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MANIPUR UNIVERSITY
COURSE STRUCTURE
FOR UNDER GRADUATE COURSE: B.Sc. (Hons)
(Semester System)

1 TO 4

Subject: BOTANY

Semester	Paper No.	Title of the paper	Marks allotted Theory/Practical
I	BOT – 101 ELECTIVE	Botany – I (Virus, Bacteria & Cryptogams)	75
		I. Virus & Bacteria	15
		II. Algae	15
		III. Fungi and Plant Pathology	15
		IV. Bryophytes	15
		V. Pteridophytes	15
	BOT – 101(P)	Practical	25
II	BOT – 202 ELECTIVE	Botany – II (Gymnosperms, Angiosperms, Applied Botany & Embryology)	75
		I. Gymnosperms & Palaeobotany	15
		II. Angiosperms	15
		III. Applied Botany & Ethnobotany	15
		IV. Anatomy of Angisperms	15
		V. Embryology & Palynology	15
	BOT – 202 (P)	Practical	25
III	BOT – 303 ELECTIVE	Botany – III (Plant Geography, Ecology, Plant Physiology & Molecular Biology)	75 + 25 = 100
		I. Plant Geography	15
		II. Principles of Ecology	15
		III. Plant Physiology	15
		IV. Biochemistry	15
		V. Molecular Biology	15
	BOT – 303 (P)	Practical	25
IV	BOT – 404 ELECTIVE	Botany –IV (Cytogenetics, Biotechnology & Biometrics)	75 + 25 = 100
		I. Cytology	15
		II. Genetics	15
		III. Plant breeding	15
		IV. Biotechnology	15
		V. Biometrics	15
	BOT – 404 (P)	Practical	25
V	BOT – 505 HONOURS	Botany – V (Microbial Diversity, Plant Pathology & Embryophyta)	100
		I. Microbial Diversity	20
		II. Microbes and Human Welfare	20
		III. Plant Pathology	20
		IV. Plant disease management	20
		V. Bryology and Pteridology	20

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V	BOT - 506 HONOURS	Botany – VI (Advance Plant Taxonomy, Anatomy, Embryology and Palynology) I. Primitive seed plants & Paleobotany II. Advance Plant Taxonomy III. Plant Resources– Management & Utilizations IV. Anatomy of Angiosperm V. Plant Embryology & Palynology	100 20 20 20 20 20 20
V	BOT – 507 (P) HONOURS	Botany – VII Practical (Based on theory papers BOT–505 and BOT–506)	100
VI	BOT – 608 HONOURS	Botany – VIII (Ecology, Plant Physiology & Molecular Biology) I. Vegetation & Natural resources II. Ecosystem & Pollution III. Plant Physiology IV. Biochemistry V. Molecular biology	100 20 20 20 20 20
VI	BOT – 609 HONOURS	Botany – XI (Cell Biology, Genetics, Plant breeding, Biotechnology & Computer Application) I. Cell Biology II. Genetics III. Plant Breeding IV. Biotechnology V. Computer Application & Bioinformatics	100 20 20 20 20 20
VI	BOT – 610 (P) HONOURS	Botany – X Practical (Based on Theory papers BOT–608 and BOT–609)	100

MANIPUR UNIVERSITY
COURSE STRUCTURE
FOR UNDER GRADUATE COURSE: B.Sc

SUBJECT – BOTANY

SEMESTER – I

BOT – 101/BOTANY PAPER – I (Virus, Bacteria and Cryptogams) Marks: 75

Unit I : Virus – General structure, viral components, classification, nomenclature, viral replication (TMV).
Bacteria – General characters, prokaryotic cell organization, brief account of Bergey's classification system, reproduction, brief account on genetic recombination in bacteria, types of nutrition, autotrophism (phototrophism and chemotrophism) and heterotrophism.
Marks: 15

Unit II : Fungi – General characters, classification (Ainsworth), asexual and sexual reproduction, life cycles of *Saprolegnia* (Mastigomycota), *Mucor* (Zygomycota), *Neurospora* (Ascomycota), *Puccinia* (Basidiomycota) and *Penicillium* (Deuteromycota), economic importance of fungi.
Lichens – Thallus structure, reproduction and economic importance
Plant Pathology – Concepts and classification of plant diseases, causes of plant disease, principles of plant disease management Marks: 15

Unit III : Algae – General characters, classification (Fritsch), range of vegetative and reproductive structure of different classes, life cycles of *Oscillatoria* (Cyanophyceae), *Oedogonium* (Chlorophyceae), *Vaucheria* (Xanthophyceae), *Cyclotella* (Bacillariophyceae), *Ectocarpus* (Phaeophyceae) and *Polysiphonia* (Rhodophyceae), economic importance of algae. Marks: 15

Unit IV : Bryophytes – General characters, classification, alternation of generation, range of structural organization of gametophytes and sporophytes, methods of reproduction, life cycles of *Riccia, Marchantia, Anthoceros, Pellia, Porella, Sphagnum* and *Funaria*
Marks: 15

Unit V : Pteridophytes – General characters, classification, anatomy of sporophytes, reproductive methods, life cycles of *Lycopodium, Selaginella, Equisetum, Isoetes, Marsilea* and *Dryopteris.* Marks: 15

BOT-101(P)/BOTANY PRACTICAL – I Marks: 25

1. Gram staining of bacteria
2. Microscopic study of vegetative and reproductive structures of algal genera included in theory syllabus
3. Microscopic study of vegetative and reproductive structures of fungal genera included in theory syllabus.
4. Study of lichen thalli – crustose, foliose and fruticose
5. Study of locally important plant diseases
6. Morphology and microscopic study of vegetative and reproductive structures of bryophyte genera included in theory syllabus
7. Morphology and microscopic study of vegetative and reproductive structures of pteridophyte genera included in theory syllabus.

