

DEPARTMENT OF BOTANY

GAUHATI UNIVERSITY



B. Sc. Programme

Effective from Academic Session 2013-2014

BOTANY MAJOR COURSE
DEPARTMENT OF BOTANY
GAUHATI UNIVERSITY

B.Sc. Syllabus under Semester System

Course Structure

Semester(s)	Course(s)	No. of Papers	Total Marks	Number of Classes/ week	Credits
First Semester	Major (Botany)	Theory: 02 Practical: 01	150 50	6/ Paper 4	6/ Paper 4
	Subsidiary Papers	Theory: 02 Practical: Nil	150	6/ Paper	6/ Paper
	English	Theory: 01	50	4	4
Second Semester	Major (Botany)	Theory: 02 Practical: 01	150 50	6/ Paper 4	6/ Paper 4
	Subsidiary Papers	Theory: 02 Practical: Nil	150	6/ Paper	6/ Paper
	English	Theory: 01	50	4	4
Third Semester	Major (Botany)	Theory: 02 Practical: 01	150 50	6/ Paper 4	6/ Paper 4
	Subsidiary Papers	Theory: 02 Practical: 02	100 100	4/ Paper 4/ Paper	4/ Paper 4/ Paper
	Environmental Studies	Theory: 01	50	4	4
Fourth Semester	Major (Botany)	Theory: 02 Practical: 01	150 50	6/ Paper 4	6/ Paper 4
	Subsidiary Papers	Theory: 02 Practical: 02	100 100	4/ Paper 4/ Paper	4/ Paper 4/ Paper
	Environmental Studies	Theory: 01	50	4	4
Fifth Semester	Major (Botany)	Theory: 04 Practical: 02	300 150	6/ Paper 6/ Paper	6/ Paper 6/ Paper
Sixth Semester	Major (Botany)	Theory: 04 Practical: 02	300 150	6/ Paper 6/ Paper	6/ Paper 6/ Paper

Summary of the Course Structure

Sl. No.	Courses		Total no. of papers	Total Marks	Total Classes/ week	Total Credits
01	Major (Botany)		Theory: 16	1200	96	96
	Semester (s): 1 st +2 nd +3 rd +4 th +5 th +6 th		Practical:08	500	48	48
02	Subsidiary Papers		Theory: 08	500	32	32
	Semester (s): 1 st +2 nd +3 rd		Practical:04	200	16	16
03	English		Papers: 02	100	08	08
04	Environmental Studies		Papers: 02	100	08	08
05	Total	Major	24	1700	144	144
		Subs	12	700	48	48
		Eng	02	100	08	08
		Env. Sc.	02	100	08	08
06	Grand Total	Total No. of Courses:04	40	2600	208	208

FIRST SEMESTER
Allotment of Marks and Credits

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
M 101 (Theory)	60	15	75	6	6
M 102 (Theory)	60	15	75	6	6
M 103 (Practical)	40	10	50	4	4
Total	160	40	200	16	16

Examination Time: Theory3 (Three Hours)
Practical.....4 (Four Hours)

Course Content

Paper: M 101 (Theory)
(Plant Kingdom, Algae and Fungi)

A. Plant Kingdom: 10

UNIT I: Classification of plant kingdom and criteria, diversity, form, life span, nutrition and ecological status

B. Algae: 30

UNIT II: General characteristics, classification, morphology, reproduction, phylogeny and economic importance of Algae

UNIT III: Life history of Chlorophyceae (*Volvox*, *Coleochaete*, *Chara*), Xanthophyceae (*Vaucheria*), Cyanophyceae (*Anabaena*, *Nostoc*)

UNIT IV: Bacillariophyceae (General account), Phaeophyceae (*Ectocarpus*, *Fucus*), Rhodophyceae (*Polysiphonia*)

C. Fungi: 20

UNIT V: General characters, cell structure, nutrition, reproduction and sexuality; Economic importance of Fungi

UNIT VI: Classification, phylogeny and life history of main classes of fungi with special reference to the types as mentioned; Phycomycetes (*Phytophthora*, *Mucor*); Ascomycetes (*Saccharomyces*, *Penicillium*); Basidiomycetes (*Puccinia*, *Agaricus*); Deuteromycetes (*Cercospora*, *Colletotrichum*)

Course Content
Paper: M 102 (Theory)
(Bryophytes and Pteridophytes)

Bryophytes: 30

UNIT I: Classification and general account of structure, morphology, anatomy and Phylogenetic relationship among Hepaticopsida with reference to *Riccia* and *Marchantia*.

UNIT II: Classification and general account of structure, morphology, anatomy and Phylogenetic relationship among Anthocerotopsida with reference to *Anthoceros*.

UNIT III: Classification and general account of structure, morphology, anatomy and Phylogenetic relationship among Bryopsida with reference to *Sphagnum* and *Polytrichum*. Economic importance of Bryophytes

Pteridophytes: 30

UNIT IV: Classification, comparative study of morphology, anatomy, reproduction, stellar diversity, heterospory and seed habit with reference to Psilopsida (*Psilotum*).

UNIT V: Classification, comparative study of morphology, anatomy, reproduction, stellar diversity, heterospory and seed habit with reference to Lycopsidea (*Lycopodium*, *Selaginella*).

UNIT VI: Classification, comparative account of morphology, anatomy, reproduction, stellar diversity, heterospory and seed habit with reference to Sphenopsida (*Equisetum*) and Pteropsida (*Adiantum* and *Marsilea*)

Course Content
Paper: M 103 (Practical)

(Division of marks: Algae-6, Fungi-6, Bryophytes-6, Pteridophytes-6, Techniques-2, Field records etc. 8 & Viva-voce -6=40)

Study of eukaryotic organisms (Algae and Fungi) through permanent preparation (mounting and staining)

I. Study of morphology and reproductive structures of the following types:

- 1) Algae: *Volvox*, *Chara*, *Ectocarpus*, *Fucus*, *Polysiphonia*, *Anabaena*
- 2) Fungi: *Phytophthora*, *Mucor*, *Penicillium*, *Puccinia*, *Agaricus*, *Colletotrichum*
- 3) Bryophytes: *Riccia*, *Marchantia*, *Anthoceros*, *Polytrichum*, *Sphagnum*
- 4) Pteridophytes: *Lycopodium*, *Selaginella*, *Equisetum*, *Adiantum*, *Marsilea*

II. Techniques of permanent preparation of types studied (slides) and herbarium

III: Field studies, submission of field reports and collections

IV. *Viva-voce*

SECOND SEMESTER

Allotment of Marks and Credits

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/ week
M 101 (Theory)	60	15	75	6	6
M 102 (Theory)	60	15	75	6	6
M 103 (Practical)	40	10	50	4	4
Total	160	40	200	16	16

Examination Time: Theory3 (Three Hours)
 Practical.....4 (Four Hours)

Course Content

Paper: M 201 (Theory)

(Gymnosperms, Paleobotany and Plant Anatomy)

Gymnosperms: 20 Marks

UNIT I: Classification, evolutionary significance and salient features and significance of gymnosperms.

UNIT II: Comparative study of morphology, anatomy and reproduction of Cycadales (*Cycas*), Coniferales (*Pinus*, *Cryptomeria*, *Thuja*), Ginkgoales (*Ginkgo*) and Gnetales (*Gnetum*)

Paleobotany: 20 Marks

UNIT III: General account, anatomy and reproduction of Psilophyta (*Rhynia*), Lepidodendrales (*Lepidodendron*) and Sphenophyllales (*Sphenophyllum*)

UNIT IV: Process of fossilization. General account, anatomy and reproduction of Cycadofilicales (*Lyginopteris*), Bennettitales (*Williamsonia*) and Cordaitales (*Cordaites*)

Plant anatomy: 20 Marks

UNIT V: Cell wall and cell membrane: Origin, ultra structure, chemical constituents and function of Cell wall and cell membrane, Models of cell membrane and organization

UNIT VI: Tissues and their classification: Theories of structural development and differentiation of roots and shoots, different tissue systems and their functions, Anatomy of primary monocot and dicot roots, secondary growth of stems and roots.

