B.Sc. BOTANY FOUR-YEAR (NEP) SYLLABUS 2024
KOHIMA SCIENCE COLLEGE, JOTSOMA

SEM	COURSE CODE	COURSE TITLE	CREDITS (T&P)	Total
I	MJ-1/MN-1	Phycology & Mycology	2(3+1)	**8**
	MDC-I	Bonsai Technique	2+1	**3**
	SEC-I	Mushroom Culture	1+2	**3**
	VAC-I	Environmental Science	3	**3**
	AEC-I	(Language-I)	3	**3**
II	MJ-2 / MN-2	Bryophytes & Pteridophytes	2(3+1)	**8**
	MDC-II	Field and Herbarium Methods	2+1	**3**
	SEC-II	Floriculture	1+2	**3**
	VAC-II	Organic Farming	3	**3**
	AEC-II	(Language-II)	3	**3**
III	MJ-3/ MN-3	Economic Botany	2(3+1)	**8**
	MJ-4	Gymnosperms and Palaeobotany	3+1	**4**
	MDC-III	Natural resources and contemporary issues	3	**3**
	SEC-III	Agroecosystems of Nagaland	1+2	**3**
	AEC-III	(Language-III)	2	**2**
IV	MJ-5 / MN-4	Cell Biology	2(3+1)	**8**
	MJ-6	Microbiology & Plant Pathology	3+1	**4**
	MJ-7	Plant Systematics-I	3+1	**4**
	MJ-8	Molecular Biology	3+1	**4**
V	MJ-9	Plant Systematics-II	3+1	**4**
	MJ-10	Biochemistry	3+1	**4**
	MJ-11 / MN-5	Reproductive Biology of Angiosperms	2(3+1)	**8**
	Internship		4	**4**
VI	MJ - 12	Plant Anatomy	3+1	**4**
	MJ – 13	Plant Physiology	3+1	**4**
	MJ – 14	Genetics & Evolution	3+1	**4**
	MJ-15/MN-6	Ecology and Ecosystem Analysis	2(3+1)	**8**
VII	MJ-16/ MN-7	Ethnobotany	2(3+1)	**8**
	MJ-17	Research Methodology	3+1	**4**
	MJ-18	Phytogeography	3+1	**4**
	MJ-19	Plant Breeding	3+1	**4**
VIII	MJ-20/ MN-8	Biofertilizers and Biopesticides	2(3+1)	**8**
	MJ-21	Biostatistics	3+1	**4**
	MJ-22	Plant biodiversity and conservation	3+1	**4**
	MJ-23	Plant Biotechnology	3+1	**4**
		Total		**160**

MJ-1 PHYCOLOGY & MYCOLOGY
Theory
Credits: 3 *Teaching Hours: 45*

Unit I: Phycology

General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; methods of reproduction; Classification; criteria, system of Fritsch; Economic importance of algae.

General characteristics, occurrence, range of thallus organization, reproduction and life cycle of Cyanophyta (*Nostoc*), Xanthophyta (*Vaucheria*), Chlorophyta (*Oedogonium*), Charophyta (*Chara*), Phaeophyta (*Ectocarpus*) and Rhodophyta (*Polysiphonia*)

Unit II: Mycology: Fungi

General characteristics of Fungi, Thallus organization, vegetative, asexual & sexual types of reproduction, classification (Alexopoulos & Ainsworth), Life cycle of *Saccharomyces, Puccinia, Rhizopus, Colletotrichum, Pythium*; significance and economic importance of fungi.

Unit III: Mycology: Allied fungi

a. Slime molds b. Lichens c. Mycorrhiza; general characteristics, types, classification, reproduction, ecological significance and economic importance of slime molds, lichens and mycorrhiza.

MJ-1 PHYCOLOGY & MYCOLOGY
Practical
Credits:1

1. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Volvox, Oedogonium, Coleochaete, Chara, Vaucheria, Ectocarpus, Fucus and Polysiphonia, through electron micrographs, temporary preparations and permanent slides.
2. *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of *Agaricus*, fairy rings and bioluminescent mushrooms to be shown.
3. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides.
4. Mycorrhizae: ectomycorrhiza and endomycorrhiza
5. *Puccinia*: transverse sections of spores and preparation of temporary mount of spores.
6. Study of different vegetative and sexual spores of *Agaricus, Rhizopus, Colletotrichum, Sachoromyces* etc from temporary slides/permanent slides.

Suggested reading:

Kumar, H.D. (1999). Introductory Phycology.Affiliated East-West Press, Delhi.

Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge.4th edition.

Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization.Aravali International, New Delhi.

Vashistha, B.R., Sinha, A.K., Singh, V.P., (2005). Algae, S. Chand. Delhi, India.

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MJ-2 BRYOPHYTES AND PTERIDOPHYTES

Theory *Teaching Hours: 45*
Credits: 3

Unit I: General notes

Unifying features of archegoniates, general characteristics of Bryophytes, transition to land habit; Alternation of generations; adaptations to land habit; Pteridophytes- general characteristics; Early land plants (Cooksonia and Rhynia).

Unit II: Bryophytes

Classification (up to family); range of thallus organization; morphology, anatomy, reproduction and evolutionary trends of *Marchantia, Anthoceros* and *Funaria*; ecological and economic importance of bryophytes.

Unit III: Pteridophytes

Classification (up to family), morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum* and *Pteris* (Developmental details not to be included). Apogamy and apospory, heterospory and seed habit, telome theory, stelar evolution; ecological and economic importance of pteridophytes.

MJ-2 BRYOPHYTES AND PTERIDOPHYTES

Practical
Credits:1

1. *Marchantia*- Morphology of thallus, whole mount of rhizoids & Scales, vertical section of thallus through Gemma cup, whole mount of Gemmae (all temporary slides), vertical section of Antheridiophore, Archegoniophore, longitudinal section of Sporophyte (all permanent slides).
2. *Anthoceros*- Morphology of thallus, dissection of sporophyte (to show stomata, spores, pseudoelaters, columella) (temporary slide), vertical section of thallus (permanent slide).

3. *Funaria*- Morphology, whole mount of leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, longitudinal section of capsule and protonema.
4. *Psilotum*- Study of specimen, transverse section of synangium (permanent slide).
5. *Selaginella*- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).
6. *Equisetum*- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).
7. Pteris- Morphology, transverse section of rachis, vertical section of sporophyll, wholemount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

Suggested reading:

Gangulee H.C., Kar A.S.(2001). College Botany VOl. II.New Central Book Agency. Calcutta, India

Gangulee H.C., Kar A.S.(2001). College Botany VOl. II.New Central Book Agency. Calcutta, India.

Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot. Allahabad.

Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology.Tata McGraw Hill, Delhi.

Vanderpoorten, A. &Goffinet, B. (2009) Introduction to Bryophytes. Cambridge University Press.

Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

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MJ-3 ECONOMIC BOTANY

Theory *Teaching Hours: 45*
Credits: 3

Unit-I: Cereals & Legumes

Cereals: Origin, morphology, processing and uses of rice, wheat and maize; Pulses: Origin, morphology and uses of chickpea and pigeon pea. Morphology, propagation and uses of potato; Morphology and processing of sugarcane; products and byproducts of sugarcane industry

Unit II: Spices, beverages, fats & oils

Listing of important spices, their family and part used; Beverages: Morphology, processing and uses of tea and coffee. General description, classification, extraction and uses of soyabean and mustard. Essential Oils: General account, extraction methods, comparison with fatty oils &their uses.

Unit III: Fibre & therapeutics

Fibres: morphology, extraction and uses of cotton and jute. Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Papaver* and *Cannabis*. Morphology, processing, uses and health hazards of tobacco. Natural Rubber -Para-rubber: tapping, processing and uses.

MJ-3 ECONOMIC BOTANY
Practical
Credits: 1

1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Chickpea, soybean (habit, fruit, seed structure, micro-chemical tests).
3. Sources of sugars and starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Sources of oils and fats: Mustard plant specimen, seeds; tests for fats in crushed seeds.
7. Essential oil-yielding plants: Habit sketch of Rosa, Vetiveria, Santalum and Eucalyptus (specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of Papaver and Cannabis.

10. Tobacco: specimen and products of Tobacco.
11. Fiber-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

Suggested reading:

Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones &BartlettPublishers.

Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.

Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,The Netherlands.

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MJ-4 GYMNOSPERMS AND PALEOBOTANY

Theory *Teaching Hours: 45*
Credits: 3

UNIT 1 General notes on Gymnosperms

History and recent systems of classification of gymnosperms; Origin of gymnosperms; affinities of gymnosperms with pteridophytes and angiosperms; distribution of gymnosperms in India; ecological and economic importance of gymnosperms.

