

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
4. Study of locally important plant diseases
5. Morphology and microscopic study of vegetative and reproductive structures of bryophyte genera included in theory syllabus
6. 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. Friisch  
Cambridge University Press, London
4. Introductory Phycology : H.D. Kumar  
East-West Press Pvt. Ltd., New Delhi
5. Introduction to Embryophyta : N.S. Parihar  
(a) Vol. I. Bryophyta  
(b) Vol. II. Pteridophyta  
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  
Memillan 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 their Classification; Morphology, Reproduction and Life cycle of *Cycas*, *Ficus* and *Gnetum*. Ecobionomic 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.  
Organisation 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

### 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<sub>3</sub>, C<sub>4</sub> 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 ECUB, 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 Gangeong'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 (3<sup>rd</sup> Ed.) : Kormondy, E.  
Prentice Hall of India, New Delhi

Unit V : Embryology and Palynology:  
 Plant embryology, Micro and mega sporogenesis, development of male and female gametophytes, fertilization, embryo and endosperm development.  
 Palynology: Pollen and spore morphology. Aerobiology and pollen allergy. Marks: 15

**BOT-202(P)/BOTANY PRACTICAL – II**

**Marks: 25**

Gymnosperms and Palaeobotany:

1. Temporary stained preparation of the reproductive structures of Gymnosperms 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 the angiosperm families mentioned in the theory  
 Ranunculaceae: *Ranunculus*  
 Apiaceae : *Coriandrum*  
 Asteraceae: *Ageratum, Gymura & Spilanthes*  
 Solanaceae: *Solanum*  
 Lamiaceae: *Leucas/Ocimum*  
 Euphorbiaceae: *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, fiber yielding plants, medicinal plants available in Manipur.
5. To prepare a chart containing the starch contains from five important crop plants and protein contains from five pulses by using internets.
6. Preparation of temporary slides for the study of anomalous secondary growth in plants included in the theory paper.
7. Preparation of stained squashed of pollen motile cells, pollen grains and dissection of endosperm and embryo.
8. Field observation of local vegetation and submission of report is compulsory.

**Recommended books**

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

### 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<sub>3</sub>, C<sub>4</sub> 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 Gangeong'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 (3<sup>rd</sup> Ed.) : Kormondy, E.  
Prentice Hall of India, New Delhi

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

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, Myrtaceae, Cucurbitaceae, Dipterocarpaceae, 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 megasporogenesis. 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, apomixis 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. Coulter & C.J. Chamberlain  
Central Book Depot, Allahabad
5. Taxonomy of Vascular Plants : G.H.M. Lawrence  
Oxford & IBH Publ. Co., New Delhi

- 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. Sanier, J.L. Ingrahan, 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, Allahabad
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 Microbiologist : 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 Progymnosperms. 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

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, *Rhoeo*, *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**

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| 1. Molecular Biology of Cell                        | : Albers, GB., Bray, D., Lewis, J., Raf, M., Roberts, K. & Naten, L.D.<br>Garland Publ. Co., New York              |
| 2. Molecular Cell Biology                           | : Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnel, J.<br>W.H. Freeman & Co., New York |
| 3. Principles of Genetics                           | : Gardner E.J., Snustad, D.P. & Simmons S, M.J.<br>John Wiley & Sons, USA  |
| 4. Molecular Cell Biology                           | : Nofle, S.H.<br>Wadsworth Publ. Co., California   |
| 5. Plant Tissue Culture: Applications & Limitations | : Bhojwani S. S.<br>Elsevier Science Publ., New York   |
| 6. Breeding Field Crops                             | : Pachlmann, J.M. & Sleeper, D.R.<br>Longman, London & New York  |
| 7. Principles & Practice of Plant Breeding          | : Sharma, J.R.<br>Tata McGraw-Hill Publ. Co., New Delhi  |
| 8. Ecology Work Book                                | : Misra, B.<br>Oxford University Press, Calcutta   |
| 9. Plant Microtechnique                             | : Johansen, D.A.<br>McGranier Hill Book Co., New York  |
| 10. Chromosome Technique (Theory & Practice)        | : Sharma, A. & Sharma, A.<br>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 (Archaeobacteria, Bacteria and Eukaryotes), microbial forms- viruses (including prions and viroids), archaeobacteria, bacteria, algae, fungi and protozoa – their characteristic features, microbiology of soil, air and water.