Course Content
Paper: M 202 (Theory)
(Cell Biology)

- UNIT I:** Introduction to cell biology: Introduction to cell, membrane structure and function, membrane pump, membrane carrier, membrane channels, membrane physiology
- UNIT II:** Chromatin, chromosome and cell nucleus, Chemical and physical structure of chromosome, Nuclear structure and dynamism, special types of chromosome and their significance.
- UNIT III:** Cellular organelles and membrane trafficking, post translational targeting of protein, mitochondria, peroxisomes, endoplasmic reticulum, secretary membrane system and golgi apparatus, endocytosis and endosomal membrane system
- UNIT IV:** Signaling mechanism, signal transduction and signal protein
- UNIT V:** Cell cycle: G phase and regulation of cell proliferation, S-phase, G2-phase mitosis and cytokinesis, meiosis
- UNIT VI:** Structure and function of DNA and RNA

Course Content
Paper: M 203 (Practical)

(Division of marks: Gymnosperm-6, Paleobotany-6, Plant Anatomy-8, Cell Biology-6, Field records etc. 8 & Viva-voce -6=40)

1. Gymnosperm: *Cycas, Pinus, Cryptomeria, Gnetum, Thuja*
2. Paleobotany: Specimen and slides studies in theory paper
3. Plant Anatomy: Study of gross anatomical details of cells, tissues and various other organs of plants
4. Study of anomalous structure: Primary and secondary growth in stems covered under theory syllabus
5. Study of various stages of mitosis and meiosis using appropriate stain and plant materials

THIRD SEMESTER

Allotment of Marks and Credits

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
M 301 (Theory)	60	15	75	6	6
M 302 (Theory)	60	15	75	6	6
M 303 (Practical)	40	10	50	4	4
Total	160	40	200	16	16

Examination Time: Theory3 (Three Hours)
Practical.....4 (Four Hours)

Course Content

Paper: M 301 (Theory) **(Ecology, Plant Geography, Evolution)**

Ecology: **Marks: 40**

UNIT I: Introduction, Ecosystem structure (abiotic and biotic components), Plant adaptations in response to water, temperature and light.

UNIT II: Population ecology: Population characteristics; Ecotypes; Ecads. Community ecology: Community characteristics; Frequency; Density; Cover; IVI; Life forms, Biological spectrum and its significance.

UNIT III: Ecosystem ecology: food chain, food web, ecological pyramids; Ecosystem function (Energy flow, Biochemical cycles), Ecosystem services, Ecosystem resilience; Ecological succession: Types and pattern.

UNIT IV: Environmental pollution: Water pollution: Sources and kinds, impact of pollution on aquatic ecosystem, eutrophication of water bodies; Air pollution: sources and kinds, impact on plants, acid rain; Soil pollution: Sources and kinds, impact on plants and ecosystems.

Plant Geography: **Marks: 10**

UNIT V: Phytogeographical regions of India; Factors regulating distribution of plants, endemism, isolation and speciation; Vegetation of India with special reference to North Eastern Regions; Major biomes of the world.

Evolution: **Marks: 10**

UNIT VI: Evidences, theories and mechanism of evolution; Origin of new species. Gene pool; Genetic drift; Changes in gene frequencies in population

Course Content
Paper: M 302 (Theory)
(Instrumentation and Laboratory Techniques)

Instrumentation:**Marks: 30**

UNIT I: Microscopy: Working principles of Electron, Phase contrast and fluorescence microscopy; Image documentation: Camera lucida- principle, types; microphotography, digital imaging-advantages of digital camera and digitization.

UNIT II: Types and techniques of micro technique, Principles and applications of hot air oven, incubators, autoclave, laminar air flow chamber, centrifuge, lux meter, pH meter

UNIT III: Chromatography: Introduction, definition, concept of partition coefficient, Paper chromatography- principle, method, advantages; TLC and column chromatography: principle, method, advantages and disadvantages; Spectroscopy: principle, Beer and Lambert's law, mechanics of measurement; Spectrophotometer- working principle and applications.

Laboratory Techniques:**Marks: 30**

UNIT IV: Fixatives and stains: principles, types, procedures and applications; Methods of sterilization and culture media; Mounting media

UNIT V: Field and herbarium techniques, preservation of museum and herbarium specimens, preservation techniques for special types of plants (submerged aquatic plants, succulent and xerophytes, palm, canes and bamboos)

UNIT VI: Preparation of normal, molal, molar, ppm and percent solutions; Somogyi's reagent, Biuret reagent, Nessler's reagent, different indicators

Course Content
Paper: M 303 (Practical)
Ecology, Laboratory Instrumentation and Laboratory techniques
(Division of marks: Ecology-14, Instrumentation-6, Laboratory Techniques-6, Field records etc. 8 & Viva-voce -6=40)

Ecology:

1. Determination of abundance and frequency of species by quadrat method.
2. To measure the dissolved oxygen content in polluted and unpolluted water samples.
3. Study of anatomical peculiarities with reference to ecological adaptations (xerophytes and hydrophytes; at least 3 plant samples for each type)
4. Soil testing for the presence of Phosphorus, Potassium, Nitrate.

Instrumentation and Laboratory Techniques:

1. Image documentation of suitable botanical microscopic preparation by using camera lucida.
2. Microtomy- Preparation and processing of suitable material up to block preparation, Sectioning, staining and mounting and permanent slides preparation.
3. Demonstrations- TLC chromatogram.
4. Demonstration of different types of instruments as per theory syllabus mentioning their principles, functions and uses.
5. Preparation of different stains, solutions and reagents as per theory paper.
6. Submission of field report, permanent slides and practical records.

FOURTH SEMESTER

Allotment of Marks and Credits

Paper (s)	Course work	Internal Assessment	Total	Credits	Classes/ week
M 401 (Theory)	60	15	75	6	6
M 402 (Theory)	60	15	75	6	6
M 403 (Practical)	40	10	50	4	4
Total	160	40	200	16	16

Examination Time: Theory3 (Three Hours)
 Practical.....4 (Four Hours)

Course Content

Paper: M 401 (Theory)

(Morphology, Palynology, Embryology of Angiosperms)

Morphology:

Marks: 20

UNIT I: Origin and evolution of Angiosperms; Inflorescence and flowers. Morphology of stamens and carpel

UNIT II: Telome theory, Phyllode theory, Carpel polymorphism, Inferior ovary. Role of morphology in plant classification.

Palynology:

Marks: 10

UNIT III: Aspects and prospects of Palynology, historical perspective, pollen morphology, methods of studying pollen, pollen production and sterility

Embryology of Angiosperms:

Marks: 30

UNIT IV: Basics of embryology, microsporogenesis and megasporogenesis, development of male and female gametophytes, Types of embryosacs and evolutionary significance

UNIT V: Fertilization, embryo development, polyembryony, apomixes, endosperm development, types, hautorial structure, experimental embryology: role in crop improvement

Course Content
Paper: M 402 (Theory)
(Plant Taxonomy)

- UNIT I:** Objectives, Principles and Evolutionary Trends in Taxonomy,
- UNIT II:** History of plant classification; Concept of species, genus and family, Concept of classificatory systems i.e. Artificial, natural, Phylogenetic, phenetic, cladistic, and APG; Detail study of Bentham and Hooker, and Takhtajan system of classifications.
- UNIT III:** Principles and rules of binomial nomenclature; ICBN- Historical developments, rules and recommendations; rules of priority and its limitations, type concepts and its applications; concept of biocode
- UNIT IV:** Modern Trend in Plant Taxonomy and classification; Role of anatomy,embryology, palynology in plant classification, Numerical Taxonomy, Chemotaxonomy, Cytotaxonomy, and Serotaxonomy
- UNIT V:** Affinities, phylogeny, economic importance and comparative studies of the following families: Magnoliaceae, Ranunculaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Malvaceae, Apiaceae, Euphorbiaceae, Solanaceae, Verbenaceae, Lamiaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Asteraceae.
- UNIT VI:** Affinities, phylogeny, economic importance and comparative studies of the following families: Arecaceae, Poaceae, Musaceae, Zingiberaceae, Liliaceae, Orchidaceae

Course Content
Paper: M 403 (Practical)
(Morphology, Palynology, Embryology, Plant Taxonomy)

(Division of marks: Morphology-5, Palynology-5, Embyology-5, Plant Taxonomy-11, Field records etc. 8 & Viva-voce -6=40)

Morphology:

1. Study of special types of inflorescences – Cyathium, Hypanthodium, Verticillaster, Hypanthium
2. Study of special types of Fruits – Spurious fruits (Dillenia); Aggregate fruits (Custard apple, Michelia, Periwinkles, Polyalthia); Multiple fruits (Pine apple, Jack fruit).