UNIT II Gymnosperms

General account and affinities of gymnosperms: Cycadales, Ginkgoales, Taxales, Coniferales, Ephedrales, Gnetales and Welwitschiales. Type study of Cycas, Pinus and Gnetum.

UNIT III Paleobotany

Geological time scale, fossil types and their formation, general account on and evolution gymnosperms, dominant fossil flora of different ages; paleobotany in relation to exploration of fossil fuels.

MJ-4 GYMNOSPERMS AND PALEOBOTANY

Practicals

Credit-1

1. Cycas- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll, transverse section of coralloid root, transverse section of rachis, vertical section of leaflet, vertical section of microsporophyll, whole mount of spores (temporary slides), longitudinal section of ovule, transverse section of root (permanent slide).
2. Pinus- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones), transverse section of Needle, transverse section of stem, longitudinal section of / transverse section of male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), longitudinal section of female cone, tangential longitudinal section & radial longitudinal sections stem (permanent slide).
3. Gnetum- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide)
4. Study of types of fossil through specimens and permanent slides.
5. Study of vegetative and reproductive stages of fossil genera through specimens and permanent slides.

Suggested reading:

Andrews H. N. (1961). Studies in palaeobotany. McGraw Hill. Arnold C. A. (1947). An Introduction to Palaeobotany. McGraw Hill. Beck B.(ed.) (1988). Origin and evolution of gymnosperms. Columbia University Press.

Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

Chamberlain C.J. (1986); Gymnosperms, structure and Evolution, CBS publishers

Palaeobotany. Systematic Association Special Volume.

Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries Publisher- Bhishan Singh Mahendra Pal Singh, Dehradun 20. Siddiqui, K.A. (2002) Elements of Palaeobotany, Kitab Mahal, Allahabad.

Thomas, B.A. & Spicer R.A. (1987): The Evolution and Palaeobiology of land plants.

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MJ –5 CELL BIOLOGY
Theory
Credits: 3 *Teaching Hours: 45*

Unit-1 The Cell and cell division *(15 Hours)*
Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Chemistry, structure and function of Plant cell wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and facilitated transport, endocytosis and exocytosis. Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role of protein kinases.

Unit-2 Cell organelles *(15 Hours)*
Cell Organelles- Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus. Cytoskeleton: Role and structure of microtubules, microfilaments and intermediary filament. Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast. Endomembrane system: Endoplasmic Reticulum – Structure and function; Golgi Apparatus – structure and function;Lysosomes- structure and function.

Unit-3 Bio energetic & enzymes *(15 Hours)*
Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled reactions, redox reactions. ATP: structure, its role as an energy currency molecule. Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, mechanism of action (activation energy, lock and key hypothesis, induced - fit theory), Michaelis – Menten equation, enzyme inhibition and factors affecting enzyme activity

MJ –5 CELL BIOLOGY
Practical
Credit: 1

1. Study of plant cell structure with the help of epidermal peel mount of Onion/ Rhoeo/ Crinum.

3. Measurement of cell size by the technique of micrometry.

4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).

5. Study the effect of organic solvent and temperature on membrane permeability.

6. Study different stages of mitosis and meiosis.

Suggested reading:

Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning

Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone

Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.

Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.

Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.

Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company

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MJ 6 MICROBIOLOGY & PLANT PATHOLOGY

Theory *Teaching Hours: 45*

Credits: 3

Unit I: Viruses & Bacteria

General characteristics of virus, DNA virus (Tphage), RNA virus (TMV), Retrovirus (HIV), Replication (lytic T4 & lysogenicλ), economic importance.

General characteristics of bacteria, types (archaebacteria, eubacteria, mycoplasma, spheroplast), reproduction- vegetative, asexual and genetic recombination (conjugation, transformation & transduction), economic importance.

Unit II: Plant diseases I

Classification of plant diseases, general symptoms, effect of environmental factors on disease development, Host-pathogen relationship, Field observation, laboratory investigation, Koch's postulate and identification of plant diseases, prevention and control of plant diseases.

Unit III: Plant diseases II

Causal organism, disease cycle and control measures. Bacterial diseases: citrus canker, leaf blight of rice Fungal disease: red rot of sugarcane, powdery mildew of peas Viral disease: leaf curl of papaya, bunchy top of banana Algal disease: red rust of tea, algal leaf spot of mango.

MJ 6 MICROBIOLOGY & PLANT PATHOLOGY
Practical
Credit: 1

1. Electron micrographs/models of viruses-(TMV/HIV/T4 & Lambda), Replication cycle
2. Gram staining of bacteria
3. Types of bacteria from temporary mounts/ permanent slides/photographs.
4. *Erysiphe:* Preparation of temporary mounts from diseased plants
5. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; sections/ mounts of spores on wheat and permanent slides of both the hosts.
6. Phytopathology: Herbarium specimens of diseased specimens of available bacterial, diseases. Preparation of temporary mounts.
7. Phytopathology: Herbarium specimens of diseased specimens of available, fungal diseases. Preparation of temporary mounts.
8. Phytopathology: Herbarium specimens of diseased specimens of available viral diseases. Preparation of temporary mounts.
9. Phytopathology: Herbarium specimens of diseased specimens of available algal diseases. Preparation of temporary mounts.

Suggested Reading:

Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.

Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.

Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.

Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.

Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.

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MJ-7 PLANT SYSTEMATICS-I
Theory
Credits:3 *Teaching Hours: 45*

Unit 1: Introduction to taxonomy&Morphology (15 L)

Definitions and concepts of plant taxonomy; importance and significance of taxonomy; Alpha and Omega taxonomy;Components of taxonomy.

Morphology of flowering plants: Root: Types and Modifications; Stem: types and Modifications; Leaf: Phyllotaxy, types of leaves; Flower: floral parts of a typical flower and Types (Actinomorphic, Zygomorphic); Inflorescence:Types; Fruits: types. Floral diagram and floral formula.

Unit 2: Systems of classification, taxonomic literatures& Botanical Nomenclature (15 L)

Salient features of Angiosperms;Taxonomic hierarchy: Ranks, categories and taxonomic groups; Types of classification: Natural, Artificial, Phylogenetic; System of classification: Natural system of classification (Bentham and hooker), Takhtajansystem of classification.

Herbarium: significance and importance of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Taxonomic Keys.

Botanical nomenclature: Principles and rules (ICN); ranks and names, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 3: Studies of angiosperm families (15 L)

Morphological, floral and distinguishing characters of following families with examples of plants of economic importance:

Dicot families: Magnoliaceae,Solanaceae, Rosaceae,Asteraceae,Fagaceae,Lamiaceae, Brassicaceae, Araceae, Balsaminaceae, Polygonaceae, Convolvulaceae.

Monocot families:Orchidaceae,Musaceae.

MJ-7 PLANT SYSTEMATICS-I
Practical
Credit:1

1. Study external morphology of root, stem and leaf structure and modifications.
2. Study of inflorescence types.
3. Study of flower and its parts.
4. Herbarium technique.
5. Study of vegetative and floral characters of few families studied in theory (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification)

Suggested Reading:

Angiosperm Phylogeny Group (2003). *An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II.* Botanical Journal of the Linnaean Society 141: 399-436.

Burkill, I.H. 1965. *Chapters on the History of Botany in India*, Delhi.

Crawford, D.J. (2003). *Plant Molecular Systematics*. Cambridge University Press, Cambridge, UK.

Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.

Davis, P.H. & V.H. Heywood, 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd Ltd., London.

Forman, L. & D. Bridson. 1989. *The herbarium Hand Book*. Royal Botanic Gardens, Kew

Gurucharan Singh, 2001. *Plant systematics Theory and Practice*. Oxford & IBH, New Delhi.

Henry, A.N. & Chandrabose *An aid to International Code of Botanic Nomenclature*.

Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. (1999). *Molecular Systematics of Plant Evolution* Taylor and Francis, London.

Jeffrey, C. 1968. *An introduction to Plant Taxonomy*, London.

Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). *Plant Systematics- A Phylogenetic Approach.*Sinaner Associates Inc, Massachusetts, USA.

Naik, V.N. *Taxonomy of Angiosperms*. TATA McGraw Hill, New Delhi

Pandey, S.N. & S.P. Misra. 2008. *Taxonomy of Angiosperms*. Ane Books India, NewDelhi.

Radford, A.E. 1986. *Fundamentals of plant systematics*. Harper & Row Publishers, New York.

Sharma, B.D. et al. (Eds.) *Flora of India vol. I.* Botanical Survey of India, Calcutta.