Recommended books:

1.	Introduction to Mycology	:	C.J. Alexopoulos and C.W. Mims Willey Eastern Ltd., New Delhi
2.	An Introduction to Mycology	:	R.S. Mehrotra and K.R. Aneja New Age International (P) Ltd., New Delhi
3.	The Structure and Reproduction of the Algae Vol. I & II	:	F.E. Fritsch Cambridge University Press, London
4.	Introductory Phycology	:	H.D. Kumar East-West Press Pvt. Ltd., New Delhi
5.	Introduction to Embryophyta (a) Vol. I. Bryophyta (b) Vol. II. Pteridophyta	:	N.S. Parihar Kitab Mahal, Allahabad
6.	The Morphology of Pteridophytes	:	K.R. Sporne B.I. Publications, Bombay
7.	Microbiology : Principles and Explorations	:	J.G. Black John Wiley and Sons,-Inc. USA
8.	The Algae	:	V.J. Chapman and D.J. Chapman Mcmillan India Ltd.

SEMESTER – II

BOT-202/BOTANY-II (Gymnosperms, Angiosperms, Applied Botany and Embryology)

Mark: 75

Unit I : Gymnosperms and Palaeobotany:

General account of Gymnosperms and that Classification; Morphology, Reproduction and Life cycle of *Cycas, Pinus* and *Guetum.* Economic importance of Gymnosperms.

Palaeobotany: Fossil formation and types. Geological time scale and dominant fossil flora of different ages. Marks: 15

Unit II : Angiosperm Taxonomy:

Introduction to Plant Taxonomy

Importance of field work, observation, herbarium preparation.

Concept of species, genus and family. Keys of identification. Rules of nomenclature (validity, effectivity and priority). Classification systems of Linnaeus, Bentham and Hooker, Engler and Prantle and Hutchinson.

Taxonomic studies of the following Families: Ranunculaceae, Brassicaceae, Malvaceae, Fabaceae, Rosaceae, Apiaceae, Asteraceae, Solanaceae, Lamiaceae, Euphorbiaceae, Liliaceae and Poaceae Marks: 15

Unit III : Applied Botany & Ethnobotany:

Origin of cultivated plants, Vavilov's centre of origin.

Origin, cultivation and improvement of Rice and Potato.

History, cultivation and processing of Tea.

Characteristics and uses of timber yielding plants:Teak and Pinus.

Medicinal plants: *Cinchona, Rauwolfia* and *Adhatoda.*

Ethnobotany: Concept, Classification and interdisciplinary approaches Marks: 15

Unit IV : Plant Anatomy:

Cell structures, cell wall and cell inclusion.

Organisantion of apical meristem. Structure and distribution of simple and complex tissues. Primary and Secondary growth in plant

Anomalous growth in *Amaranthus, Mirabilis* and *Dracaena* stem Marks: 15

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Unit V : Embryology and Palynology:
Plant embryology, Micro and mega sporogenesis, development of male and fe gametophytes, fertilization, embryo and endosperm development.
Palynology: Pollen and spore morphology. Aerobiology and pollen allergy. Marks

BOT-202(P)/BOTANY PRACTICAL – II

Marks

Gymnosperms and Palaeobotany:

1. Temporary stained preparation of the reproductive structures of Gymnosp included in the theory.
2. Examination of the available specimens/slides of the fossil plants
3. Description and classification of a representative species from each of angiosperm families mentioned in the theory.
   Ranauculaceae: *Ranunculus*
   Apiaceae : *Coriandrum*
   Asteraceae: *Ageratum, Gynura & Spilanthes*
   Solanaceae: *Solanum*
   Lamiaceae: *Leucas/Ocimum*
   Enphorbiaceae: Castor
   Liliaceae: Onion/*Asparagus*
   Poaceae: *Dactyloctenium/Cynodon*
   Malvaceae: *Sida/Urena*
   Identification of collected plants from the field
4. Collection and identification of three plants each from cereals, pulses, yielding plants, medicinal plants available in Manipur.
5. To prepare a chart containing the starch contains from five important crop p and protein contains from five pulses by using internets.
6. Preparation of temporary slides for the study of anomalous secondary grow plants included in the theory paper.
7. Preparation of stained squashed of pollen motile cells, pollen grains and dissec of endosperm and embryo.
8. Field observation of local vegetation and submission of report is compulsory.