Palynology:

1. Study the morphological nature of pollen grains by permanent preparation of pollen slides from the plant materials available in the locality.

Embryology:

Study from permanent preparation of slides

1. T.S. of young Anther; T.S. of mature Anther.
2. Male gametophyte
3. L.S. of different types of Ovules.
4. L.S. of ovule showing different nuclear stages of embryo sac.
5. L.S. of ovule showing types of Endosperm
6. L.S. of Embryo – Dicotyledonous, Monocotyledonous

Plant Taxonomy:

1. Description of specimen from members of locally available Dicotyledonous and Monocotyledonous families included in the theory.
2. Description of specimens with preparation of keys up to generic level of locally available plants.
3. Submission of at least 20 numbers of herbarium of plant materials as per theory syllabus and palynology slides.

Field trips:

1. Study of vegetation, local and different localities in the country through Academic excursions.

FIFTH SEMESTER

Allotment of Marks and Credit

Paper	Course work	Internal Assessment	Total	Credit	Class /week
M 501 (Theory)	60	15	75	6	6
M 502 (Theory)	60	15	75	6	6
M 503(Theory)	60	15	75	6	6
M 504 (Theory)	60	15	75	6	6
M 505 (Practical)	60	15	75	6	6
M 506 (Practical)	60	15	75	6	6
Total	360	90	450	36	36

Examination Time: Theory3 (Three Hours)
 Practical.....4 (Four Hours)

Course Content

Paper: M 501 (Theory) **(Microbiology and Immunology)**

- UNIT I:** General Microbiology: History and development, scope of Microbiology, introduction to microbial world, microbial taxonomy and its modern trends
- UNIT II:** Microbial nutrition, growth and metabolism, microbiology of soil, air and water, role of microorganisms in biogeochemical cycles (N, C, S cycles) in nature, biological nitrogen fixation
- UNIT III:** Distinguishing features of Actinomycetes, Archaeobacteria and Mycoplasma
- UNIT IV:** General account; Classification of Bacteria, Modern concept of Bacterial cell, Reproduction and Growth of Bacteria- genetic recombination; General account of Rickettsiae, Chlamydeae and diseases caused by them
- UNIT V:** General characteristics; Classification of viruses, Nature of Viruses, Viroids, Virusoides, Prions, Replication of viruses – Lytic Cycle and Lysogenic Cycle (Bacteriophage), Transmission of viruses
- UNIT VI:** Concept of immunology, types of immunity, cell mediated and humoral immunity, primary and secondary immune responses, antigen and antibody-structure and classes

Course Content
Paper: M 502(Theory)
(Plant Pathology and Lichen)

Plant Pathology:**Marks: 50**

UNIT I: General account and historical development; Common symptoms of plant disease; Types of plant diseases according to major causal agents; Disease resistance; Physiology of parasitism; Host-parasite interaction.

UNIT II: Concept of disease cycle, mechanism of disease development, dissemination and transmission of plant pathogens, Epidemiology and Disease forecasting

UNIT III: Defense mechanism: concept and definition; structural, chemical and biochemical mechanisms

UNIT IV: Study of following diseases with reference to causal organisms, symptoms, disease cycle and control measures:

Late blight of potato, Rust of wheat, Grey blight of tea, White rust of crucifers, Powdery mildew of pea, Leaf spot disease of cabbage, Citrus canker, Yellow mosaic of bhindi, , papaya and Tobacco mosaic virus (TMV) disease

UNIT V: Plant disease management- chemical control, biological control and development of transgenic for controlling plant diseases

Lichen:**Marks: 10**

UNIT VI: Lichens: General account, classification, structure and reproduction

Course Content
Paper: M 503 (Theory)
(Cytogenetics, Plant Breeding and Biometrics)

Cytogenetics:**Marks: 30**

UNIT I: Principles of inheritance- Mendel's Laws, deviations to Mendel's law- Incomplete dominance, Co-dominance, Quantitative and polymeric gene interaction, sex linked inheritance, Non-mendelian inheritance, extra chromosomal inheritance

UNIT II: Structural and numerical changes of chromosome: Structural changes- Chromosomal aberrations and evolutionary significance; Numerical changes- Euploidy (Polyploidy) and evolutionary significance

UNIT III: Linkage and crossing over, recombination and cytological basis of crossing over, linkage map

Plant Breeding:**Marks: 20****UNIT IV:** Principles of plant breeding-Introduction, selection, hybridization and back cross method**UNIT V:** Heterosis and inbreeding depression- genetic basis; male sterility**Biometrics:****Marks: 10****UNIT VI:** Mean, mode, median, standard deviation, t-test, chi-square test, measurement of gene frequency, Hardy-Weinberg equilibrium**Course Content****Paper: M 504 (Theory)
(Applied Botany)****UNIT I:** Algae as food, feed, medicine and commercial products, role of algae in soil fertility**UNIT II:** Fungi- Role of fungi in agriculture, fungi as food, medicine and commercial products (Antibiotics, alcohols), mycotoxins and mycotoxicosis, Lichens as indicator plants, mycorrhiza and its role in plant development, Allergy and allergens**UNIT III:** Bacteria- useful and harmful effects, role of bacteria in agriculture, medicine, bioremediation, serology**UNIT IV:** Breeding for disease resistance, induced mutation and crop improvement, induction of polyploidy and crop evolution**UNIT V:** Deforestation and its effect on environment, impact of climate change**UNIT VI:** Application of plant growth regulators in agriculture, methods of plant propagation-grafting, layering and budding; bonsai, indoor gardening**Course Content****Paper: M 505 (Practical)
(Microbiology, Plant Pathology and Lichen)****(Division of marks: Microbiology-25, Plant Pathology-15, Lichens-4, Field records etc. 8 & Viva-voce -8=60)****Microbiology:**

1. Gram staining of Bacteria
2. Preparation, Sterilization of culture media: Basic liquid media (Broth) for cultivation of bacteria; Basic solid media for routine cultivation of fungi.
3. Isolation of soil microorganisms by the serial dilution and agar plating method.

4. Isolation of microorganisms from air.
5. Isolation of fungal pathogens from diseased plant parts.
6. Pure culture technique: Streak-plate methods; Pour-plate method.
7. Counting of bacterial cells using haemocytometer

Plant pathology:

1. Isolation and culture of plant pathogen and establishment of Koch's postulates and their pathogenicity.
2. Study of plant diseases like Late blight of potato; Black rust of *Justicia* and wheat; Leaf spot disease of cabbage; Grey blight disease of tea; Citrus canker; Yellow mosaic disease of papaya and bhindi; Tobacco mosaic virus representing Fungal, Bacterial and Viral diseases studying their symptoms and by making permanent slides where ever possible.
3. Collection, identification and preparation of field notes on diseased specimen of any locality (at least 10 numbers).