Marks : 20

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

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

**BOT-507(P)/BOTANY - VII PRACTICAL (Based on theory paper BOT-505 and BOT-506)**

**Marks: 100**

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*, *Escherichia*, *Nostoc*, *Anabaena*, *Saccharomyces*, *Candida*, *Aspergillus*, *Trichoderma*.
6. Morphological and anatomical studies of different types of root nodules (pea, broad bean, *Mimosa*, *Sesbania*).
7. Demonstration of Koch's postulates.
8. Symptoms, causal organisms and microscopic studies of diseased plant specimens included in theory syllabus.
9. Demonstration of commercial fungicides and equipments for field application
10. Comparative studies of thallus and reproductive structures of *Riccia*, *Anthoceros* and *Polygonum*.
11. Comparative studies of morphological and anatomical structures of *Lycopodium*, *Selaginella* and *Marsilea* in relation to stellar evolution and heterospory.
12. Gymnosperm and palaeobotany:  
*Ginkgo* and *Taxus* – Temporary mounts of transverse sections of young and mature stems, radial section and maturation secondary wood; transverse and vertical sections of needle; 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. of leaf, 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 representative 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*.  
 Anacardiaceae: *Mangifera*  
 Cucurbitaceae: *Luffa*  
 Rubiaceae: *Mussaenda*  
 Apocynaceae: *Vinca*  
 Asclepiadaceae: *Calotropis/Asclepias*  
 Acanthaceae: *Justicia/Adhatoda*  
 Verbinaceae: *Duranta/Lantana*  
 Polygonaceae: *Polygonum*  
 Orchidaceae: *Vanda/Dendrobium*  
 Scitamineae: *Musa/Canna/Maranta/Zingiber*  
 Arecaceae: *Phoenix*  
 Cyperaceae: *Cyperus*

15. Utilization of plants and Ethnobotany: Collection and identification of five plants each used as a source of carbohydrate, Protein, wood, oil-seed, spice and condiment and drug. 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, afforestation, 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*.

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, ultrastructure, 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.

Marks: 20

Unit II : Genetics:

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.

Marks: 20

Unit III : Plant Breeding:

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.

Marks: 20

Unit IV : Biotechnology:

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.

Marks: 20

Unit V : Computer application and Bioinformatics

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.

Marks: 20

Recommended Books

1. Molecular Biology of Cell : Albers, 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

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

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.

Marks 20

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: 100

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

4.	Molecular Cell Biology	: Nolfe, S. H. Wadsworth Publ. Co., California
5.	Plant Tissue Culture: Applications & Limitations	: Bhojwani S.S. Elsevier Science Publishing, 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<sub>2</sub> and O<sub>2</sub> 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 frequency using leaf epidermal peeling/impression
8. Separation of plant pigment by paper chromatography technique and chemical method
9. Isolation of chloroplast and demonstration of Hill's 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 *Tradescantia* staminal cells/hairs.
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 dividing pollen mother cells, root tips and pollen grains.

20. Preparation of karyotypes from dividing root tip cells and pollen grains
21. Detection of anomalies 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, *lemun* 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

**MANIPUR UNIVERSITY**  
**SYLLABUS**  
**FOR UNTER GRADUATE COURSE : B.Sc. (General)**  
**( Semester V & VI)**

Subject : **BOTANY**

Semester	Paper No.	Title of the paper	Marks allotted Theory/Practical
V	BOT – 505(G) (ELECTIVE)	Botany – V (G) (Microbiology, Plant Pathology, Archegoniate, Taxonomy, Developmental Biology and Plant Resources I. Microbiology & Plant Pathology II. Archegoniate and Primitive seed plants III. Advanced Plant Taxonomy IV. Developmental Biology V. Plant Resources	75  15 15 15 15
	BOT – 505(P)	Practical	25
VI	BOT – 606 (G) (ELECTIVE)	Botany – VI (G) (Plant Physiology, Molecular Biology, Genetics, Plant Breeding, Ecology and Bioinformatics) I. Plant Physiology & Biochemistry II. Cell & Molecular Biology III. Genetics, Plant Breeding & Biotechnology IV. Ecology & Environment V. Computer Application & Bioinformatics	75  15 15 15 15
	BOT – 506(P)	Practical	25

**MANIPUR UNIVERSITY**  
**SYLLABUS**  
**FOR UNTER GRADUATE COURSE : B.Sc. (General)**  
**( Semester V & VI)**

Subject : **BOTANY**

**SEMESTER – V**

**BOT – 505(G) (ELECTIVE) / BOTANY – V**

Marks : 75

(Microbiology, Plant Pathology, Archegoniate, Taxonomy, Developmental Biology and Plant Resources)

**Unit-I Microbiology and Plant Pathology :**

History of microbiology, Archaeobacteria, Bacteria, Eukaryotes, Microbiology of air, soil and water, Microbes in human welfare (industry, agriculture, medicine and food),

History of Plant Pathology, Koch's postulates, Studies on symptoms, disease cycle and disease management of white rust of crucifers, powdery mildew of pea, stem rust of wheat, citrus canker, rice blast. Concept of integrated disease management (IDP).