Recommended books

1. Economic Botany : A. F. Hill
   Tata McGraw-Hill Publishing Co., New Delhi
2. The Embryology of Angiosperms : S.S. Bhojwani & S.P. Bhatnagar
   Vikas Publishing House Pvt. Ltd., New Delhi
3. Palynology : M.R. Saxena
   Oxford & IBH Publ. Co. Ltd., New Delhi
4. Morphology of Gymnosperms : J.M. Coultar & C.J. Chamberlain
   Centra Book Depot, Allanabad
5. Taxonomy of Vascular Plants : G.H.M. Lawrence
   Oxford & IBH Publ., New Delhi
6. A Handbook of Field and Herbarium Methods : S K. Jain & R R. Rao
   Today & Tomorrows Print. & Publ., New Delhi
7. A Manual of Ethnobotany : S.K. Jain
   Scientific Publications, Jodhpur.
8. Plant Anatomy : K. Esau
   John Wiley & Sons Inc., New York.
9. An Introduction to Palaeobotany : C.A. Arnold
   Tata McGraw-Hill Co., New Delhi

Semister – III

3rd Semester

SEMESTER III

BOT-303/BOTANY – III (Plant Geography, Ecology, Plant Physiology & Molecular Biology)

Marks: 75

Unit I : Plant Geography- Its scope and importance; phytogeographical regions of India, factors affecting distribution; plant dispersal, migration methods, endemism and barrier of distribution. Marks: 15

Unit II : Principles of Ecology: Ecosystem concept, structure and function, ecological pyramids, energy flow and mineral cycling (CNP), food chain, food web and trophic levels, structure of plant community, ecological factors (abiotic and biotic factor); ecological adaptation of xerophytes, hydrophytes, ecological succession- hydrosere and xerosere. Marks: 15

Unit III : Plant Physiology: Plant water relationship-diffusion, imbibitions, osmosis, water potential and its component; absorption and translocation of water; ascent of sap (theories); mineral nutrition; transpiration-significance, factors affecting transpiration, mechanism of stomatal movement: Translocation of solutes;
Growth and development, concept of photoperiodism and vernalization; Photosynthesis: Photosynthetic pigment system, cyclic and non-cyclic photophosphorylation, C_3, C_4 and CAM pathways, factors affecting photosynthesis; respiration – aerobic, anaerobic, factors affecting respiration; biological Nitrogen fixation-symbiotic and non-symbiotic. Marks: 15

Unit IV : Biochemistry: Chemical bonds, pH, buffer; structure, classification and function of biomolecules (carbohydrates, lipids, amino acids, proteins, nucleic acids and vitamins). enzyme-properties, nomenclature and classification as per ECIUB, mechanism of enzyme action, respiration-glycolysis, krebs cycle, electron transport system. Marks: 15

Unit V : Molecular Biology: Gene organization of prokaryotes and Eukaryotes, structure and physical properties of DNA and RNA; biosynthesis of nucleic acids; DNA – replication; RNA translation, mechanisms of protein synthesis. Marks: 15

BOT-303(P)/ BOTANY PRACTICAL– III Marks: 25

1. Preparation of map of phytogeographical regions of India
2. Determination of the minimum size of the quadrat by species area curve method
3. Determination of frequency of vegetation in a community by quadrat method.
4. Determination of osmotic potential of vacuolar sap by plasmolytic method using *Rheo/Tradescantia* leaf and onion peel.
5. Determination of rate of transpiration by Gangong's potometer
6. Extraction of chlorophyll pigments from leafy plants by paper chromatographic Technique.
7. Study of rate of photosynthesis under different light intensities.
8. Determination of RQ of plant materials having fats, protein.
9. Simple tests for carbohydrate, protein, fats and nucleic acids
10. Preparation of buffer-Phosphate and Tris acetate buffer
11. Isolation of DNA from plant seedlings
12. Field observation of local vegetation and submission of report is compulsory

Recommended Books

1. Basic Ecology : Odum, E.P. Saunders, Philadelphia, USA
2. Concepts of Ecology (3rd Ed.) : Kormondy, E. Prentice Hall of India, New Delhi

3.	Ecology, Environment and Resource Conservation	:	Singh J.S., Singh S.P. and Gupta S.R. Anamaya Publishers, New Delhi
4.	Fundamentals of Ecology	:	Odum E.P. Prentice Hall of India, New Delhi
5.	Plant Physiology	:	Salisbury F.B. and Ross C.W. Wassworth Publ. Co.,/CBS Publ. & Dist., Delhi
6.	Plant Physiology	:	Bidwell R.G.S. Macmillan Publication Co. New York.
7.	Plant Physiology	:	Devlin RM & Francis H. Witham Fourth Edn. CBS, New Delhi
8.	Outlines of Biochemistry	:	Conn E.E., P.K. Stumpt, G. Bruerning and R.H. Doi John Willey & Co., New York
9.	Biochemistry	:	Stryer L. W.H. Freeman & Co., New York
10.	Principles of Biochemistry	:	Lehninger A.I., Nelson D.L. & Cox M.M. CBS Publ., Delhi
11.	Cell and Molecular Biology	:	De Robertis EMF & EDP De Robertis BI Waverly Pvt. Ltd.
12.	Molecular Biology of Cell	:	Bruce Alberts et. al. Garland Publications

SEMESTER IV

BOT-404/BOTANY-VI (Cytogenetics, Biotechnology and Biometrics) Marks 75

Unit I : Cytology:

General accounts of organisation and function of cell and its components: Cell wall; plasmalemma; endoplasmic reticulum; golgi apparatus; ribosomes; mitochondria, plastids and nucleus. Structure and function of chromosome. Mitosis and meiosis – their significance. Marks: 15

Unit II : Genetics:

Mendelism: Law of segregation and independent assortment; back cross and test cross; Gene interaction; Gene expression; Structure of gene; transfer of genetic information: transcription; translation. Protein synthesis; t-RNA. Linkage and Crossing over; mutation and mutagens: chromosome alterations – deletions, duplications, translocations, inversions; variation in chromosome number: aneuploidy, polyploidy. Extra-nuclear inheritance: Sex chromosome and sex determination in plants. Marks: 15

Unit III : Plant Breeding:

Principles of plant breeding: breeding behaviour, sexual, asexual, apomixis; polyembryony; breeding methods – conventional; methods of breeding in self and cross pollinated crops; heterosis. Marks: 15

Unit IV : Biotechnology:

Basic aspects of plant tissue culture; cellular totipotency; differentiation and morphogenesis; Genetic engineering in plant improvement; application of plant biotechnology in medicine, agriculture and human welfare. Marks: 15

Unit V : Biometry:

Scope and application; collection of data. Sample and sampling – theory and methods; mean, mode, median and standard deviation; probability; chi-square test and analysis. Marks: 15

BOT-404(P)/BOTANY PRACTICAL –IV Marks: 25

1. To study cell structure from Onion leaf peel, demonstration of staining and mounting methods
2. Comparative study of Cell structures in Onion cells, *Spirogyra;* Study of Cyclosis in *Tradescantia* staminal Cells.
3. Study of plastids to examine pigment distribution in plants (e.g. *Cassia* and *capsicum*)
4. Examination of electron micrographs of eukaryotic cells with special reference to organelle.
5. Examination of various stages of mitosis and meiosis using appropriate land material (e.g. Onion root tips, Onion flower buds, *Rheoe*, *Tradescantia*).
6. Working out the law of inheritance using seed mixtures.
7. Callus induction, organogenesis and plant regeneration (rice mature embryo)
8. Protoplast isolation e.g. tobacco, proteins
9. Preparation of tissue culture media, sterilization and inoculation of plant material.
10. Analysis of data for mean, mode, median and standard deviation.

Recommended Book

1.	Molecular Biology of Cell	:	Albors, GB., Bray, D., Lewis, J., Raf, M., Roberts, K. & Naten, L.D. Garland Publ. Co., New York
2.	Molecular Cell Biology	:	Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnel, J. W.H. Freeman & Co., New York
3.	Principles of Genetics	:	Gardner E.J., Snustad, D.P. & Simmons S, M.J. John Wiley & Sons, USA
4.	Molecular Cell Biology	:	Nolfe, S.H. Wadswooth Publ. Co., California
5.	Plant Tissue Culture: Applications & Limitations	:	Bhojwani S. S. Elsevier Science Publ., New York
6.	Breeding Field Crops	:	Pachlmann, J.M. & Sleeper, D.R. Longman, London & New York
7.	Principles & Practice of Plant Breeding	:	Sharma, J.R. Tata McGraw-Hill Publ. Co., New Delhi
8.	Ecology Work Book	:	Misra, R. Oxford University Press, Calkutta
9.	Plant Microtechnique	:	Johansen, D.A. McGranier Hill Book Co., New York
10.	Chromosome Technique (Theory & Practice)	:	Sharma, A. & Sharma, A. Butterworths, London.

SEMESTER – V

BOT-505/BOTANY –V (Microbial Diversity, Plant Pathology and Embryophyta) Marks: 100

Unit I : Microbial Diversity – History of microbiology, five kingdom system of classification, Carl Woese's Three Domains of living organism (Archaebacteria, Bacteria and Eukaryotes), microbial forms- viruses (including prions and viroids), archaebacteria, bacteria, algae, fungi and protozoa – their characteristic features, microbiology of soil, air and water. Marks : 20

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Unit II : Microbes and Human Welfare – Role of microbes in industry (alcohol, antibiotics, organic acids, enzymes, proteins, vitamins, biofuel), agricultural microbiology (biofertilizers and biopesticides), food microbiology (food spoilage and food preservation,), medical microbiology (microbes as pathogenic organisms). Marks: 20

Unit III : Plant Pathology – History of plant pathology, Koch's postulates of Host pathogen interrelation, classification of plant diseases on the basis of causal organisms and symptoms, studies on symptoms, disease cycles and control measures of the following diseases – damping-off of seedlings, late blight of potato, white rust of crucifers, powdery mildew of pea, blast of rice, stem rust of wheat, leaf blight of paddy, citrus canker and TMV. Marks: 20

Unit IV : Plant Disease Management – Plant quarantine, seed certification, cultural practices, fungicides (classification on the basis of chemical nature and mode of action), biological control, breeding for resistant varieties, genetically modified plants (merits and demerits), concept of integrated pest disease management. Marks: 20

Unit V : Bryology and Pteridology – Bryophytes as the first land plants, evolutionary trend, ecological and economic importance of bryophytes, brief account on the development of Bryology in India. Origin and evolution in pteridophytes, relationship of pteridophytes with bryophytes and gymnosperms, heterospory, seed habit and stellar evolution in pteridophytes, ecological and economic importance of pteridophytes. Marks: 20