Lichen:

1. Study the thallus morphology of Foliose; Crustose; Fruticose Lichens.

Course Content

Paper: M 506 (Practical)

(Cytogenetics, Plant Breeding, Biometrics and Applied Botany)

(Division of marks: Cytogenetics-15, Plant Breeding-15, Applied Botany-12, Field records etc. 10 & Viva-voce -8=60)

1. Karyotype study in onion, garlic and Aloe vera
2. Study of chromosomal aberration in *Tradescantia* / *Rhoeo*
3. Study of gene interaction
4. Study of emasculation process in any plant
5. To work out mean, mode, standard deviation and standard error
6. Isolation of *Rhizobium* from root nodules
7. Counting of pollen grains in honey samples
8. Submission of permanent slides (at least 5 numbers)
9. Submission of practical notebooks and collected specimens showing applied aspects

SIXTH SEMESTER

Allotment of Marks and Credit

Paper	Course work	Internal Assessment	Total	Credits	Class /week
M 601 (Theory)	60	15	75	6	6
M 602 (Theory)	60	15	75	6	6
M 603(Theory)	60	15	75	6	6
M 604 (Theory)	60	15	75	6	6
M 605 (Practical)	60	15	75	6	6
M 606 (Practical)	60	15	75	6	6
Total	360	90	450	36	36

Examination Time: Theory3 (Three Hours)
 Practical.....4 (Four Hours)

Course Content

Paper: M 601 (Theory) **(Molecular Biology and Plant Biochemistry)**

Molecular Biology:

30 Marks

- UNIT I:** Structure and organization of gene, expression and regulation of gene (Lac operon concept), Genetic code; properties and evidences
- UNIT II:** DNA replication, different forms of RNA and their roles, concept of exons and introns, Transcription and Translation in Prokaryotes
- UNIT III:** Mutation: Point mutation-transition, transversion, frameshift mutation, molecular mechanism (tautomerization, alkylation, deamination, base analogues, dimerization)

Plant Biochemistry:

30 Marks

- UNIT IV:** Nitrogen metabolism, Amino acid metabolism and protein synthesis
- UNIT V:** Enzymes- Classification and nomenclature of enzymes, Enzyme as biocatalyst, properties and function
- UNIT VI:** Carbohydrate metabolism - Structure of monosaccharides, disaccharides and polysaccharides

Course Content
Paper: M 602 (Theory)
(Bioinformatics, Computer Application and Biotechnology)

Bioinformatics: Marks: 20

UNIT I: Introduction to Bioinformatics, branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics, biological databases, classification format of databases, biological database retrieval system

UNIT II: Application of Bioinformatics: Basics of Molecular phylogeny, drug discovery and drug design, DNA data bank, genomics, proteomics and their application in crop improvement

Computer Applications: Marks: 10

UNIT III: Basics of computer, use of operating system (MS Office), Data representation, Internet browsing and searching of biological data using search engines

Biotechnology Marks: 30

UNIT IV: History, scope and significance of biotechnology

UNIT V: Plant Tissue culture-different techniques, micropropagation, meristem culture, embryo culture, somatic embryogenesis, pollen culture and development of haploid plants, somaclonal variation, transgenic plants

UNIT VI: Plant genetic engineering, techniques and applications: (restriction enzymes, construction of DNA libraries, DNA fingerprinting, DNA sequencing), application in agriculture and medicines

Course Content
Paper: M 603 (Theory)
(Plant Physiology)

UNIT I: Plant-soil-water relationship: component and classification of soil, Soil to plant-water potential, osmotic potential, Movement of water within the plant body: absorption, transpiration and its significance, factors, mechanisms of transpiration, ascent of sap

UNIT II: Mineral nutrition and mineral salt absorption, criteria of essentiality of elements, micro and macro nutrients- specific functions and deficiency symptoms, mineral salt absorption

- UNIT III:** Photosynthesis: photolysis of water, cyclic and non-cyclic photophosphorylation, electron transport system, C3 cycle, photorespiration and glycolytic metabolism (C2 cycle), CAM pathway, C4 cycle, chemosynthesis
- UNIT IV:** Respiration: Aerobic respiration, Glycolysis (EMP, PPP) and TCA cycles and its regulation, anaerobic respiration mechanism and factors
- UNIT V:** Translocation of organic solutes: mechanism of translocation, diffusion, Munch hypothesis, source and sink relationships, phloem loading and unloading
- UNIT VI:** Growth and development: Phases of growth, growth regulation-physiological role and mechanism of action (Auxins, cytokinins, GA, ABA, ethylene); Physiology of flowering - photoperiodism and vernalization; seed dormancy-types and causes, methods of overcoming dormancy; senescence and aging; stress physiology-concept of biotic, abiotic and xenobiotic stresses.

Course Content

Paper: M 604 (Theory) (Plant Resource Utilization)

- UNIT I:** Origin of Cultivated Plants: Concept of centers of origin; Plant introduction; Crop domestication; Classification of plant resources on the basis of their uses; Cereals: Rice, wheat and their role in green revolution; Leguminous plant resources: soybean, arhar dal, pea - their products and uses
- UNIT II:** Beverages: Tea, Coffee and cocoa - their sources, products and uses; Spices and condiments: Sources and uses of black pepper, cinnamon, clove, bay leaf, turmeric, zinger; Oil: Mustard, groundnut, castor and citronella
- UNIT III:** Fibers - Botany and uses of cotton, jute and ramie; Fruits - orange, pineapple, banana; Products and byproducts of sugar industry - Sugarcane, sugar beat
- UNIT IV:** Timber and non-timber plant resources: sal, gamari, teetasopa; Botany and uses of cane and bamboo, Para-rubber, herbal dye (henna, manjistha, bixa); Botany and uses of medicinal plants (*Holarhena*, *Rauwolfia*, *Catharanthus*, *Taxus*, *Plumbago*, *Azadirachta*, *Andrographis*)
- UNIT V:** Pharmacognosy: Pharmacognosy and its importance in medicinal plant uses
- UNIT VI:** Ethnobotany- Definition, concept and scope; discipline and sub-disciplines of ethnobotany, importance of traditional knowledge in relation to plant uses and IPR (Intellectual Property Rights)

Course Content

Paper: M 605 (Practical)

(Molecular Biology, Biotechnology, Bioinformatics and Computer Application)

(Division of marks: Molecular Biology-14, Biotechnology-10, Bioinformatics-10, Computer Application-10, Field records etc. 8 & Viva-voce -8 = 60)

Molecular Biology:

1. Prepare the standard curve of protein and determine protein content in plant materials by Biuret method.
2. Separate and identify amino acids present in plant extract by (i) Paper Chromatography, (ii) Thin Layer chromatography.
3. Quantitative estimation of reducing sugar and total sugar by Somogyi's method.
4. Separate and identify chlorophyll pigments by Paper Chromatography.
5. Determine Titratable Acid Number (TAN) in Bryophyllum leaves.
6. Estimation of Total Nitrogen by Micro Kjeldahl method.

Biotechnology:

1. Preparation and sterilization of the medium, Slant preparation and Inoculation - MS medium.
2. Micro propagation of some important plants.
3. Study of Genetic engineering Techniques (photographs): FISH, DNA Fingerprinting, DNA Sequencing, Gene gun, Ti plasmid.
4. Study of steps of genetic engineering techniques from photographs (Bt cotton, Golden rice, Flavr Savr tomato)
5. Construction of Restriction Map from the data provided.
6. Aseptic seed germination - legume seed
7. Study of different bio fertilizers.
8. Homology Modeling through the BLAST (For Genes)

Bioinformatics:

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree

Computer Application: As per theory syllabus

Course Content

Paper: M 606 (Practical)

(Plant Physiology and Plant Resource utilization)

(Division of marks: Plant Physiology-25, Plant Resource Utilization-20, Field records etc. - 7 & Viva-voce -8=60)

Plant Physiology:

1. Determine the osmotic potential of cell sap by plasmolytic method.
2. Determine the water potential of plant tissue.
3. Determine the stomatal index, stomatal frequency and estimate the transpiration rate of different types of leaves.
4. Study the effect of temperature on the rate of imbibitions and determine the Q_{10} .
5. Determine RQ of different plant materials (Seeds, Leaf buds, Flower buds).
6. Extract and separate chloroplast pigments by solvent method and Paper chromatography
7. Determine effect of CO_2 concentration on the rate of photosynthesis.