Sharma, O.P. 1996. *Plant Taxonomy*. TATA McGraw Hill, New Delhi

Simpson, M.C. (2006). *Plant Systematics*. Elsevier, Amsterdam.

Simpson, M.G. 2006. *Plant Systematics*. Elsevier Academic Press, London

Sivarajan, V.V. 1991. *Introduction to Principles of Plant Taxonomy.* Oxford & IBH, New

Sporne, K.R. 1974. *Morphology of Angiosperms*. Hutchinson University Press London.

Stressy, T.F. 1990. *Plant Taxonomy – The systematic evaluation of Comparative data*. Columbia University Press, New York.

Stussy, T.F. 1990. *Plant Taxonomy*, Columbia University Press, USA.

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MJ-8 MOLECULAR BIOLOGY
Theory
Credits: 3 *Teaching Hours: 45*

Unit I Nucleic Acids & DNA Replication

Structures of DNA and RNA. Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organellar DNA - mitochondria and chloroplast DNA. Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, Prokaryotic and eukaryotic DNA replication. Various models of DNA replication, including rolling circle, θ (theta) mode of replication,

Unit II Transcription

General principles of Transcription; basic structure and organization of typical gene, mechanism of transcription in prokaryotes: initiation, chain elongation and termination. Products of transcription and their functions.

Transcription Regulation and RNA Processing. General principles of gene regulation; operon concept: mechanism of lactose metabolism in E.coli; eukaryotic gene regulation. Gene silencing. Eukaryotic mRNA processing: 5' methylation and 3' polyadenylation ; eukaryotic mRNA editing and transport.

Unit III Translation

Central dogma, Genetic code (deciphering & salient features). Mechanism: Translation machinery: ribosome assembly in prokaryotes and eukaryotes; Charging of tRNA; phases of translation process: initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifications.

MJ-8 MOLECULAR BIOLOGY
Practical
Credit:1

1. Preparation of LB medium and raising E.Coli.
2. Isolation of genomic DNA from E.Coli.
3. DNA isolation from cauliflower head.
4. DNA estimation by diphenylamine reagent/ UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.
9. Nucleic acid separation through chromatography paper
10. Estimation of DNA size through electrophoresis

Suggested Reading:

Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.

Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.

Russell, P. J. (2010). i-Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.

Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.

Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

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MJ-9 PLANT SYSTEMATICS-II
Theory
Credits: 3 *Teaching Hours: 45*

Unit 1: Origin of angiosperms&Modern Taxonomy

Salient features, origin and evolution of Angiosperms; A general account with special reference to Bennettitalean, Gnetalean, Caytonialean and Herbaceous origin theories; primitive living angiosperms; evolution of flower; co-evolution of flowers and insects.

Concept of taxa (family, genus, species);Evidences from palynology embryology, cytology, phytochemistry and molecular data; taxonomy as synthetic discipline.

Unit 2: Phylogeny of Angiosperms & Biometrics

Principles of Angiosperm Phylogeny Group; Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly, clades, synapomorphy, symplesiomorphy, apomorphy, lineage sorting, serial homology etc)

Biometrics, numerical taxonomy and cladistics: Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Unit 3: Studies of angiosperm families

Morphological, floral and distinguishing characters of following families with examples of plants of economic importance:

Dicot families: Ranunculaceae, Melastomataceae, Amaranthaceae, Anonaceae, Moraceae, Euphorbiaceae, Cucurbitaceae, Acanthaceae, Meliaceae, Malvaceae, Balanophoraceae,

Monocot families: Poaceae, Zingiberaceae.

MJ-9 PLANT SYSTEMATICS-II
Practical
Credit:1

1. Identification of taxa with the help of computerized key.

2. Study of vegetative and floral characters of few families studied in theory (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification) and identify up to species using the flora.

3. Field visit: Local or outside area/ Botanical Garden/ tribal settlements. Submission: Record book, Tour report and Herbarium (Preparation of 05 properly identified herbarium specimens; mounting of a properly dried and pressed specimen of any common plants from your locality with herbarium label).

Suggested Reading:

Angiosperm Phylogeny Group (2003). *An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II.* Botanical Journal of the Linnaean Society 141: 399-436.

Burkill, I.H. 1965. *Chapters on the History of Botany in India*, Delhi.

Crawford, D.J. (2003). *Plant Molecular Systematics*. Cambridge University Press, Cambridge, UK.

Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York.

Davis, P.H. & V.H. Heywood, 1963. *Principles of Angiosperm Taxonomy*. Oliver & Boyd Ltd., London.

Forman, L. & D. Bridson. 1989. *The herbarium Hand Book*. Royal Botanic Gardens, Kew

Gurucharan Singh, 2001. *Plant systematics Theory and Practice*. Oxford & IBH, New Delhi.

Henry, A.N. & Chandrabose *An aid to International Code of Botanic Nomenclature*.

Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. (1999). *Molecular Systematics of Plant Evolution* Taylor and Francis, London.

Jeffrey, C. 1968. *An introduction to Plant Taxonomy*, London.

Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. and Donoghue, M.J. (2008). *Plant Systematics- A Phylogenetic Approach.*Sinaner Associates Inc, Massachusetts, USA.

Naik, V.N. *Taxonomy of Angiosperms*. TATA McGraw Hill, New Delhi

Pandey, S.N. & S.P. Misra. 2008. *Taxonomy of Angiosperms*. Ane Books India, NewDelhi.

Radford, A.E. 1986. *Fundamentals of plant systematics*. Harper & Row Publishers, New York.

Sharma, B.D. et al. (Eds.) *Flora of India vol. I.* Botanical Survey of India, Calcutta.

Sharma, O.P. 1996. *Plant Taxonomy*. TATA McGraw Hill, New Delhi

Simpson, M.C. (2006). *Plant Systematics*. Elsevier, Amsterdam.

Simpson, M.G. 2006. *Plant Systematics*. Elsevier Academic Press, London

Sivarajan, V.V. 1991. *Introduction to Principles of Plant Taxonomy.* Oxford & IBH, New

Sporne, K.R. 1974. *Morphology of Angiosperms*. Hutchinson University Press London.

Stressy, T.F. 1990. *Plant Taxonomy – The systematic evaluation of Comparative data*. Columbia University Press, New York.

Stussy, T.F. 1990. *Plant Taxonomy*, Columbia University Press, USA.

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MJ-10 BIOCHEMISTRY
Theory
Credits: 3

Teaching Hours: 45

Unit I Carbohydrates

Carbohydrates: Nomenclature and classification; Monosaccharides; Disaccharides; Oligosaccharides and polysaccharides.

Unit II Lipids

Definition and principle classes of lipids. Storage, metabolic and structural lipids; Fatty acids Types, structure and functions; Essential fatty acids; Triacyl glycerols structure, functions and properties; Phosphoglycerides.

Unit III Proteins

Structure and classification of amino acids; Levels of protein structure primary, secondary, tertiary and quarternary; Protein denaturation and biological roles of proteins.

MJ-10 BIOCHEMISTRY
Practical
Credits: 1

1. Qualitative tests for carbohydrates,
2. Qualitative tests for reducing sugars and non-reducing sugars
3. Qualitative tests for lipids
4. Qualitative tests for proteins.

Suggested Reading:

Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning

Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone

Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman

Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company

Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.

Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.

Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.

Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco. 10. Rastogi, S. C. (2003). Biochemistry. 2nd edition.

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MJ-11 REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
Theory
Credits: 3 *Teaching Hours: 45*

Unit I: Development of reproductive structures

Structure of a typical flower. Male gametophyte: Structure of anther, anther wall, tapetum, microsporogenesis, microgametogenesis; pollen development and pollen sterility. Female gametophyte: ovules and types, megasporogenesis, megagametogenesis, organisation of embryo sac and types of embryo sac.

Unit II: Pollination, fertilization and fruit development

Pollination and types, contrivances of self and cross pollination; pollen germination, pollen tube growth and guidance; pollen-pistil interaction, self incompatibility, methods to overcome incompatibility; double fertilization.

Endosperm development and types; embryogenesis,; suspensor; nutrition of embryo; seed development; polyembryony; apomixes; parthenogenesis and parthenocarpy; fruit development and growth.

Unit III: Palynology

Pollen morphology; pollen units, polarity and symmetry; NPC-system; sporoderm stratification, exine ornamentation and sculpturing. Pollen viability; pollen storage and significance; storage protein; pollen allergy; pollen calendar.

MJ-11 REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
Practicals
Credit:1

1. Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall(micrograph); Pollen viability: Tetrazolium test. germination: Calculation of percentage germination in different media using hanging drop method.
3. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/specimens/photographs).
4. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
5. Intra-ovarian pollination; Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

Suggested Reading:

Bhattacharya, K., M R Majumdar and S G Bhattacharya 2006: A Text book of

Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.