Marks : 15

**Unit-II Archegoniate & Primitive seed plants :**

Bryophytes as primitive land plants, evolution and economic importance of Bryophytes, Stellar evolution in Pteridophytes, heterospony, seed habits, Economic importance of Pteridophytes, Distribution of Gymnosperms in India. Salient features and life cycle of *Ginkgo* and *Ephedra*. Primitive land plants – *Rhynia*, *Lepidodermis*, *Sphenophyllum*. Fossil gymnosperms order – Cycadofilicals.

Marks : 15

**Unit-III Advanced Plant Taxonomy**

Aims and objectives of Plant taxonomy, methods and techniques of herbarium preparation, Concept of chemotaxonomy, numerical taxonomy, molecular taxonomy, Role of Botanical Survey of India and Botanical gardens. Taxonomic studies & economic importance of the families – Magnoliaceae, Myrtaceae, Rutaceae, Asteraceae, Apocynaceae, Acanthaceae, Musaceae, Zingiberaceae, Orchidaceae.

Marks : 15

**Unit-IV Developmental Biology :**

Apical meristems & theories of shoot and root apices, vascularization, primary shoots of monocotyledonous & dicotyledonous plants, Cambium and its function, formation of secondary xylem (wood), sapwood and heart wood. Developmental biology of male and female gametophytes, pollen pistil interaction, compability & incompatibility, syngamy & triple fusion, Delopment of monocot and dicot embryo, Application of palynology – role of taxonomy and melittopalynology.

Marks : 15

**Unit-V Plant Resources :**

Classification of economic plants based on their uses. Origin, cultivation & improvement of maize, mustard, pea, timber yielding plants - *Dipterocarpus*, *Phoebe*, medicinal plants - *Aloe-vera* & *Vinca*, Cyanobacteria - *Spirulina* as single cell protein. Importance of ethnobotany in gene pool & germplasm conservation, Forest resources and their conservation, Agroforestry and social forestry.

Marks : 15

**BOT - 505 (P) / BOTANY PRACTICAL-V (ELECTIVE)**

1. Preparation of culture media for bacteria and fungi (nutrient agar media and PDA).
2. Isolation of microorganisms (bacteria and fungi) from soil / water / air.
3. Staining of bacteria and fungi.
4. Microscopic study of *Rhizobium* *Bacillus*, *Nostoc*, *Anabaena* *Candida*, *Aspergillus*, *Trichoderma*, *Saccharomyces*.
5. Symptoms, causal organisms and microscopic studies of diseased plant specimens included in theory syllabus.
6. Studies of fossil slides included in the theory syllabus.
7. Description and classification upto genus of a representative species from each of the angiospermic families mentioned in the theory  
 Rutnua : *Citrus*  
 Magnoliaceae : *Michelia champaca*  
 Myrtaceae : *Callistamon*  
 Asteraceae : *Eclipta / Gymura*  
 Apocynaceae : *Vinca*  
 Acanthaceae : *Justicia / Adhatoda*  
 Musaceae : *Musa / Canna*  
 Zingiberaceae : *Zingiber*  
 Orchidaceae : *Dendrobium / Vanda*
8. Collection and identification of three plant species used as sources of carbohydrate, timber, drug and medicine.
9. Study of different types of ovary.
10. Study of four pollen types.

**Recommended books :**

1. Plant Diseases R.P. Singh, Oxford & IBH Pub. Co., New Delhi.
2. Introduction to Principles of - do -

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| 3. Plant Pathology                               | R.S. Mehrotra, Tata McGraw-Hill Pub. Co., New Delhi.                   |
| 4. Text Book of Microbiology                     | R. Ananthanarayan & C.K.J. Paniker, Orient Longman, Bombay.            |
| 5. An Introduction to Embryophyta (Bryophyta)    | N.S. Prihar, Kitab Mahal, Allhabad.                                    |
| 6. An Introduction to Embryophyta (Pteridophyta) | N.S. Prihar, Kitab Mahal, Allhabad.                                    |
| 7. The Embryology of Angiosperms                 | S.S. Bhojwani & S.P. Bhatnagar, Vikas Pub. House Pvt. Ltd., New Delhi. |
| 8. Taxonomy of Vascular Plants                   | G.H.M. Lawrence, Oxford & IBH Pub. Co., New Delhi.                     |
| 9. A Manual of Ethnobotany                       | S.K. Jain, Scientific Pub., Jodhpur.                                   |
| 10. Plant Anatomy                                | K/ Easu, John Wiley & Sons Inc., New York.                             |
| 11. An Introduction to Paleobotany               | C.A. Arnold, Tata McGraw-Hill Book Co., New Delhi.                     |
| 12. Plant Systematic : An Integrated Approach    | Gurucharan Singh, Sciences Pub., Inc., USA.                            |

### SEMESTER-VI

#### **BOT – 606(G) (ELECTIVE) / BOTANY – VI**

(Plant Physiology, Molecular Biology, Genetics, Plant Breeding, Ecology and Bioinformatics)

Marks : 75

#### **Unit-I Plant Physiology and Biochemistry :**

Availability and importance of essential elements, physiological roles of essential elements & their deficiency symptoms. Growth, phytohormones (auxin, gibberellins & cytokines), Photosynthesis (Light and Dark reactions), Comparative Studies of C<sub>3</sub>, C<sub>4</sub> & CAM cycles. Biological nitrogen fixation.