Plant Resource Utilization:

1. Chemical tests for tannins (Tea); Alkaloids (*Vinca rosea*)
2. Pharmacognosical studies of both crude and powdered drugs - Zinger, Holarrhena, Rauwolfia
3. Histochemical test for *Curcuma longa*, starch in non-lignified vessels (Zingiber); Alkaloid (*Andrographis*, Neem and *Plumbago*)

BOTANY GENERAL COURSE
GAUHATI UNIVERSITY
B.Sc. Syllabus under Semester System

Course Structure

Semester(s)	Course(s)	No. of Papers	Total Marks	No. of Classes/w	Credit (s)
1 st	Botany General	01 (E101) Theory	75	6	6
2 nd	Botany General	01 (E201) Theory	75	6	6
3 rd	Botany General	02 E301-Theory E302-Practical	50+50 (100)	(4+4) 8	(4+4) 8
4 th	Botany General	02 E401-Theory E402-Practical	50+50 (100)	(4+4) 8	(4+4) 8
5 th	Botany General	02 E501-Theory E502-Practical	100+100 (200)	(8+8) 16	(8+8) 16
6 th	Botany General	02 E601-Theory E602-Practical	100+100 (200)	(8+8) 16	(8+8) 16
Total Marks			750	60	60

FIRST SEMESTER
Allotment of Marks and Credits

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
E 101 (Theory)	60	15	75	6	6
Total	60	15	75	6	6

Examination Time: Theory 3 (Three) Hours

COURSE CONTENT
Paper: E 101(Theory)
(Diversity of Microbes and Cryptogams)

- UNIT I: Introductory Botany: Classification of plant kingdom, Importance of plant for human life and support system
- UNIT II: Algae - General characters, classification, Life history and Economic importance of Cyanophyceae (*Anabaena*), Chlorophyceae (*Volvox*, *Oedogonium*), Phaeophyceae (*Ectocarpus*), Rhodophyceae (*Polysiphonia*)
- UNIT III: Viruses, Bacteria, and Lichen - General account of viruses, Bacteriophages, Transmission of viruses; Classification of bacteria, Ultra structure of bacterial cell, reproduction and economic importance of bacteria; Lichen - General Account and economic importance
- UNIT IV: Fungi and Plant Pathology- General Characters, cellular organizations, nutrition, reproduction, classification, and Economic importance; Life history of Phycomycetes (*Phytophthora*, *Mucor*); Ascomycetes (*Saccharomyces*, *Penicillium*, *Peziza*); Basidiomycetes (*Puccinia*); Deuteromycetes (*Helminthosporium*); Plant disease symptoms, disease cycle and control measures
- UNIT V: Bryophytes - Morphology, structural organization, habit, reproduction, classification and life histories of the following: Hepaticopsida (*Marchantia*); Anthocerotopsida (*Anthoceros*) and Bryopsida (*Funaria*)
- UNIT VI: Pteridophytes - Origin and evolutionary trends, classification, morphological and anatomical characteristics and life cycles of the following: Lycopsida (*Lycopodium*, *Selaginella*); Sphenopsida (*Equisetum*); Pteropsida (*Pteris*)

SECOND SEMESTER

Allotment of Marks and Credits

Paper(s)	Course work	Internal Assessment	Total	Credit	Class/week
E 201 (Theory)	60	15	75	6	6
Total	60	15	75	6	6

Examination Time: Theory 3 (Three) Hours

COURSE CONTENT

Paper: E 201(Theory)

(Cell Biology and Genetics)

UNIT I: Structure of prokaryotic and eukaryotic cell, ultra structure of nucleus, mitochondria, and chloroplast

UNIT II: Chromosome organization - morphology of chromosome, types of chromosome; structure and function of DNA and RNA and their replications

UNIT III: Cell division - Mitosis and meiosis and their significance

UNIT IV: Gene expressions - Structure of genes, protein synthesis, regulation of gene expression in prokaryotic and eukaryotic cell

UNIT V: Mendelian genetics - Laws of segregation and independent assortment, allelic and non-allelic interactions, incomplete dominance

UNIT VI: Linkage and crossing over and their significance; Changes in chromosome structure and number and their role in evolution, mutations- spontaneous and induced

THIRD SEMESTER

Allotment of Marks and Credits

Paper	Course work	Internal Assessment	Total	Credit	Class/week
E 301 (Theory)	40	10	50	4	4
E 302 (Practical)	40	10	50	4	4
Total	80	20	100	8	8

Examination Time: Theory: 3 Hours
 Practical: 4 Hours

Course Content
Paper: E 301 (Theory)
(Diversity of Seed Plants and their Systematic)

- UNIT I:** Gymnosperms: Introduction, general characters, classification, Origin & Evolution of seed habit.
- UNIT II:** Morphology of vegetative and reproductive structures, anatomy of stem & leaf, and life cycle of the following types: *Cycas*, *Pinus*, *Gnetum*
- UNIT III:** Fossilization processes, General characteristics of Cycadofilicales, Bennettitales.
- UNIT IV:** Taxonomy of angiosperms: Introduction, Scope and objectives, Binomial Nomenclature, Taxonomic Ranks, General accounts of systems of classification – artificial, natural, phylogenetic. Salient features of classification systems with merits and demerits of Bentham and Hooker; Engler and Prantl.
- UNIT V:** Diversity of flowering Plants: Systematic position (Bentham & Hooker system) distribution, general characters, floral formula, floral diagram, distinguishing characters and economically important plants of the following families.
 1. Magnoliaceae, 2. Malvaceae, 3. Papilionaceae, 4. Caesalpinaceae, 5. Mimosaceae, 6. Apiaceae, 7. Euphorbiaceae, 8. Lamiaceae, 9. Solanaceae, 10. Verbenaceae, 11. Asteraceae, 12. Poaceae, 13. Orchidaceae

Course Content
Paper: E 302 (Practical)
**(Diversity of Microbes and Cryptogams, Cell Biology and Genetics,
 Diversity of Seed Plants and their Systematics)**

(Division of Marks: Diversity of Microbes and Cryptogams: 10; Cell Biology and Genetics: 10; Diversity of Seed Plants and their Systematics:10; practical records etc. 5; Viva –voce:5)

1. Study of vegetative, reproductive bodies of genera included under Algae, Fungi (inclusive of plant diseases) of theory syllabus.
2. Study of morphology, anatomy and detailed reproductive structures of Bryophyta and Pteridophyta genera included under theory syllabus.
3. Gram staining of Bacteria.
4. Examination of stages of Mitotic and Meiotic cell divisions.
5. Gymnosperms: Study morphology and anatomy of leaf/stem, detailed reproductive structures of *Cycas*, *Pinus*, *Gnetum*.
6. Study of fossil specimens and slides.
7. Angiosperms: Description of specimen from representative of locally available plants belongs to the families included in theory syllabus.
8. Submission of Practical Note Books, Permanent slides.
9. Field work report

FOURTH SEMESTER

Allotment of Marks and Credits

Paper	Course work	Internal Assessment	Total	Credit	Class/ week
E 401 (Theory)	40	10	50	4	4
E 402 (Practical)	40	10	50	4	4
Total	80	20	100	8	8

Examination Time: Theory: 3 Hours
Practical: 4 Hours

Course Content

Paper: E 401 (Theory) **(Plant Physiology and Biochemistry)**

- UNIT I: Plant water relations: Plant-water relations:** Different bio-physio-Chemical phenomenon: definition, phenomenon and Importance of permeability, diffusion, osmosis, Plasmolysis, imbibition, Absorption of water-Introduction, mechanism of water absorption (Active and passive theories), Ascent of sap: Definition, mechanism- (root pressure theory, capillarity, Imbibitional and transpiration pull theories), Transpiration: Definition, types, structure of stomata. Mechanism of opening and closing of stomata (Starch- sugar, K⁺ (Potassium ion) pump theory)
- UNIT II: Mineral nutrition:** Essential macro and micro elements and their role in plants (deficiency, symptoms, disease and functions), Translocation of organic solutes: Introduction, direction of translocation, Mechanism: Mass flow or munch hypothesis, protoplasmic streaming theory
- UNIT III: Plant metabolism:** Photosynthesis: introduction, Ultra structure of chloroplast, photosynthetic pigments, concepts of two Photo systems, Light phase: cyclic and non cyclic photophosphorylation (z- scheme), Dark phase: calvin cycle (C3) Hatch and Slack cycle (C4) and crassulacean acid metabolism, significance of photosynthesis, Respiration: Introduction, Types of respiration - Aerobic: Glycolysis, TCA cycle ETS (Oxidative phosphorylation) respiration
- UNIT IV: Growth and Development:** Growth and growth hormones: Phases of growth, factors affecting growth, Plant growth substances, hormones and their Practical applications; Seed dormancy: Introduction, methods of breaking Seed Dormancy, factors affecting seed dormancy; Physiology of flowering: Photoperiodism (LD/SD/DN plants) Vernalization and Devernalization; Plants movements: Classification of movements, Movements of curvature. Movements of variation (paratonic –nastic)
- UNIT V: Biochemistry:** Elementary biochemistry: Introduction, different organic constituents of the cell, Functions of carbohydrates (mono /oligo / polysaccharides) starch, Cellulose, Hemicellulose, proteins and nucleic acids,

lipid, alkaloids, gums, mucilage and organic acids; Nitrogen metabolism: Introduction, physical and biological nitrogen fixation, nitrogen in soil, ammonification and nitrification, denitrification; Enzymes: Introduction, nomenclature and classification, mechanism and mode of action. Concept of holoenzymes, apoenzymes, coenzymes and cofactors.