Erdtman, G.1988 : Pollen morphology and plant taxonomy.

Fageri, K and J Inversen, 1964: Text book of pollen analysis.

Johri, B.M. l (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.

Maheshwari, P.1963: Recent advances on the embryology of Angiosperm Palynology.

Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.

Shivanna, K.R. (2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.

Stanley, R G and F.L. Linkens 1974: Pollen biology, Biochemistry management

Tilak, S T. 1989: Airborne pollen and fungal spores.

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MJ-12 PLANT ANATOMY
Theory
Credits: 3 *Teaching Hours: 45*

Unit 1: Plant Cells, Tissues, Tissue systems and adaptations

Introduction, objectives and scope of Plant Anatomy; General structure of plant cells - structure of plant cell wall; Tissue and tissue systems-Definitions, structure and functions of Meristematic tissues and permanent tissues (Simple and Complex); A brief account of plant secretary tissues/cells; Concept of tissue systems - Ground tissues, Dermal tissues and Vascular tissues; Trichomes and stomata: types, structure and function; adaptations in Hydrophytes, Xerophytes, epiphytes and Halophytes.

Unit 2: Meristematic tissues

Classification of meristem based on location, Origin (promeristem, primary and secondary meristem) and function (protoderm, procambium and ground meristem). Generalised structure of shoot apex, theories on organization of Shoot Apical Meristem (SAM). Molecular control on the development of SAM, cytological zonation. Generalised structure of root apex, theories on organisation of Root Apical Meristem (RAM).

Unit 3: Primary and Secondary anatomy of Angiosperms

Primary anatomy of root: Dicot & monocot. Primary anatomy of stem: Dicot & Monocot; Nodal anatomy; Anatomy of leaf: Dicot & Monocot; Secondary Growth: Normal Secondary growth in stem and root; Anomalous secondary growth in *Aristolochia* and *Boerhaavia* (dicot stem), *Dracaena* (monocot stem); Wood Anatomy - Wood elements, heartwood and sapwood, Tension Wood; Periderm and Lenticel, Tylosis; Applications of anatomy in Plant systematics, forensics and Pharmacognosy.

MJ-12 PLANT ANATOMY
Practical
Credit:1

1. Study of meristem (Permanent slides/ Photographs).
2. Study of Simple Tissues: Parenchyma, Collenchyma and Sclerenchyma
3. Complex Tissues - xylem and phloem; Maceration technique to study elements of xylem and phloem.
4. Study of primary structure of dicot and monocot stem.
5. Study of primary structure of dicot and monocot root and leaf.
6. Study of Normal secondary growth structure in dicot stem and root (Sunflower) and Anomalous secondary growth: *Aristolochia*, *Boerhaavia*(dicot stem) *Dracaena* (monocot stem).
7. Study of trichomes and stomata with the help of locally available plant materials

Suggested Reading:

CoutlerE. G., 1969. Plant Anatomy – Part I Cells and Tissues – Edward Arnold, London.
Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA

Eames A. J. - Morphology of Angiosperms - Mc Graw Hill, New York.
Esau, K. 2007. Plant Anatomy, Wiley Eastern Pvt Ltd New Delhi
Evert, R.F. (2006) Esau's Plant Anatomy: Meristem, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc
Fahn, A.1992. Plant Anatomy, Pergamon Press, USA
Mauseth, J.D. (1988). Plant Anatomy, the Benjammin/Cummings Publisher, USA.
Pandey, B. P. 2001. Plant Anatomy, S.Chand Publishing Co. Pvt.Ltd. Delhi.
Raghuvanshi, P. 2020. Plant Anatomy, Book Enclave
Vashishta, P.C. 1997. Plant Anatomy, Pradeep Publications.

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MJ – 13 PLANT PHYSIOLOGY
Theory
Credits: 3 *Teaching Hours: 45*

Unit I: Water and minerals

Basic concept of diffusion, osmosis and imbibitions; water potential in plant, absorption of water and minerals; ascent of sap; transpiration; stomatal movement. Micro and macronutrients, its roles, mineral deficiency symptoms, root nodule formation, nitrogen fixation.

Unit II: Carbon assimilation and oxidation

Photosynthetic pigments and its roles, photosynthetic electron transport, Q-cycle, C_3 , C_4, and CAM pathway, photorespiration. Glycolysis, Pyruvate decarboxylation, Kerbs cycle and their regulations; NADH shuttle; Mitochondrial electron transport chain, Oxidative phosphorylation; Cyanide resistance respiration, Respiratory quotient.

Unit III: Plants growth regulators, flowering and Movements

Discovery and physiological role of Auxin, Cytokinin Gibberellin, Ethylene, ABA and Brassinosteriod. Concept of Photoperiodism, Florigene,Vernalization. Germination, Photomorphgenesis, dormancy and senescence. Plants movement (tropical and nastic movement)

MJ – 13 PLANT PHYSIOLOGY

Practical
Credit: 1

1. Determination of osmotic potential of plant cell sap by plasmolytic method.

2. Determination of water potential of given tissue (potato tuber) by weight method.

3. Study of the effect of CO2 on the rate of photosynthesis.

4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.

5. Complete separation of chlorophyll pigments.

6. To study the phenomenon of seed germination (effect of light).

7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay).

8. To study the effect of cytokinin on chlorophyll degradation by leaf disc method.

9. To determine the R.Q of the given substrate(carbohydrate)

Suggested Reading:

Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual. Narosa Publishing House, New Delhi.

Goodwin T. W. and Mercer E. I. (1983). Introduction to Plant Biochemistry. Pergamon Press.

Hopkins W.G. and Hunter N.P. (2003). Introduction to Plant Physiology. John Wiley & Sons.

Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.

Krauss G. (1999) Biochemistry of Signal Transduction & Regulation. John Wiley.

Lehniger A. L. (1993). Principle of Biochemistry. CBS.

Lender D. W. (2001). Photosynthesis. Mercel Deker.

Leopold A. C. and Kreidman P. E. (1980). Plant growth and development. Tata MacGraw Hill.

Lincoln T. and Zeiger E. (2002). Plant Physiology. Palgrave Macmillian.

Mattoo A. K. and Shuttle, J. C. (1995). The Plant hormone Ethylene. CRC. Press.

Mukherji S. and Ghosh A. K. (1996). Plant Physiology. Tata- McGraw Hill.

Noggle G. R. and Fritz C. J (1989). Introductory Plant Physiology. Prentice Hall

Seigler D. S. (1994). Plant secondary metabolism. Narosa

Srivastava H. S. (1994). Plant Physiology. Rastogi and Co.

Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

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MJ-14 GENETICS & EVOLUTION
Theory
Credits: 3 *Teaching Hours: 45*

Unit I Mendelian Genetics, Linkage & Crossing Over

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance. Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit II Extrachromosomal Inheritance, Gene Mutation And Chromosomal Aberrations

Cytoplasmic inheritance in plants, Variegation in Four o'clock plant; Cytoplasmic inheritance due to mitochondria; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramoecium. Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation. DNA repair mechanisms. Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit III Fine Structure Of Gene, Population And Evolutionary Genetics

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional alleles; Structure of Phage T4, rII Locus. Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

MJ-14 GENETICS & EVOLUTION
Practical
Credits: 1

1. Meiosis through temporary squash preparation. Mendel's laws through seed ratios. Laboratory exercises in probability and chisquare.
2. Chromosome mapping using point test cross data.
3. Pedigree analysis for dominant and recessive autosomal and sex-linked traits.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Blood Typing: ABO groups & Rh factor. 6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
7. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

8. Study of human genetic traits: Sickle cell anaemia, Xeroderma Pigmentosum, Albinism, red & green Colour blindness, Widow's peak, rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

Suggested Reading:

Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.

Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition. Paper title: Analytical techn

Gupta P. K. (1995). Cytogenetics. Rastogi & Co.

Gupta P. K. (1998). Genetics and Biotechnology in Crop Improvement. Rastogi & Co.

Hartl D. L. and Jones E. W. (2001). Genetics-Analysis of Genes & Genomes. Jones and

Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A. 9th edition.

Snustad D. P. and Simmons M. J. (2000). Principles of Genetics. John Wiley and Sons.

Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

Stansfield W. D. (1969). Theory and Problems of Genetics. McGraw-Hill.

Strickberger M. W. (1985). Genetics. Macmillan.

Sybenga J. (1972). General Cytogenetics. North Holland.