Recommended Books

1. Plant Diseases : R.S. Singh
   Oxford & IBH Publ. Co., New Delhi
2. Introduction to Principles of Plant Pathology : R.S. Singh
   Oxford & IBH Publ. Co., New Delhi
3. Plant Pathology : R.S. Mehrotra
   Tata McGraw-Hill Publ. Co., New Delhi
4. The Microbial World : R.Y.Stanier, J.L. Engrahan, M.L. Wheelis and P.R Painter: Prentice–Hall of India, New Delhi
5. Text Book of Microbiology : R. Ananthanarayan & C.K.J. Paniker,
   Orient Longman, Bombay
6. An Introduction to Embryophyta (Bryophyta) : N.S. Parihar
   Kitab Mahal, Allhabad
7. An Introduction to Embryophyta (Pteridophyta) : N.S. Parihar
   Kitab Mahal, Allahabad
8. Morphology of Pteridophyta : K.R. Spome
   B.I. Publications, Bombay
9. Diseases of Crop Plants in India : G. Rangaswamy
   Prentice Hall of India, New Delhi
10. Lab Manual of Microbiology : G. Gunasekaran
    New Age Publication

BOT-506/BOTANY-VI (Advanced Plant Taxonomy, Anatomy, Embryology and Palynology)

Marks: 100

Unit I : Primitive seed plants and Palaeobotany:
Concept of Progymonosperms. Diversity among Gymnosperms and their distribution in Indian sub-continent. Origin and Evolution of Gymnosperms. Salient features and life cycle of *Ginkgo*, *Taxus* and *Ephedra*.
Fossil algae and fungi. Primitive land plants: *Rhynial*, *Lepidodendron*, *Calamites* and Sphenophyllum. Fossil Gymnosperm orders. Cycadofilicales, Bennettitales and

Cordaitales. Fossil Angiosperm: *Palmoxylon*, *Enigmocarpon*, *Sahnianthus*. Palaeobotany in the exploration of fossil fuels. Marks: 20

Unit II : Advanced Plant Taxonomy

Objective, Principles and Practices of Plant taxonomy. Methods and techniques of herbarium preparation. Development of chemotaxonomy, Cytotaxonomy and Numerical taxonomy. Biosystematics, Taxonomy on the web: Molecular Taxonomy: Application of DNA hybridization technique in plant Taxonomy; Importance of biochemical markers and DNA markers in taxonomic studies. Role of Botanical survey of India and Taxonomic Literatures. Classical system of Classification: Bentham and Hooker Taxonomic studies affinities and economic importance of the following families: Magnoliaceae, Asteraceae, Rutaceae, Anacardaceae, Myrttaceae, Cucurbitaceae, Dipteriocarpaceae, Polygonaceae, Moraceae, Rubiaceae, Apocynaceae, Asclepeadaceae, Acanthaceae, Verbinaceae. Aracaceae, Scitaminae (Musaceae, Zingiberaceae, Cannaceae and Marantaceae) Orchidaceae and Cyperaceae. Marks: 20

Unit III : Plant Resources – Management and Utilization

Classification of economic plants, based on their uses. Cyanobacteria: *Spirulina*. Origin, cultivation and improvement of Maize, Mustard, Pea and Banana. History, cultivation and processing of Rubber. Characteristics and uses of timber yielding plants: *Dipterocarpus*, *Phoebe* and *Melanorrhoea*. Medicinal Plant: *Ephedra*, *Carthamus*, *Aloe vera* and *Vinca*. Pharmacognosy: Aims and objects, Collection and preparation of drugs. Importance of ethnobotany in genepool and germplasm conservation. Marks: 20

Unit IV : Anatomy of Angiosperm:

Apical meristem and histological theories of shoot and root apices. Vascularization: Primary shoots of monocotyledons and dicotyledons. Formation of internodes, branching pattern, monopodial and sympodial growth. Root-stem transition, Cambium and its function; formation of secondary xylem, characteristics of growth ring, sapwood and heartwood. Secondary phloem, stomata and their types. Anomalous secondary growth in *Bauhinia*, *Bougainvillea* and *Nyctanthus*. Marks: 20

Unit V : Plant Embryology and Palynology:

Plant Embryology. Microsporangium and types of pollen tetrad. Megasporangium and types of meganetogenesis. Pollen- pistil interaction, compatibility and incompatibility, syngamy and triple fusion. Development, structure and function of endosperm. Types of haustoria, Embryogeny- types. Development of monocot and dicot embryos. Suspensor, synergid, polyembryony, apomixes and their role. Pollen production and dispersion in space and time. Role of pollen in taxonomy. Application of palaeopalynology, melisso-palynology and forensic palaeopalynology. Marks: 20

Recommended Books

1. Economic Botany : Albert F. Hill
   Tata McGraw-Hill Publ. Co., New Delhi
2. The Embryology of Angiosperms : S.S. Bhojwani & S.P. Bhatnagar
   Vikas Publ. House Pvt. Ltd., New Delhi
3. Palynology : M.R. Saxena
   Oxford & IBH Publ. Co. Ltd., New Delhi
4. Morphology of Gymnosperms : J.M. Coultar & C.J. Chamberlain
   Central Book Depot, Allahabad
5. Taxonomy of Vascular Plants : G.H.M. Lawrence
   Oxford & IBH Publ. Co., New Delhi