COURSE CONTENT
Paper: E 402 (Practical)
(Plant Physiology and Biochemistry)

1. Determine the osmotic potential of cell sap by plasmolytic method.
2. Determine the Diffusion Pressure Deficit (DPD) of plant cells.
3. Determine the effect of time period on the rate of imbibition in different types of seeds.
4. Determine the relation between absorption and transpiration.
5. Measure the effect of different environmental conditions on the rate of transpiration of a twig by Ganong's Potometer.
6. Determine the effect of CO₂ concentration on the rate of photosynthesis.
7. Determine RQ of different plant materials (Germinating seeds, Leaf buds, Flower buds).
8. Qualitative analysis of plant materials to prove the presence of Sucrose, Glucose, Proteins, Fats and Cellulose.
9. Qualitative analysis of Plant ash to prove the presence of Iron, Potassium, Calcium, Magnesium, Phosphorus.

FIFTH SEMESTER
Allotment of Marks and Credits

Paper	Course work	Internal Assessment	Total	Credits	Class/week
E 501 (Theory)	80	20	100	8	8
E 502 (Practical)	80	20	100	8	8
Total	160	40	200	16	16

Examination Time: Theory: 3 Hours
Practical: 4 Hours

COURSE CONTENT

Paper: E 501 (Theory)

(Structure, Development and Reproduction in Flowering Plants)

- UNIT I:** Basic body plan of flowering plant, modular type of growth, diversity in plant forms – annuals, biennials and perennials, Histological organization of root and shoot apices, various theories of cellular organization
- UNIT II:** Types of tissue: Meristematic tissue – meristem, structure and types based on origin and position, Permanent tissue: Simple, Complex and Secretary, Epidermal tissue: Trichomes and Stomata.
- UNIT III:** Anatomy: Primary structure of root, stem and leaf of Monocot and Dicot, Secondary growth in root and stem, Wood anatomy: Growth rings, heart wood and sap wood, Periderm: Origin, structure and functions, Floral biology
- UNIT IV:** Embryology: Microsporogenesis and development of male gametophyte, megasporogenesis and development of female gametophyte, Double fertilization and its significance.
- UNIT V:** Development of dicot embryo, Structure, development and types of endosperms, Fruit: Development and maturation of fruit, types and parts of fruits, fruit dispersal strategies, Vegetative propagation: Grafting, layering and budding.
- UNIT VI:** Seed: Types of seed, germination of seeds-types and nature and dispersal of seeds, factors affecting germination

COURSE CONTENT

Paper: E 502 (Practical)

(Structure, Development and Reproduction in Flowering Plants)

1. Study of non-living cell inclusion (ergastic matters): Starch grains, Aleurone grains, Raphides, Cystolith.
2. Study of types of stomata.
3. Study of epidermal hairs.
4. Study of secondary growth in thickness by permanent preparation of differentially stained slide: *Amaranthus*, *Boerhavia*, *Mirabilis*, *Bougainvillea*, *Dracaena*, *Tinospora*.
5. Study from permanent slide: T.S. through young and mature anther; Male gametophyte; L.S. of ovule showing different nuclear stages of embryo sac; L.S. of ovule showing types of Endosperm; L.S. of Embryo – Dicotyledonous, Monocotyledonous.
6. Study of spurious fruits, aggregate fruits, composite fruits (at least 2 types each).
7. Study the adaptation in fruits and seeds for dispersal through air (at least 4 types).
8. Demonstrate the process of: Budding; Air layering; Scion grafting.
9. Practical Records, Permanent slides to be submitted in the examination.

SIXTH SEMESTER

Allotment of Marks and Credits

Paper	Course work	Internal Assessment	Total	Credits	Class/week
E 601 (Theory)	80	20	100	8	8
E 602 (Practical)	80	20	100	8	8
Total	160	40	200	16	16

Examination Time: Theory: 3 Hours
Practical: 4 Hours

COURSE CONTENT

Paper: E 601 (Theory)

(Ecology and Utilization of Plants)

Ecology:

UNIT I: Introduction, concept, definition, Autecology and Synecology, Ecosystem Ecology: Introduction, ecological organization – species population, community ecosystem and biosphere, Kinds of ecosystem, structure and function of ecosystem, abiotic components, biotic components and their role.

UNIT II: Ecological succession-Types and pattern, food chain, food web, ecological pyramid

UNIT III: Bio-geo-chemical cycles-concept, details of Nitrogen and carbon cycle, Composition and functioning of ecosystem: i) Simple – pond ecosystem, ii) Complex – forest ecosystem, iii) Artificial – crop land ecosystem.

UNIT IV: Ecological grouping of plants with reference to their significance of adaptive external and internal features: Hydrophytes and Xerophytes. Environmental pollution with special reference to Air and Water pollutions - causes, effects and control measures; Green house effect.

Utilization of Plants:

UNIT V: Classification of plants on the basis of Botanical sources and uses of Rice, Wheat, Maize,

UNIT VI: Sugar cane, Gram, Pea, Coffee and Tea, Black pepper, Turmeric, Clove, and mustard - Their uses and botanical sources

UNIT VII: Non timber plant products - Cotton, Jute, Rubber, Bamboo, and Jatropha. Their uses and botanical sources

UNIT VIII: Timber and medicinal plant resources: Teak, Sal, Rauwolfia, Neem, Cinchona-their uses and botanical sources

COURSE CONTENT
Paper: E 601 (Practical)
(Ecology and Utilization of Plants)

Ecology:

1. Determine the frequency and density of herbaceous species by quadrat method
2. Study the anatomical features of some common

Hydrophytes: Root of Eichhornia, Petiole of Eichhornia, stem of Hydrilla, Petiole of Nymphaea.

Xerophytes: Leaf of Nerium, Leaf of Thevetia, Leaf of Grass.

3. Test for the presence of inorganic salts in the soil: Chloride, Sulphate, Phosphate.

Utilization of Plants:

1. Study the morphology, parts used, chemical nature and uses of the following plants
 - a) Cereals – Rice.
 - b) Pulses and legumes – Pea.
 - c) Beverages – Tea.
 - d) Fibres – Cotton, Jute
 - e) Fats and oils –Mustard.
 - f) Spices – Black pepper, Turmeric.
 - g) Medicinal – Rauwolfia, Neem.
 - h) Fuel – Jatropha.
 - i) Sugar-Sugar cane

BOTANY MAJOR

REFERENCES

FIRST SEMESTER

PAPER: M 101

PLANT KINGDOM

Dutta A. C. : Botany for Degree Students

ALGAE

1. Chapman, V.J. & D.J. Chapman : The Algae.
2. Kumar, H.D, & H.N. Singh : A Text Book of Algae
3. Pandey, B.B : A Text Book of Botany - Algae.
4. Sharma. O.P : Text Book of Algae
5. Singh, S.K. & S. Srivastava : A Text Book of Algae.
6. Vashishta, B.R : Botany for degree students –Algae.