Tamarin R. H. (2002). Principles of Genetics. Tata McGraw-Hill.

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MJ-15 ECOLOGY AND ECOSYSTEM ANALYSIS
Theory
Credits: 3 *Teaching Hours: 45*

UNIT I: Ecosystem concept and Population ecology:

Ecosystem organization. Concepts relating to limiting factors; environmental factors-soil, water, light, temperature and fire.

Population concept, Population growth; survivorship curves and life-table analysis; population dynamics and plant population regulation; Life history strategies, r & k selection; population interactions with emphasis on resource competition and allelopathy, Ecological niche and ecotypes.

UNIT II : Community Structure and dynamics

Structure and attributes of plant community, life forms and biological spectrum, species dominance, keystone stone species, ecotone and edge effect. Ecological succession – concept, models and mechanisms; changes in community attributes during succession; concept of climax; Ecosystem stability- perturbations, resistance and resilience.

UNIT III: Ecosystem Functions:

Primary productivity and its measurement; Primary productivity of terrestrial and aquatic ecosystems of the world; energy dynamics: trophic organization, energy flow pathways, ecological efficiencies. Decomposition: mechanism and controlling factors. Biogeochemical cycles with particular reference to cycling of carbon, nitrogen, phosphorus and sulphur.

MJ-15 ECOLOGY AND ECOSYSTEM ANALYSIS
Practical
Credits: 1

1. Study of interactions between plants and environment
   a. Study of microclimatic conditions in open and closed communities
   b. Study of plastic response of plant species under contrasting environmental conditions
2. Study of physico-chemical properties of soil; (a) texture, (b) porosity, (c) water holding capacity (d) organic matter content
3. Study of analytical characters of plant community using plot and plot-less methods
4. Study of survivorship plant populations and life-table analysis
5. Estimation of phytomass and its distribution in different compartments in grassland communities
6. Determination of leaf-area index in the grassland community
7. Estimation of primary productivity of plant community by (a) harvest method, and (b) light and dark bottle method
8. Estimation of rate of carbon dioxide evolution from different soils by alkali absorption method

Suggested Reading:

Anderson J. M. and Ingram J.S. I (1993). Tropical soil biology and fertility: A handbook of methods. CAB International.

Begon M.Harper J.L. and Townsend C. R. (1990). Ecology: Individual, Populations and Communities. Blackwell Scientific Publisher.

Daubernmire R. (1974). Plants and environment. John Wiley & Sons.

Hanson H. C. and Churchill E. D. (1963). Plant Communities. Reinhold.

Kormondy E. J. (1996). Concepts of ecology. Prentice-Hall.

Misra R. (1968). Ecology Workbook. Oxford & IBH.

Muller-Dombois D. and Ellenberg H. (1974). Aims and Methods of vegetation ecology. John Wiley & Sons.

Odum E. P. (1971). Fundamentals of Ecology. W. B. Saunders.

Odum E. P. (1983). Basic Ecology. Holt Saunders International.

Odum, E. P. (1971). Fundamentals of Ecology. W. B. Saunders.

Poole R. W. (1974). An Introduction to Quantitative Ecology. Mc Graw Hill Inc.

Underwood A. J. (1997). Experiments in ecology. Cambridge University Press.

White J. (1985). Studies on plant demography. Academic Press.

Whittaker R. H. (1975). Communities and Ecosystems. McMillan.

Wild A. (1994). Soils and the environment. Cambridge University Press.

Zar J. H. (1984). Biostatistical analysis. Prentice-Hall International.

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MJ- 16 ETHNOBOTANY
Theory
Credits: 3 *Teaching Hours: 45*

Unit 1: Concept and Scope

Ethnobotany Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science; Various branches of Ethnobotany; the relevance of ethnobotany in the present context; Role of Ethnobotany in conservation and sustainable development; ethnobotanical studies: tools and techniques.

Unit 2: Ethnic groups and plants

Ethnic groups in Ethnobotany; Role of ethnic groups in conservation of plant genetic resources, endangered taxa and forest management; temple and sacred places in Ethnobotany; mythology, Taboos and totems in relation to plants. Plants used by the tribals: food plants, intoxicants and beverages, Resins & oils, rituals (with special reference to Naga tribe)

Unit 3: Ethnomedicine and Medico-ethnobotanical sources in India

Introduction to ethnomedicine and use of traditional herbal medicines; different methods of preparation of traditional medicines; traditional medicine and its relationship with modern medicine.

Significance of the following plants in ethnobotanical practices: *Azadiractha indica*, *Ocimum sanctum*, *Vitex negundo*, *Gloriosa superba*, *Tinospora cordifolia*, *Batea monosperma*, *Cassia*

fistula, Indigofera tinctoria; Role of ethnobotany in modern medicine with special example *Rauvolfiasepentina, Terminalia arjuna, Artemisia* spp., *Withaniasomnifera*.

MJ- 16 ETHNOBOTANY
Practical
Credits: 1

Practical:

1. To visit botanical garden/herbal garden/medicinal plant repositories for the identification of ethnomedicinal plants
2. To be familiar with the preparation of herbarium specimen of the ethnobotanical/ ethnomedicinal plant species.
3. To study major ethnomedicinal plants and practices followed in India/Nagaland
4. To prepare a standard proforma or questionnaire for ethnobotanical field studies
5. To visit the tribal communities/ villages for the collection of ethnobotanical knowledge
6. To collect, identify and archive some plants of ethnobotanical importance from natural habitats

Suggested Reading:

Anthwal, A., Gupta, N., Sharma, A., Anthwal, S., & Kim, K. H. (2010). Conserving biodiversity through traditional beliefs in sacred groves in Uttarakhand Himalaya, India. Resources, Conservation and Recycling, 54(11), 962-971.

Appadurai, A. (1977). Kings, sects and temples in south India, 1350-1700 AD. The Indian Economic & Social History Review, 14(1), 47-73.

Bhattacharjee SK. *Hand book of medicinal plants.* Jaipur: Pointer Publishers; 2001. pp. 18–25. [Google Scholar].

Chauhan Kanika, Role of Ethnobotany on Indian Society: A Review (2020), Journal of Arts, Culture, Philosophy, Religion, Language and Literature e-ISSN: 2457-0346, Volume-4, Issue-2, May-August, 2020; pp. 109-111.

Chowdhary, H.J. and Murti, S.K. (2000). Palnt Diversity and Conservation in India: An overview. ISBN: 8121102243.

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

Gadgil, M., & Vartak, V. D. (1975). Sacred groves of India-a plea for continued conservation. Journal of the Bombay Natural History Society, 72(2), 314-320.

Gupta S.M (1971), Plants Myths and traditions of India, Leiden Netherlands.

JhaSantosh Kumar (Edition: 2018), Research Methodology in Ethnobotany, Advances In Ethnobotany (pp.169-191), Satish Serial Publishing House, Delhi.

Lone et al., Palaeoethnobotany

Maheshwari, J.K. (2003). Ethnobotany and Medicinal plants of Indian subcontinent. ISBN: 9788172332211.

Pandey,B.P. (1989),Sacred plants of India, shree publishing House New Delhi.

Pullalah, T., Krishnamurthy, K.V. and Bahadur, B. (2017). Ethnobotany of India. Vol. 5. ISBN: 9781315186627.

Rajiv K. Sinha - Ethnobotany the Renaissance of Traditional Herbal medicine.

Rama Ro, N and A.N. Henry (1996). The Ethnobotany of ern Ghats in AndhraPradesh, India. Botanical Survey of India. Howrah.

S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society ofethnobotanists, Lucknow, India.

S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi -1981

S.K. Jain, 1990. Contributions of Indian ethnobotany, Scientific publishers,Jodhpur. Education.

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

Sensharma, P (1989), Plants in Indian Puranas, an ethnobatanical investigation, Navya Prakash culcutta.

Sharma and Alam (2019), Ethnobotany, Rastogi Publication, Meerut.

Shaw D. Risks or remedies? Safety aspects of herbal remedies. J. Roy. Soc. Med. 1998; 91:294–296. [PMC free article] [PubMed] [Reference list].

Sinha B.C. (1997), Tree worship in Ancient India, Books today New Delhi.

Varghese, A., Oommen, M.A., Paul, M.M. and Nath, S. (2022). Sustainable use of Biodiversity conservation in India. ISBN: 9781032290836.

Vogl Christian R. & Vogl -Lukasserb Brigitte (2004), Tools and Methods for Data Collection in Ethnobotanical Studies of Homegardens, Institute for Organic Farming, University for Natural Resources and Applied Life Sciences Vienna.