6	A Handbook of Field and Herbarium Methods	:	S.K. Jain & R.R. Rao Today & Tomorrows Prin. & Publ., New D
7.	A Manual of Ethnobotany	:	S.K. Jain Scientific Publications, Jodhpur.
8.	Plant Anatomy	:	K. Esau John Wiley & Sons Inc., New York.
9.	An Introduction to Palaeobotany	:	C.A. Arnold Tata McGraw-Hill Book Co., New Delhi
10.	The Morphology of Gymnosperms	:	K.R. Sporne B.I. Publications, Delhi
11.	An Introduction to the Embryology of Angiosperms	:	P. Maheshwari Tata McGraw-Hill Publ. Co., New Delhi
12.	The Morphology of Angiosperm	:	K.R. Sporne B.I. Publications, New Delhi
13.	The Classification of flowering Plants Volumes I & II	:	A.B. Rendle Vikas Publ. House Pvt. Ltd., New Delhi
14.	Plant Systematic: Theory and Practical	:	Gurucharan Singh Oxford & IBH Publ. Co., New Delhi
15.	Plant Systematics: An Integrated Approach	:	Gurucharan Singh Sciences Publ. Inc., USA

BOT-507(P)/BOTANY - VII PRACTICAL (Based on theory paper BOT-505 and BO

Ma

1. Preparation of culture media for bacteria and fungi (nutrient agar and PDA).
2. Isolation of microorganisms (bacteria and fungi) from soil/water/air.
3. Pure culture maintenance of bacteria and fungi.
4. Staining of bacteria and fungi.
5. Microscopic study of *Bacillus, Coccus, Staphylococcus, Spirillum, Eschirichia, Anabaena, Saccharomyces, Candida, Aspergillus, Trichoderma.*
6. Morphological and anatomical studies of different types of root nodules (pea, bro *Mimosa, Sesbania*).
7. Demonstration of Koch's postulates.
8. Symptoms, causal organisms and microscopic studies of diseased plant specimens in theory syllabus.
9. Demonstration of commercial fungicides and equipments for field application
10. Comparative studies of thallus and reproductive structures of *Riccia, Anthoc Polygonum.*
11. Comparative studies of morphological and anatomical structures of *Lycopodium, Se* and *Marsilea* in relation to stellar evolution and heterospory.
12. Gymnosperm and palaeobotany:
    Ginkgo and *Taxus* – Temporary mounts of transverse sections of young and matu radial section and maturation secondary wood; transverse and vertical sections o whole mounts of mature microspores, young and mature embryo.
    Ephedra – T.S. of node and internode of stem, whole mount of epidermal peel, L.S microspores and embryos; permanent preparation of anther and ovule.
13. Examination and classification of specimen/slides of the fossil plants as per syllabus.
14. Advance plant Taxonomy: Description and classification up to genus of a repre species from each of the angiosperm families mentioned in the theory.
    Magnoliaceae: *Michelia*
    Brassicaceae: *Brassica/Cardamine*
    Rutaceae: *Citrus*
    Fabaceae: *Crotalaria/Vigna/Cassia/Caesalpinia/Mimosa/Acacia*

Myrtaceae: *Callistemon/Eucalyptus,*
Ancardaceae: *Mangifera*
Cucurbitacea: Luffa
Rubiaceae: *Mussaenda*
Apocynaeceae: *Vinca*
Asclepiadaceae: *Calotropis/Asclepias*
Acanthaceae: *Justicia/Adhatoda*
Verbinaceae *Duranta/ Lantana*
Polygonaceae: *Polygonum*
Orchidaceae: *Venda/Dendrobium*
Scitaminae: *Musa/Canna/Maranta/Zingiber*
Arecaceae : *Phoenix*
Cyperaceae: *Cyprus*

15. Utilizationof plants and Ethnobotany: Collection and identification of five plants each used as a source of carbohydrate, Protein, wood, oil-seed, spice and condiment and drung. Preparation of charts containing the percentage of carbohydrate contain, protein contain, oil contain, from five different species each from internet data.
16. Anatomy: Preparation of permanent/semipermanent slides for the study of anomalous secondary growth in plants included in the theory paper (Double Staining).
17. Embryology and Palynology: Examination of cleared and dissected whole mount permanent preparation of various structures mentioned in theory paper. Preparation of stained slides of endosperm and embryo. To study the germination percentage of pollen grains. Preparation of pollen slides by acetolysis method. Description and illustration of six selected pollen/spore types.
18. Identification and preparation of field notes of 50 plant species in the field.
19. An external field study tour to nationally important botanical gardens/herbaria/ sanctuaries/research laboratories, etc. and submission of the study report is compulsory.

SEMESTER VI

BOT-608/BOTANY – VIII (Ecology, Plant Physiology and Molecular Biology) **Marks: 100**

Unit I : Vegetation and Natural resources: Detailed study of the vegetation and floristic regions of India-evergreen, deciduous, mangrove forest. Natural resources-forest resources, conservation, aforestation, social forestry, agro forestry-timber extraction, dams and their effects – Mineral resources-water resources-floods, drought, Energy resources-renewable and non-renewable resources. Marks: 20

Unit II : Ecosystems and Pollution: Physical environment; biotic environment; biotic and a biotic interaction, concept of habitat and niche. Ecosystem-basic component of ecosystem. Energy flow in ecosystem, trophic levels, Environmental pollution-Major pollutants-air and water and solid, pollution-control measure; Climate change and Global warming-environmental revolution. Biodiversity- concept of biodiversity. Marks: 20