FUNGI

1. Alexopoulos, C.J : Introductory Mycology.
2. Dube., H.C. : A Text Book of Fungi.
3. Purohit, S.S. : Viruses, Bacteria and Mycoplasma.
4. Sharma, O.P. : Text Book of Fungi.
5. Singh, S.K. & S. Srivastava : A Text Book of Fungi.
6. Srivastava, J.P. : An introduction of Fungi.
7. Vashista, B.R. : Botany for Degree students. Part II. Fungi.

PAPER: M 102

BRYOPHYTES

1. Chopra, R.N. : Bryophyta
2. Gupta, S.K. : Introductory Botany Vol II - Bryophyta and Gymnosperms
3. Parihar, N.S : An Introduction to Embryophyta.
4. Puri, P. : Bryophytes.
5. Rashid, A. : An Introduction to Bryophyta.
6. Singh, S.K. : Text Book of Bryophyta.
7. Vashishta, B.R. : Botany for degree student –Bryophyta.

PTERIDOPHYTES

1. Pandey, B.P. : A Text Book of Bryophyta, Pteridophyta and Gymnosperms
2. Parihar, N.S. : An introduction to Embryology. Vol-II. Pteridophyta and Gymnosperms
3. Rashid, A. : Pteridophyta.
4. Singh, S.K. : Pteridophyta.
5. Vashishta, P.C. : Botany for Degree Students, Vol IV – Vascular Cryptogams (Pteridophyta),

SECOND SEMESTER
PAPER: M 201

GYMNOSPERMS

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|--------------------------------|---|--------------------------------------|
| 1. Bhatnagar, S.P. & A. Moitra | : | Gymnosperms. |
| 2. Chamberlain, C.J | : | Gymnosperm, Structure and Evolution. |
| 3. Vasishtha, P.C | : | Gymnosperm. |

PALAEOBOTANY

- | | | |
|------------------------------|---|------------------------------------------------------|
| 1, Agashe, S.N. | : | Palaeobotany. |
| 2. Andrews, Jr.H.N. | : | Studies in Palaeobotany. |
| 3. Arnold, C.A | : | An Introduction to Paleobotany |
| 4. Meyen, S.V. | : | Fundamentals of Palaeobotany. |
| 5. Shukla.A.C. & S.P. Mishra | : | Essentials of Palaeobotany. |
| 6. Taylor, T.N. | : | Palaeobotany-An Introduction to Fossil Plant Biology |

PLANT ANATOMY

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| 1. Eames, A.J. & Mac Daniels | : | An Introduction to Plant Anatomy. |
| 2. Esau, K. | : | Plant Anatomy. |
| 3. Fahn, A. | : | PLANT Anatomy. |
| 4. Pandey, B.P. | : | Plant Anatomy. |
| 5. Vashista, P.C. | : | A text Book of plant Anatomy. |

PAPER: M 202

CELL BIOLOGY

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| 1. Berry, A.K. | : | A Text Book of Cell Biology |
| 2. Power, C.B. | : | Cell Biology. |
| 3. Rastogi, S.C. | : | Cell biology. |
| 4. Singh S.P & B.S. Tomar | : | Cell biology. |
| 5. Sundara Rajan, S. | : | Introduction Cell Biology. |

THIRD SEMESTER

PAPER: M 301

ECOLOGY

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|---------------------------------|---|---------------------------------|
| 1. Odum, E.P. | : | Fundamentals of Ecology |
| 2. Odum, E.P. | : | Basic Ecology |
| 3. Sharma, P.D | : | Ecology and Environment. |
| 4. Shukla, R.S & I.P.S. Chandel | : | Plant Ecology and Soil Science. |
| 5. Shukla,R.S. & P.S. Chandel | : | A Text Book of Plant Ecology |
| 6. Samba Murty, S. | : | Ecology |
| 7. Vasishtha, P.C. | : | Plant Ecology. |
| 8. Verma, V. A. | : | Text Book of plant Ecology. |
| 9. Weaver & Clements | : | Plant Ecology. |

EVOLUTION

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| 1. Strickberger | : | Evolution. |
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PAPER: M 302**BIOLOGICAL INSTRUMENTATION**

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| 1. Bajpai, P.K. | : | Biological instrumentation & methodology. |
| 2. Rana, S.V.S. | : | Biotechniques – Theory and Practice. |

PLANT MICROTECHNIQUE

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| 1. Johansen, D.A. | : | Plant Microtechnique. |
| 2. KHASIM, J.K. | : | Botanical Microtechnique, Principles and Practice. |
| 3. Prasad and Prasad | : | Outlines of Botanical Micro technique. |
| 4. Sas. Joe E | : | Botanical Microtechnique. |

FOURTH SEMESTER**PAPER: M 401****MORPHOLOGY**

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| 1. Eames, A.J. | : | Morphology of Angiosperms. |
| 2. Rao, A. | : | Morphology of Angiosperms. |

PALYNOLOGY

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| 1. Erdtman, G. | : | Pollen Morphology and Plant Taxonomy. |
| 2. Faegri, K. & J. Iverson | : | Text Book of Pollen Analysis. |
| 3. Nair, P.K.K. | : | Pollen Morphology of Angiosperms. |
| 4. Saxena, M.R. | : | Palynology – A treatise. |
| 5. Shivana & Johri | : | The Angiosperm Pollen. |
| 6. Shivana, K.R. & N.S. Rangaswami: | : | Pollen Biology. |

EMBRYOLOGY OF ANGIOSPERMS

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| 1. Bhojwani, S.S & S.P. Bhatnagar | : | The Embryology of Angiosperms. |
| 2. Dwivedi, J. N. | : | Embryology of Angiosperms. |
| 3. Johri, B.D. | : | Embryology of Angiosperms. |
| 4. Maheshwari, P. | : | An Introduction to the Embryology of Angiosperms. |
| 5. Pandey, B.P. | : | Embryology of Angiosperms. |
| 6. Pandey, S.N. & A. Chadha | : | Plant Anatomy & Embryology. |

PAPER: M 402**PLANT TAXONOMY AND SYSTEMATIC BOTANY**

- | | | |
|---------------------|---|---------------------------------------------------|
| 1. Lawrence, G.H.M. | : | Taxonomy of Vascular Plants. |
| 2. Mitra, J.N. | : | An Introduction to Systematic Botany and Ecology. |
| 3. Mondal, A.K. | : | Advanced Plant Taxonomy. |
| 4. Mukherjee, S.K. | : | College Botany (Vol. III). |
| 5. Naik, V.N. | : | Taxonomy of Angiosperms. |
| 6. Pandey, P.B | : | Taxonomy of angiosperms (Systematic Botany) |

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| 7. Pandey, B.P | : | Taxonomy of Angiosperms. |
| 8. Saxna, N.B. & S. Saxena | : | Plant Taxonomy. |
| 9. Sharma, A.K. & R. Sharma | : | Taxonomy. |
| 10. Singh, G. | : | Plant Systematics. |
| 11. Singh, V. & D.K. Singh | : | Taxonomy of Angiosperms. |
| 12. Sivarajan, V.V. | : | Introduction to Principles of Plant Taxonomy. |
| 13. Vashista, P.C | : | Taxonomy of Angiosperms. |

FIFTH SEMESTER

PAPER: M 501

MICROBIOLOGY

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|----------------------------------------------|---|---------------------------------|
| 1. Dubey, R.C & D.K. Maheswari | : | A Text Book of Microbiology. |
| 2. Kaushik, P. | : | Microbiology. |
| 3. Kumar, H.D. & S. Kumar | : | Modern Concept of Microbiology. |
| 4. Pelczar, Chan and King | : | Microbiology |
| 5. Purohit, S.S. | : | Microbiology. |
| 6. Rangaswami, R. & C.K.J. Panikar | : | Text Book of Microbiology. |
| 7. Sharma, P.D. | : | Microbiology and Pathology. |
| 8. Singh, U.S. & K. Kapoor | : | Introductory Microbiology. |
| 9. Trivedi, P.C. Pandey, S. & Seema Hadauria | : | Text Book of Microbiology. |

VIRUS

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| 1. Biswas, S.B. & A. Biswas | : | An Introduction to Virus. |
| 2. Madahar, C.L. | : | Introduction of Plant Virus. |
| 3. Purohit, S.S. | : | Viruses, Bacteria and Mycoplasma |