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MJ-17 RESEARCH METHODOLOGY
Theory
Credits: 3 *Teaching Hours: 45*

Unit I Research concept & Scientific writing

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical). Research methods vs methodology. General account of process of conducting research.

Scientific writing and ethics- Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. PowerPoint presentation. Poster presentation, Introduction to copyright-academic misconduct/ plagiarism.

Unit II General laboratory practices

Understanding the details on the label of reagent bottles. Knowledge about common toxic chemicals and safety measures in their handling. Common calculations in botany laboratories- Molar, molal and normal solutions; Molarity and normality of common acids and bases. Preparation of solutions- Dilutions, percentage solutions. Technique of handling micropipettes. Maintaining a laboratory record. Tabulation and generation of graphs.

Unit III Methods to study plant cell & tissue structure

Classification of stains and staining procedures. Imaging of tissue specimens and application of scale bars. Methods to study plant cell/tissue structure-Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections. Reactive dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags)

MJ-17 RESEARCH METHODOLOGY
Practical
Credits: 1

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

Suggested Reading:

Kothari, C.R. 2004. Research Methodology: Methods & Techniques**.** New age international (p) limited, publishers, New Delhi.

Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.

Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists a training reference manual. West Africa Rice Development Association, Hong Kong.

Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publishing House, New Delhi.

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MJ -18 PHYTOGEOGRAPHY
Theory
Credits: 3 *Teaching Hours: 45*

UNIT I: Phytogeography:

Phytogeography: concept and importance; major phytogeographical regions of the World. phytogeographical regions of India: Western Himalaya, Eastern Himalaya, Indus plain, Gangetic, sub-mountain zone, temperate zone, Alpine zone and N.E. India.

UNIT II: Mechanism of distribution

Continental drift: A general account, tectonic movements. Patterns of geographic distribution, disjunct distribution and Vicariance, Vicariance biogeography, dispersal mechanism, migration and endemism: types and causes.

UNIT III: Vegetation and their distribution

Major plant communities of the world and their distribution. Centres of diversity; Native taxa, naturalization of exotic taxa. General characters of flora of India and Nagaland.

MJ -18 PHYTOGEOGRAPHY
Practical
Credits: 1

1. Drawing maps of Floristic regions of India.
3. Drawing maps of continental drift
4. Listing plants of theCollege campus
5. Listing of wild edible plants
6. Studying species distribution and its measurements
7. Check list of locally available exotic / invasive species

Suggested Reading:

Advanced Plant Geography Author: Shiv Manikant Dube. 2011 Swastik Publications.

Edible Wild Plants of the Prairie: An Ethnobotanical Guide by Kelly Kindscher (1987)

Plant geography by George Simonds Boulger (Jan 1, 1912)

Textbook of the Plant Geography of India. by F.R. Bharucha

Walter's Vegetation of the Earth: Ecological Systems of the Geo-Biosphere (4th Edition) by Heinrich Walter, Siegmar-Walter Breckle. Paperback - October 2002

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MJ-19 PLANT BREEDING
Theory
Credits: 3 *Teaching Hours: 45*

Unit I Plant Breeding Methods

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit II Inheritance

Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic Inheritance. History, genetic basis of inbreeding depression and heterosis

Unit III Applications

Role of plant breeding in crop improvement. Role of mutations; Polyploidy, Distant hybridization and role of biotechnology in crop improvement.

MJ-19 PLANT BREEDING
Practical
Credits: 1

1. Self pollination experiment
2. Cross pollination experiment
3. Emasculation, bagging and tagging
4. Grafting and layering experiment
5. Effect of light and temperature in pollen germination
6. Seed viability test

Suggested Reading:

Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Allard R. W. (1960). Principles of Plant breeding. John Wiley.

Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.

Chopra V. L. (1989). Plant Breeding. Oxford & IBH.

Gupta P. K. (1998). Genetics and Biotechnology in Crop Improvement. Rastogi & Co.

Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops. Iowa State University Press.

Sharma J. R. (1994). Principles & Practices of Plant Breeding. Tata-McGraw Hill.

Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

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MJ-20 BIOFERTILIZERS AND BIOPESTICIDES
Theory
Credits: 3 *Teaching Hours: 45*

Unit I Fundamentals of Biofertilizers: Bacteria

Definition, Classification, Advantages and Constraints. Role of biofertilizers in modern agriculture. Bacterial biofertilizers - A general account of *Azospirillum, Azotobacter, Frankia, Phosphobacteria* and *Rhizobium*.

Unit –II Cyanobacteria (BGA) and Mycorrhizae

A general account of *Anabaena, Nostoc, Cylindrospermum, Gloeocapsa, Plectonema. Scytonema* and *Tolypothrix*. Symbiotic association of Cyanobacteria. *Azolla* as biofertilizer. A general account, types, examples and applications of mycorrhizae.

Unit –III Biopesticides

Uses and limitations of Biopesticides and their application. Advantages over chemical pesticides. Biocontrol of plant diseases. Cross protection. Fungal and bacterial biopesticides – *Trichoderma, Aspergillus flavus, Bacillus thuringiensis*. Bioinsecticides – Insecticidal plants (Neem and others).Virus, bacteria and fungi as insecticides.

MJ-20 BIOFERTILIZERS AND BIOPESTICIDES
Practical
Credits: 1

1. Methods of collection, wet sieving and decanting method and inoculum production
2. Isolation and identification of Cyanobacteria (BGA) mentioned in theory paper
3. Field application of Cyanobacterial inoculants.
4. Cultivation of *Azolla*
5. Isolation of root nodules (*Rhizobium*)
6. Isolation and identification of biocontrol agents
7. Isolation and culturing of *Aspergillus, Trichoderma* and *Bacillus sp.*

Suggested Reading:

Agrios, G. N. Plant Pathology, Fourth Edition 1997, Academic Press.

Dubey, R. C. (2008): A Textbook of Biotechnology. S. Chand & Co., New Delhi.

Ilan chet (Ed.). Innovative Approaches to plant disease Control. Wiley Inter Science Publication, Ihon Wiley and Sons New York (1987)

Newton, W. E. et al. (1977): Recent Developments in Nitrogen Fixation. Academic Press, New York. 5. Schwintzer, C. R. and Tjepkema, J. D. (1990): The Biology of Frankia and Actinorhizal Plants. Academic Press Inc., San Die go, USA.

Stewart W. D. P. and Gallon J. R. 1980): Nitrogen Fixation. Academic Press, New York.

Subba Rao, N. S. (1982): Advances in Agricultural Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Subba Rao, N. S. (2002): Soil Microbiology. 4th ed. Soil Microorganisms and Plant Growth. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Subba Rao, N. S. and Dommergues, Y. R. (1998): Microbial Interactions in Agriculture and Forestry. Vol. I, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Verma, A. (1999): Mycorrhiza. Springer Verlag, Berlin. 17 9. Wallanda, T. et al. (1997). Mycorrhizae. Backley's Publishers, The Netherlands.

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MJ-21 BIOSTATISTICS
Theory
Credits: 3 *Teaching Hours: 45*

Unit I: Fundamentals of statistics

Basic principles, statistical methods - functions, limitations and uses of statistics. Types of data, Methods of data collection procedures and sampling methods; Classification- tabulation and presentation of data. Concept of normality, p-value, confidence interval and outliers.

Unit II: Descriptive Statistics and probability

Measures of central tendency: Mean, median, mode, geometric mean. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation; Co- efficient of variations. Priori probability, addition rule, multiplication rule

Unit III: Inferential statistics, Correlation and regression

Null hypothesis – Type I & Type II errors; Test of Hypothesis:'t' test, ANOVA, Z test, chi square test and 'F' test, test of independence and test of homogeneity. Correlation and regression analysis. Introduction to statistical software.

MJ-21 BIOSTATISTICS
Practical
Credits: 1
1. Calculation of mean, standard deviation and standard error
2. Calculation of correlation and regression
3. Hypothesis testing: 't' test, ANOVA, Z test, chi square test and 'F' test
4. Use of basic statistical software

Suggested Reading:

An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S and Richards, J. Christian Medical College, Vellore

Biostatistics, Daniel, W.W., 1987.New York, John Wiley Sons.

Statistical Analysis of epidemiological data, Selvin, S., 1991. New York University Press.

Statistics for Biologists, Campbell, R.C., 1998.Cambridge University Press.

Statistics for Biology, Boston, Bishop, O.N. Houghton, Mifflin.

The Principles of scientific research, Freedman, P. New York, Pergamon Press.