Unit III : Plant physiology: Absorption of water, Absorption of mineral elements-roots as absorbing surfaces-passive and active absorption. Physiological role of micro and macro elements-their deficiency symptoms. Phases of Growth-growth curve, Plant hormones (Auxins, Giberellins, Cytokinins, Ethylene, Abscisic acid)– physiological functions, senescences, photoperiodism, physiology of flowering-Photomorphogenesis: phytochromes, physiological role.
Photosynthesis – Significance-light reactions, Calvin cycle, photorespiration, Laws of limiting factors, chemosynthesis-a brief account. Pentose Phosphate Pathway, Biological Nitrogen fixation-mechanism, elementary knowledge of *Nif, Nod, Hup*

genes and leghaemoglobin Stress plant physiology (Principles and application).

Marks: 20

Unit IV : Biochemistry: Water as universal solvent, weak interactions in aqueous system, Principles of biophysical chemistry (pH, buffer; reaction kinetics, thermodynamics and colligative properties), Bioenergetics, Enzymes and enzyme Kinetics, enzyme regulation, Isozymes; Respiration-glycolysis, Kreb's cycle, Fermentation, Oxidative phosphorylation, ATP synthesis. Biosynthesis of Nucleic acids and Protein synthesis.

Marks 20

Unit V : Molecular Biology: Gene structures, expression and regulation: Gene organisation in prokaryote and eukaryotes, Operon concept; gene regulation in prokaryotes and eukaryote, positive and negative gene regulation; interrupted genes in eukaryotes; RNA splicing; mRNA stability.

Recombinant DNA technology; Restriction endonucleases prokaryotic and eukaryotic clone vectors; genomic and DNA libraries; various techniques of gene mapping and concept of DNA fingerprinting; polymerase chain reaction; DNA sequencing.

Nucleic Acid: Composition of nucleic Acids; DNA structure; A, B and Z forms of DNA; denaturation and renaturation of DNA; Chromatin structure; DNA replication and recombinations; DNA polymerases; different forms of RNA.

Marks: 20

Recommended books

1. Fundamentals of Ecology : Odum E.P. Prentice Hall of India, New Delhi
2. Concepts of Ecology : Kormondy, E. Prentice Hall of India, New Delhi
3. Environmental studies : Chary, S.N. Mc. Millan India Ltd.
4. Applied Ecology : Newman, E.I. Blackwell Scientific Publ., London
6. Plant Physiology : Ting I.P. Addison Wesley Publ. Co., Phillippines
7. Plant Physiology : Taiz L. & Zeige E. Sinauer Associates Inc., Massachusetts
8. Plant Biochemistry : Goodwin TW & Mercer E.I. Pergamon Press, Oxford
9. Principles of Biochemistry : Lehninger A.K., Nelson D.K.&Cox MM CBS publ. & Dist., New Delhi
10. Biochemistry : Lupert Stryer Freeman International Edn., USA
11. Fundamentals of Biochemistry : Jain J.L. S. Chand & Co., New Delhi
12. Cell and Molecular Biology : De Robertis EMF & EDPDe Pobertis BI Waverly Pvt. Ltd.

BOT-609/BOTANY – IX (Cell Biology; Genetics; Plant breeding, Biotechnology and Computer Application)

Marks: 20

Unit I : Cell Biology:

The Cell: Historical back ground; Cell theory. Kingdom-wise cell size and structure. Comparative account of prokaryotic and eukaryotic cell; Characteristics of archaebacteria and mycoplasma.

Nucleus and ribosomes: Ultrastructure; nuclear envelope and nuclear pore complex; nuclear matrix and nucleoplasm; DNA and Histones; nucleosome and higher level of organisation; centromere and telomere. Ribosome structure; prokaryotic, eukaryotic; organelle ribosomes and their functional significance

Mitochondrion and chloroplast: origin, structure and biogenesis; Organelle membrane and organisation of macromolecular complexes; variation in size, shape and number; types of plastids; organelle nuclear interactions; organelle gene organisation.

Structure and function of Golgi Complex; endoplasmic reticulum; lysosomes; microbodies peroxysome and glyoxysomes; Cytoskeleton

Cell membrane: Origin, ultrastracture; Chemical constituents and models of cell membrane organisation; roles of various membrane proteins, lipids and carbohydrates; role of ion channels and pumps in cellular transport and signaling.

Unit II : Genetics: Marks: 20

Mendels' experiments and principles of inheritance; Back Cross and test Cross; Gene interactions and modified dihybrid ratios- Complementary, Supplementary, epistatic and duplicate factors.

Multiple allelism: Multiple alleles in Drosophila (eye colour), man (blood groups), Plants (self-incompatibility)

Quantitative genetics: Quantitative traits and quantitative genetics; the multiple factor hypothesis.

Unit III : Plant Breeding: Marks: 20

Types of plant reproduction: Vegetative, sexual and apomixis; their effect on generating and fixing genotypic variation.

Methods of plant improvement: Pure line and mass selection; hybridization in self-and cross, pollinated Crops; introduction and acclimatization Hybrid vigour.

Mutation and Polyploidy as methods of Plant improvement.