Water as universal solvent, weak interaction in aqueous system, basic thermodynamic concept (bioenergetics), Enzyme kinetics, Respiration, glycolysis, Kreb's cycle, Fermentation, Oxidative phosphorylation. ATP synthesis.

Marks : 15

#### **Unit-II Cell Biology and Molecular biology :**

The cell-historical background, cell theory, comparative account of eukaryotic and prokaryotic cells. Mitochondrion & chloroplast-ultrastructure, origin and function. Nucleus, ribosome and chromosome- ultrastructure and function.

ucleic acid : Composition of nucleic acid, DNA- structure and replication, DNA polymerases, different forms of RNA. Gene- structure, expression and regulation. Operon concept, gene regulation in prokaryotes and eukaryotes.

Marks : 15

### Unit-III Genetics, Plant breeding and Biotechnology:

Mendel's experiments and principles of inheritance, gene interactions and modified dihybrid ratios – complementary, supplementary, epistatic, duplicate factors, Multiple allelism, Multiple alleles in *Drosophila* (eye colour) and man (blood group).

Types of plant reproduction, methods of plant improvement, pure line and mass selection. Introduction and acclimatization, hybrid vigour, Hybridization in self and cross pollinated plants.

History, definition, scope of biotechnology, cellular totipotency, differentiation. Organogenesis, embryogenesis, Application of biotechnology in agriculture, medicine & human welfare, Transgenic plants. Marks : 15

### Unit-IV Ecology and environment :

Physical environment, biotic environment, abiotic and biotic interaction. Concept of habitat & niche. Ecosystem and its components. Energy flow in ecosystem.; trophic levels.

Environment pollution (air, water, soil, noise) and control measures. Global warning & climate change and its impact. Bio-diversity – concept and conservation of biodiversity. Marks : 15

### Unit-V Computer application & bioinformatics

Organization of digital computer : word processor, spread sheet, presentation of software, concept of data base, internet & its applications. communication tools, computer application in plant sciences.

Bioinformatics – introduction & access of bioinformatics tools. Marks : 15

### BOT – 506 (P) / BOTANY PRACTICAL-VI (ELECTIVE)

Marks : 25

1. Study of various stages of mitosis and meiosis using appropriate plant materials (root tips, flower buds of onion / pea / broadbean).
2. Separation of plant pigments by paper chromatography technique.
3. Separation of amino acids by paper chromatography technique.
4. Determination of stomatal frequency using epidermal peeling / impression.
5. Measurement of pH of beet, carrot, potato tuber and *Amaranthus* leaves.
6. Preparation of tissue culture media, sterilization and inoculation of plant materials.

7. Demonstration of techniques of in vitro culture of explants.
8. Determination of density and abundance of vegetation in a community by using minimum size of quadrat.
9. Determination of physical characteristics of soil like pH, moisture content and temperature.
10. Determination of dissolved O<sub>2</sub> and CO<sub>2</sub> in water samples.
11. Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*. Study of cyclosis in *Tradescantia* stigma / cell hairs.
12. Determination of mean and standard deviation using MS Excel / SPSS.
13. Field observation of local vegetation.

**Recommended Books :**

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| 1. Fundamental of Ecology                  | Odum E.P., Prentice hall of India, New Delhi.                         |
| 2. Environmental Studies                   | Chary, S.N., McMillan India Ltd.                                      |
| 3. Plant Physiology                        | Ting I.P., Addison Wesley Pub. Col, Phillipines.                      |
| 4. Principles of Biochemistry              | Lehninger A.K., Nelson D.K. & Cox MM, CBS Pub. & Dist., New Delhi.    |
| 5. Cell and Molecular Biology              | De Robertis EMF & EDPDe Pobertis BI Waverly Pvt. Ltd.                 |
| 6. Principles of Genetics                  | Gardner E.J., Snustad, D.P. & Simmons S.M.J., John Wiley & Sons, USA. |
| 7. Principles & Practice of Plant Breeding | Sharma, J.R., Tata McGraw-Hill Pub. CoI, New Delhi.                   |
| 8. Ecology Work Book                       | Misra, R., Oxford University Press, Calcutta.                         |
| 9. Introduction to Bioinformatics          | Attwood, T.K. & Parry Smith. D.J. Pearson Education Asia.             |