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MJ-22 PLANT BIODIVERSITY AND CONSERVATION
Theory
Credits: 3 *Teaching Hours: 45*

Unit-1: Fundamental account on Biodiversity
Species concept, importance and concept of biodiversity. Levels (α, β, γ) and types of biodiversity (genetic, species and ecosystem diversity). Concept of and biodiversity hotspots of world and India, Mega biodiversity centers of world and India and origin centers of crop plants. measures of biodiversity: biodiversity indices.

Unit-2: Threats to Biodiversity
Loss of Biodiversity: Casual factors of threat, Impact of habitat loss and habitat fragmentation, Categories of treat endangered, vulnerable, rare, threatened and extinct. Red Data Book. Legal aspects of biodiversity in India. Policy and priority setting. Biodiversity conservation future strategies for India.

Unit-3: Conservation of Biodiversity
Biodiversity Conservation: Objectives, implication and action plans, a brief account on International and National organizations for conservation of biodiversity; Conservation methods: *in situ* conservation – protected areas, biosphere reserves, national parks, sanctuaries and sacred groves, *ex situ* – conservation, botanical gardens, gene banks, medicinal conservation parks, herbal gardens.

MJ-22 PLANT BIODIVERSITY AND CONSERVATION
Practical
Credit: 1

1. Study of the characters and threatened plants included in the theory.
2. Calculation of biodiversity using diversity indices
3. Determination of the minimum size of the quadrat suitable for an area using 'species area curve' method.
4. Determination of Importance Value Index (IVI) of the plant species in the community by quadrat method.
5. Study of Phytogeographic maps of world and India.
6. Map of Hot spots, Continental drift.

Suggested Reading:

CSIR 1986. The Useful Plants in India.

Glasson, J., Therivel, R. & Chadwick, A. 1995. - Introduction to environment impact assessment. UCL Press Ltd., London.

Heywood, V.H. & Wyse Jackson, R.S. (eds.), 1991. - Tropical Botanical Gardens- their role in conservation and development. Academic Press, San Diego.

Heywood, V.M. and Watson, R.T. 1985. Global Biodiversity Assessment, Cambridge Univ. Press, Cambridge.

Kothari, 1987. Understanding biodiversity, life sustainability and equity, Orient Longman.

Nayar, M.P. & Sastry, A.R.K. 1987, 1989, 1990. - Red Data Book of Indian Plants (3 vols.).

Nayar, M.P. 1996. - Hot spots of endemic plants of India, Nepal, and Bhutan. TBGRI, Trivandrum.

Negi, S.S. 1993. Biodiversity and its Conservation in India.

Peter B. Kaufman et al., 1999. Natural Products from Plants

Richard B. Primack. 1993. Essentials of Conservation Biology

Swaminathan, M.N. & Jain, R.S. Biodiversity: Implications for global security, Macmillan, 1982.

Walter, K.S. & Gillett, H.J. 1998. - IUCN Red List of threatened plants. The World Conservation Union, Cambridge.

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MJ-23 PLANT BIOTECHNOLOGY

Theory

Credits: 3 *Teaching Hours: 45*

Unit I Plant Tissue Culture

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit II Recombinant DNA Technology

Restriction Endonucleases, Prokaryotic & Eukaryotic Vectors (YAC). Restriction Mapping (Linear and Circular); Bacterial Transformation and selection of recombinant clones. PCR mediated gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR. Agrobacterium-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics–selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit III Applications of Biotechnology

Pest resistant (Bt-cotton); herbicide resistant plants (Round-Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

MJ-23 PLANT BIOTECHNOLOGY

Practical

Credit:1

1. (a) Preparation of MS medium. (b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of tobacco, Datura, Brassica etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plant genomic/ plasmid DNA.
8. Restriction digestion and gel electrophoresis of plasmid DNA.

Suggested Reading:

Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.

Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication House Pvt. Ltd., New Delhi. 5th edition.

Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.

Stewart, C.N. Jr. (2008). Plant Biotechnology.

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SKILL ENHANCEMENT COURSE -I (3 Credits)

SEC-1 MUSHROOM CULTIVATION

Theory

Credits: 1 *Teaching Hours: 15*

UNIT I: Introduction on mushroom. Common edible mushrooms available in India; Poisonous mushrooms; Nutritional and medicinal value of edible mushrooms (Proteins - amino acids, mineral elements, carbohydrates, crude fibre content, vitamins); Storage and nutrition: Short-term storage- Refrigeration, Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Factors affecting substrate (for cropping) quality.

SEC-1 MUSHROOM CULTIVATION

Practical *Teaching Hours: 30*

Credits: 2

1. Familiarization of materials and tools for mushroom cultivation
2. Medium preparation and sterilization for pure culturing
3. Isolation of mother culture
4. Spawn multiplication
5. Spawn seeding
6. Collection of substrate locally available material
7. Substrate preparation for cropping
8. Spawn running
9. Cropping, monitoring
10. Harvesting and marketing

Suggested Reading:

Bahl, N. (2000). Hand book of Mushrooms. Oxford & Ibh Publishing Co. Pvt Ltd.

Dr. Anil K. Thakur, Dr. Susheel K. Bassi, Dr. N.S. Atri. (2020). Mushroom Cultivation Technology (Skill Enhancement Course) B.Sc. Classes. S. Dinesh & Co., Jalandhar, Punjab.

Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) OysterMushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

Sarkar Krishnendu Acharya and Anirban Roy. (2021). Mushroom Cultivation Technology. Techno World, Kokata, West Bengal.

Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

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SKILL ENHANCEMENT COURSE -II (3 Credits)

SEC-II: FLORICULTURE

Theory

1 Credits *Teaching Hours: 15*

UNIT I: Introduction: Importance and scope of floriculture; Flower propagation methods: Sexual and vegetative; Diseases and Pests management. Ornamental Plants: Flowering annuals; Herbaceous perennials; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor plants.

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Methods to prolong vase life

SEC-II: FLORICULTURE

Practical

Credit:2 *Teaching Hours: 30 hours*

1. Plant propagation methods.
2. Routine flower management- Soil preparation, Seed sowing, Pricking, Planting and transplanting, Staking, Stopping or pinching, Defoliation.
3. Flower arrangements.
4. Disease and pests managements.
5. Packaging of cut flowers.
6. Cultivation of *Chrysanthemum*, *Alstromeria*, *Mathiola*, *Lilium*

Suggested Reading:

Anjana Sisodia and Anil K. Singh. (2021) . Textbook of Floriculture and Landscaping. New India Publishing Agency, New Delhi.

B.L. Jagetiya and Laxmi Lal. (2018). Textbook of Commercial Floriculture. Agrotech Publishing Academy. Udaipur, Rajasthan.

Desh Raj. (2020). Floriculture At A Glance. Kalyani publishers, Guwahati, Assam.

Dr. Bharati Kashyap, Dr. Anil K. Thakur , Dr. Susheel K. Bassi. (2020). Gardening & Floriculture (Skill Enhancement Course) For B.Sc. 2nd Year. S. Dinesh & Co. Jalandhar, Punjab.

Khriemenuo Pusa, (2020). Floriculture in northeast India. Publisher. Mittal Publications, Mathura U.P.

Nagaland Flower Growers Society. (2014). Blooming tales: A book of floral arrangements. Multiplex, Kohima Nagaland.

Nagaland Flower Growers Society. 2014. Blooming tales: A book of floral arrangements. Multiplex, Kohima Nagaland.

Pooja. 2012. Handbook of Floriculture. Discovery Publishing House Pvt.Ltd., New Delhi

Randhawa, G.S. and Mukhopadhyay, A. (1986). Floriculture in India. Allied Publishers.

Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

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SKILL ENHANCEMENT COURSE -III (3 Credits)

SEC-III: AGROECOSYSTEMS OF NAGALAND

Theory:

Credits: 1 *Teaching Hours: 15*

Unit I:

Agroecosystem concept; types of agroecosystems in Nagaland; Jhum cultivation- field preparation, crop diversity & management, soil management, fallow management. Alder based jhum cultivation. Impact of jhum cultivation- social, economic and environmental.

Wet terrace cultivation: types of wet terrace cultivation, field preparation and management, cropping system, water management. Traditional kitchen garden and its impact on family economics. Local food supply and its relevance in the present context.

SEC-III: AGROECOSYSTEMS OF NAGALAND

Practical

Credit: 2 *Teaching Hours: 30 hours*

1. Soil management practices in jhum system of Nagaland.
2. Water management in wet terrace system.
3. Collection of local food items through market survey.
4. Comparative evaluation of agroecosystems in Nagaland through field survey or interview methods.
5. Evaluation of system properties of representative agroecosystems.
6. Field visit for observation of agroecosystems-jhum and wet terrace cultivation fields.

