiological functions.	
Chapter 4	**Enzymes and Toxins**	**7 Lectures**
	4.1Enzymes and toxins in plant disease. 4.2Pathogenicity of biotrophic and necrotrophic pathogens.	
Chapter 5	**Disease Development**	**4 Lectures**
	5.1 Environmental factors and disease development-effect of temperature, humidity, soil pH, soil texture, light, CO2 and O2 levels, nutrients and disease development.	
Chapter 6	**Genetics of plant pathogen interactions**	**3 Lectures**
	6.1 Genetics of plant pathogen interactions- genetics of host parasitic interactions, phytoalexin and antigenhypothesis, vertical and horizontal resistance, physiological specialization, adaptation of fungi to different hosts.	
Chapter 7	**Plant defense mechanism**	**3 Lectures**
	7.1 Plant defense mechanism- morphological and biochemical defense, defense through induced synthesis of proteins and enzymes, detoxification of pathogen toxins and hypersensitivity of defense reactions, concept of phytoncides.	

Chapter 8 Molecular Biology 3 Lectures

8.1 Molecular biology of host pathogen interactions, pathogenesity genes, avirulance genes, hostR genes, effecter molecules, miRNA.

8.2 Concept of post-harvestdiseases of fruits, vegetables and seeds

Chapter 9 Disease Management and Related Aspects 5 Lectures

9.1Diagnostic methods for detecting pathogens.

9.2Breeding methods for improving resistance in plants.

Chapter 10 Disease Control 9 Lectures

10.1Control of disease using fungicides and other chemicals.

10.2 Bio-control agents for controlling disease.

10.3 Disease control using biological and chemical activators of resistance.

10.4 Plant disease assessment.

10.5 Biotechnology and its role in plant pathology.

Chapter 11 Discussion/guidance of experiential learning through field work 1 Lectures

References:

1. Plant Pathology by R. S. Mehrotra, first edition, McGraw-Hill Education publication, 1982.
2. Plant Pathology by George N Agrios, fifth edition, Academic Press, London, 2005.
3. Plant Nematode: Morphology, Systematics, Biology and Ecology by M. R. Khan,first edition, Science Publishers, 2008.
4. Plant Pathogenesis and Resistance by Jeng-Sheng Huang, first edition, Springer, Netherlands, 2001.
5. Plant Pathology by R. S. Mehrotra and Ashok Agarwal, second edition, Tata McGrawHill Education, 2003.
6. Biocontrol of Plant Diseases by P. C. Trivedi, first edition, Aavishkar Publishers and Distributors, 2007.
7. Concise Encyclopedia of Plant pathology by P. Vidhyasekaran, first edition, CRC Press, 2004.
8. Topics in Mycology and Pathology by L. N. Nair, first edition, New Central BookAgency Kolkata, 2007.
9. Fundamentals of plant pathology by A.K. Sinha, Kalyani Publishers
10. Disease of crops plants of India by Rangswami and Mahadevan, Prentice Hall Publication.