Unit IV : Biotechnology: Marks: 20

History, definition and scope; Cellular differentiation and totipotency; Organogenesis and embryogenesis; protoplast isolation and culture; Somatic hybridization; clonal propagation; Genetic engineering of plants; Vectors for gene delivery; selectable markers and reporter genes; methods of gene delivery; *Agrobacterium* – the natural genetic engineer; salient achievements in crop biotechnology (with suitable examples) and prospects.

Unit V : Computer application and Bioinformatics Marks: 20

Computer organisation programming principles; programming language; Internet and its applications; communication tools – word processing, spread sheet and presentation of software; Concept of database, Applications of Computer in Biological Sciences; introduction to biostatistical analysis of data; Application software for Botany.

Bioinformatics – introduction and asses of bioinformatics tools.

Recommended Books

1. Molecular Biology of Cell : Albors, G.B., Bray, D., Lewis, J., Raf, M., Roberts, K. & Naten, L.D. Garland Publishing Co., New York
2. Molecular Cell Biology : Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnel, J. W.H. Freeman & Co., New York
3. Principles of Genetics : Gardner E.J., Snustad, D.P. & Simmons S.M.J. John Wiley & Sons, USA

4.	Molecular Cell Biology	:	Nolfe, S. H. Wadswooth Publ. Co., California
5.	Plant Tissue Culture: Applications & Limitations	:	Bhojwani S.S. Elsevier Science Pubushing, New York
6.	Breeding Field Crops	:	Pachlmann, J.M. & Sleeper, D.R. Longman, London & New York
7.	Principles & Practice of Plant Breeding	:	Sharma, J.R. Tata McGraw-Hill Publ. Co., New Delhi
8.	Ecology Work Book	:	Misra, R. Oxford University Press, Calcutta
9.	Plant Microtechnique	:	Johansen, D.A. McGraw-Hill Co. Inc., New York
10.	Chromosome Technique (Theory & Practical)	:	Sharma, A. & Sharma, A. Butterworths, London
11.	Bioinformatics: Sequence and Structure Analysis	:	David Mount
12.	Introduction to Bioinformatics	:	Attwood, T.K. & Parry Smith, D.J. Pearson Education Asia
13.	Bioinformatics in Biological Science and Medicine	:	Rashidi, H.H. & Buchler, L.K. CRC Press, London.

BOT-610(P)/BOTANY - X PRACTICAL (Based on theory papers BOT-608 and BOT-609)

Marks: 100

1. Field observation of local vegetation
2. Study of structure of a plant community by random & belt transect methods
3. Determination of density and abundance of vegetation in a community by using minimum size of quadrat
4. Determination of physical characteristics of soil like pH, Temperature and moisture content
5. Water analysis (determination of chlorine, dissolved CO_2 and O_2 in water and measurement of pH)
6. Determination of dissolved oxygen and biochemical oxygen demand (BOD) in unpolluted and polluted water.
7. Determination of stomatal frequently using leaf epidermal peeling/impression
8. Separation of plant pigment by paper chromatography technique and chemical method
9. Isolation of chloroplast and demonstration of Hills activity.
10. Estimation of starch in photosynthesizing leaves
11. Estimation of protein by Bradford method
12. Paper chromatography separation of amino acids
13. Measurement of pH of beet, carrot, potato, tuber, *Amaranthus* leaves and sap of water hyacinth.
14. Study of Cell structure from onion leaf peels; demonstration of staining and mounting methods
15. Comparative study of cell structure in Onion cells, *Hydrilla* and *Spirogyra*. Study of cyclosis in *Tradescanta* stamina/cells haire.
16. Study of plastids to examine pigment distribution in plants (e.g. *Cassia, Lycopersicum, Capsicum*)
17. Examination of electron micrographs of eukaryotic cells with special reference to organelles
18. Study of various stage of mitosis and meiosis using appropriate plant material (e.g. root tips, flower buds of onion/pea/broad bean).
19. Determination of chromosome counts from

20. Preparation of karyotypes from dividing root tip cells and pollen grains
21. Detection of aromatics in chromosome pairing and disjunction caused by mutant genes and structural alterations of Chromosome.
22. Preparation of chromosome maps from 3-point test cross data.
23. Correlation of floral structure with pollination system (e.g. *Salvia, Sesamum, Pisum, Lathyrus, Triticum, Oriza, Ricinus*).
24. Field exploration for detection of male sterile plants and estimation of their pollen fertility in locally grown crop plants e.g. tomato, *lenum* etc.
25. Estimation of pollen ovule ratios and its bearing on pollination system.
26. Emasculation and bagging of flowers of Brassicaceae, Poaceae, Papilionaceae, Malvaceae etc. pollinating them manually and estimating fruits and seed set.
27. Preparation of tissue culture media, sterilization and inoculation of plant materials
28. Demonstration of techniques of *in vitro* culture of various explants.
29. Isolation of plant protoplasts (e.g. tobacco, petunia) using enzymes available commercially and estimation of their yield
30. Isolation, purification of DNA from plant materials
31. Separation of DNA fragments through gel electrophoresis
32. Isolation of plasmids for *Bacillus/Pseudomonas*
33. Hybridization experiments – F_1 and available F_2 material analysis for specific character.
34. Determination of mean, standard deviation, using MS Excel/SPSS
35. Preparation of presentation of cell organelles, using MS powerpoint or similar packages
36. Retrieving the botanical articles from internet