Suggested Reading:

Nakhro, V. 2011. Traditional Agricultural Practices and Sustainable Livelihood . A Thematic Report. Department of Planning & Coodination. Government of Nagaland.

Cairns, M & Brookfield, H. 2011. Composite farming systems in an era of change: Nagaland, Northeast India. Asia Pacific Viewpoint, Vol. 52, No. 1.

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VALUE ADDED COURSE-I (3 Credits)

VAC-I ENVIRONMENTAL SCIENCE
Theory:
Credits: 3 *Teaching Hours: 45*

Unit I: Environmental Pollution
Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, nuclear hazards and human health risks; solid waste management: Control measures of urban and industrial waste. Pollution case studies.

Unit II: Environmental Policies & Practices

Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture; environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit III: Human Communities and the Environment

Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Suggested Reading:

Bharucha E. (2008). Textbook of Environmental Studies. University Press Pvt. Ltd. Hyderabad, India.

VALUE ADDED COURSE-II (3 Credits)

VAC-II: ORGANIC FARMING

Theory:
Credits: 3 *Teaching Hours: 45*

UNIT-1

Introduction to Organic Farming, Organic Certification and Marketing

Definition and principles of organic farming, methods and benefits: health and environment, prospects of organic farming. IFOAM. Understanding organic certification, certification bodies and procedures standards and regulations for organic farming, quality management and organic trademark. Concept of marketing and Indian organic market, economics of organic farming and government schemes to support organic farming.

UNIT-II
Organic soil, weed and disease management
Overview of soil, soil texture and types, structure, profile, humus & soil pH, role of soil in organic farming, C: N ratio of good fertile soil; green manure- method of composting, organic compost: over ground compost, pit compost, liquid compost, vermi compost; soil microorganism: mycorrhiza, rhizosphere- significance; neem products and other botanicals for pest and disease control, weed control, Integrated Pest Management (IPM)

UNIT-III

Activities: Field management practices

Record-Keeping and Documentation, application of compost, land and seed bed preparation, seed selection and seedling preparation, selection of crops for organic farming, intercropping, planting techniques and schedules, weed management, efficient water use, rainwater harvesting and conservation methods. Cultural, biological and mechanical pest management, field visits.

Suggested reading:

Bansal, M. 2017. Basics Of Organic Farming .

Dongarjal R. P. and Zade S.B. 2019. Insect Ecology and Integrated Pest Management, Akinik Publications, New Delhi.

Dushyent Gehlot. 2019. Organic Farming- standards, accreditation, certification and inspection. Agribios, India.

FAO 2014. Training Manual for Organic Agriculture guide on Introduction to Organic Agriculture (FAO-TECA), International Federation of Organic Agriculture Movements (IFOAM - Organics International).

Gupta, M., 2004. Organic Agriculture Development in India. ABD publishers, Jaipur, India.

NPCS Board of Consultants & Engineers 2021. The Complete Book on Organic Farming and Production of Organic Compost (2nd Revised Edition)

Sathe, T.V. 2004, Vermiculture and Organic Farming. Daya Publishers.

Somasundaram, E. Udhaya Nandhini, D. et al. 2019. Principles of Organic Farming (With Theory and Practicals)

Yadav Shweta and Singh V.K. 2014. Vermitechnology: Rebuilding of Sustainable Livelihoods. Nova Science Publisher, Inc: 400 Oser, Ave, Suite 1600: Hauppauge, New York, USA. ISBN 978-1-6317-943-3.

Yadav, A.K. 2015. Organic Agriculture (Concept, Scenario, Principals and Practices), National Centre of Organic. Farming Department of Agriculture and Cooperation, Ministry of Agriculture, Govt of India, CGO-II, Kamla Nehru Nagar Ghaziabad, 201 001, Uttar Pradesh.

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MULTI-DISCIPLINARY COURSE-I (3 Credits)

MDC-I: BONSAI TECHNIQUE
Theory
Credits: 2 *Teaching Hours: 30*

Introduction and Techniques

Introduction- history, aim, scope and importance of Bonsai. Overview of bonsai making process. Guide to choosing bonsai plants; Sources of Material for Bonsai: uprooting from ground, seeds, cuttings, dividing, grafting and layering. Re-potting, training, pruning, defoliation. Bonsai soil, irrigation, fertilizers, pest and disease management.

UNIT II: (15 hours)

Designing, Styles and entrepreneurship.

Bonsai architecture/ styles – Upright, Slanting, Windswept, Broom, Cascade, Formal and informal styles. Trunk: single, twin, multiple, forest styles. Roots. Display and exhibition. Valuation of Bonsai. Bonsai making as a business proposition.

MDC-I: BONSAI TECHNIQUE
Practical
Credit:1 *Teaching Hours: 15*

1. Tools and materials for bonsai making.
2. Soil preparation
3. Training: wiring

4. Pruning: stem and roots
5. Display and exhibition
6. Field visits

Suggested Reading:

Ken Norman. (2013). Complete Practical Encyclopedia of Bonsai: The Essential Step-By-Step Guide to Creating, Growing, and Displaying Bonsai with Over 800 Photographs. Lorenz Books, Anness Publishing, Ohio, USA.

D.K. (2014). Bonsai. Dorling Kindersley Limited, London, U.K.

Dan Barton. (2019). The Bonsai Book: The Definitive Illustrated Guide. Racehorse, *New York City, U.S.A*

Harry Tomlinson. (2019). 101 Essential Tips Bonsai. Dorling Kindersley Limited, London, U.K.

Larry W Morton and Walter Pall. (2016). Modern Bonsai Practice: 501 Principles of Good Bonsai Horticulture. Larry W Morton, Wisconsin, U.S.A.

Peter Chan. (2018). The Bonsai Beginner's Bible. Mitchell Beazley, London, U.K.

Yukio Hirose. (2020) The Ultimate Bonsai Handbook: The Complete Guide for Beginners. Tuttle Publishing, Vermont, U.S.A.

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MULTI-DISCIPLINARY COURSE-II (3 Credits)

MDC-II FIELD AND HERBARIUM TECHNIQUES

Theory

Credits: 2 *Teaching Hours: 30*

Unit 1: Introduction to Herbarium

History, objective and role of herbarium in research and academics; details of different types of herbaria, acronyms, functions of herbaria and few important herbaria of world and India; Field equipment, field work, field notebook, and details of collection process of specimen for herbarium.

Unit 2: Processing of specimens and Maintenance

Details of poisoning, pressing, drying, mounting, stitching, labelling, identification and determination of plant, incorporation; introduction to different methods of maintenance of such as fumigation, heating, chemical treatment;

Unit 3: Collection, preservation and identification.

Brief discussion on Collection, preservation and identification of different plant groups- Angiosperm, gymnosperms, Algae, wild mushrooms, and bryophytes.

MDC-II FIELD AND HERBARIUM TECHNIQUES
Practical
Credit:1 *Teaching Hours: 15*

1. Collection of wild plant specimens, Press, Dry and mount on standard herbarium sheet.
2. Description and identification of collected taxa using taxonomic keys.

Suggested readings:

1. Jain, S.K. & Rao, R.R. 1977. *Handbook of field and Herbarium Methods*. Today and Tomorrow Publishers, New Delhi.
2. Pandey, S.N. & S.P. Misra. 2008. ***Taxonomy of Angiosperms***. Ane Books India, NewDelhi.
3. Sharma, O.P. 1996. ***Plant Taxonomy***. TATA McGraw Hill, New Delhi

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MULTI-DISCIPLINARY COURSE-III (3 Credits)

MDC-III NATURAL RESOURCES AND CONTEMPORARY ISSUES
Theory
Credits: 3 *Teaching Hours: 45*

Unit-1 Contemporary practices for sustainable utilization
Environmental Impact Assessment (EIA) in India and the world, Bioprospecting, Biopiracy, Intellectual Property Rights (IPR), Trade-Related Intellectual Property Rights (TRIPS), Geographic Information System (GIS) and its applications.

Unit-2 Current issues

Global warming and future scenarios; Ecological Footprint: components, biocapacity, ecological overshoot, calculation; carbon footprint and carbon credits; climate resilience, livelihood and food security, overview of programmes to improve food security in India.

Unit–III Global institutions and initiatives

Natural Resource Accounting: significance, functions and methods; Participatory Resource Appraisal. Alternative sources of food, Convention of Biodiversity (CBD): its organs and objectives; UNEP and UNDP. Concept and significance of sustainable development.

Suggested Reading:

Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Singh, S. and Marwah, R. (2023). Politics of Climate Change: Crises, Conventions and Cooperation. World Scientific, https://doi.org/10.1142/13067.

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