BACTERIA

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| 1. Clifton, A. | : | Introduction to Bacteria |
| 2. Madahar, C.L. | : | Introduction of Plant Virus |
| 3. Singh, V. & V. Srivastava | : | Introduction of Bacteria. |

IMMUNOLOGY

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|---------------------------------|---|----------------------------------------------|
| 1. Banerjee, A.K. & N. Banerjee | : | Fundamentals of Microbiology and Immunology. |
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PAPER: M 502

PLANT PATHOLOGY

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|--------------------|---|-----------------------------------------------|
| 1. Bilgrami & Dube | : | A Text Book of Modern Plant Pathology. |
| 2. Mehrotra, R.S. | : | Plant Pathology. |
| 3. Pandey, B.P. | : | Plant Pathology, Pathogen and Plant Diseases. |
| 4. Pathak, V.N. | : | Fundamentals of Plant Pathology. |
| 5. Rangaswami, G. | : | Diseases of Crop Plants of India. |
| 6. Sharma, P.D. | : | Plant Pathology. |
| 7. Singh, R.S. | : | Plant Diseases. |

8. Singh, R.S. : Introduction to Principles of Plant Pathology.
 9. Trivedi, P.C. : Plant Disease and its Management.
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LICHEN

1. Misra, A. & R.P. Agarwal : Lichens – A Preliminary Text.

PAPER: M 503**CYTOGENETICS**

1. Gupta, P.K. : Genetics.
 2. Powar, C.B. : Essential of Cytology
 3. Pawar, C.B. : Genetics- (Vol. I & II).
 4. Strickberger : Genetics
 5. Shukla & Chandel. : Cytogenetics & Plant Breeding
 6. Sundararajan, S. ; Cytology
 7. Verma, P.S. & V.K. Agarwal : Genetics.

PLANT BREEDING

1. Chauduri, H.K. : Elementary Principles of Plant Breeding.
 2. Singh, B.D. : Plant Breeding.
 3. Singh, S.P. Lakhi Ram Singh,
 Srivastava, J.P. : Plant Breeding.

BIOSTATISTICS

1. Gupta, S. C. : Fundamentals of Statistics
 2. Jasra, P.K. & Gurdeep Raj : Biostatistics.
 3. P.N. Arora & P.K. Malhan : Biostatistics.
 4. Steve Selvin. : Biostatistics: how it works.

SIXTH SEMESTER**PAPER: M 601****MOLECULAR BIOLOGY**

1. Arora, M.P. & Chandra Kanta : Molecular Biology.
 2. Gupta, P.K. : Cell and Molecular Biology.
 3. Kar, D.K. & S. Halder : Cell Biology, Genetics, Molecular Biology.
 4. Kumar, H.D. : Molecular biology and biotechnology.

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1. Dubey R.C. : A text book of Biotechnology.
 2. Ignachimuthu, S. : Basic biotechnology.
 3. Ramawat, K.G. & S. Goyal : Comprehensive Biotechnology.
 4. Singh, B.D. : Biotechnology: Expanding horizons
 5. Trivedi, P.C. : Plant Biotechnology.

PLANT TISSUE CULTURE

1. Kalyan Kumar, D. : An Introduction to plant tissue culture.
 2. Narayanaswamy, S. : Plant Cell & Tissue Culture

PAPER: M 602**BIOINFORMATICS**

1. Attwood, T.K. : Introduction to Bioinformatics.
 2. Bansal, M. : Basic Bioinformatics.
 3. Ghosh, Z. & B. Mallick : Bioinformatics: Principles and Applications.
 4. Harisha, S. : Fundamentals of Bioinformatics Text Book.
 5. Ignacimuthu, S. : Basic Bioinformatics.
 6. Mukherjee, A. : Bioinformatics.
 7. Ranga, M.M. : Bioinformatics.
 8. Sundararajan, S. & R. Balaji : Introduction to Bioinformatics.

COMPUTER APPLICATIONS

1. Bangia, R. : Learning Computer Fundamentals.
 2. Norton, P. : Introduction to Computers.
 3. Rajaraman, V. : Fundamentals of Computers.
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PAPER: M 603**PLANT PHYSIOLOGY**

1. Ahmed, M. : Plant Physiology.
 2. Gill, D.S. : Plant Physiology
 3. Malik, C.P. : Plant Physiology.
 4. Mukherji, S, & A.K. Ghosh : Plant Physiology.
 5. Pandey, S.N. : Plant Physiology.
 6. Salisbury & Ross : Plant Physiology
 6. Verma, V. : A Text Book of Plant Physiology.
 7. Wilkins, M.B. : Advanced Plant Physiology.

PAPER: M 604**ECONOMIC BOTANY**

1. Govind Prakash and S.K. Sharma : Introductory Economic Botany.
 2. Hill, A. (adapted by O.P. Sharma) : Economic Botany.
 3. Nehra, S. : Economic Botany.
 4. Pandey, B.P. : Economic Botany.
 5. Pandey & Chaddha : Economic Botany
 6. Subramanyam, Samba Murty : Economic Botany

PHARMACOGNOSY

1. Quadri & Shah : Pharmacognosy

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1. Jain, S.K. : Glimpses of Indian Ethnobotany.
2. P.C.Trivedi : Ethnobotany.

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2. Jain, J.L. : Fundamentals of Biochemistry.
3. Lehninger, A.L. : Principles of Biochemistry,
4. Nagini, S. : Text Book of Biochemistry.
5. Power, C.B. & G.R. Chatwal : Biochemistry.

BOTANY GENERAL COURSE REFERENCES

FIRST SEMESTER

PAPER: E 101

ALGAE

1. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)
2. Pandey, B.B : A Text Book of Botany - Algae.
3. Sharma. O.P : Text Book of Algae
4. Singh, S.K. & S. Srivastava : A Text Book of Algae.
5. Vashishta, B.R : Botany for degree students –Algae.

FUNGI

1. Dube., H.C. : A Text Book of Fungi.
2. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)
3. Sharma, O.P. : Text Book of Fungi.
4. Srivastava, J.P. : An introduction of Fungi.
5. Vashista, B.R. : Botany for Degree students. Part II. Fungi.

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1. Biswas,S.B. & A. Biswas : An Introduction to Virus.
2. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)

BACTERIA

1. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)
1. Singh, V. & V. Srivastava : Introduction of Bacteria.

PLANT PATHOLOGY

1. Pandey, B.P. : Plant Pathology, Pathogen and Plant Diseases.
2. Rangaswami, G. : Diseases of Crop Plants of India.
3. Sharma, P.D. : Plant Pathology.

4. Singh, R.S. : Plant Diseases.
 5. Singh, R.S. : Introduction to Principles of Plant Pathology.

BRYOPHYTES

1. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)
 2. Parihar, N.S : An Introduction to Embryophyta.
 3. Puri, P. : Bryophytes.
 4. Rashid, A. : An Introduction to Bryophyta.
 5. Vashishta, B.R. : Botany for degree student –Bryophyta.

PTERIDOPHYTES

1. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol. I)
 2. Pandey, B.P. : A Text Book of Bryophyta, Pteridophyta and Gymnosperms.
 3. Parihar, N.S. : An introduction to Embryology. Vol-II. Pteridophyta and Gymnosperms
 4. Rashid, A. : Pteridophyta.
 5. Vashishta, P.C. : Botany for Degree Students, Vol IV – Vascular Cryptogams (Pteridophyta),

SECOND SEMESTER

PAPER: E 201

CELL BIOLOGY

1. Power, C.B. : Cell Biology.

CYTOGENETICS

1. Gupta, P.K. : Genetics.
 2. Verma, P.S. & V.K. Agarwal : Genetics.

THIRD SEMESTER

PAPER: E 301

GYMNOSPERM

1. Chamberlain, C.J : Gymnosperm, Structure and Evolution.
 2. Mitra J. N., Mitra D & Chaudhuri S. K.: Studies in Botany (Vol. I)
 3. Vasishta, P.C : Gymnosperm.

PALAEOBOTANY

1. Arnold, C.A : An Introduction to Paleobotany
 2. Shukla.A.C. & S.P. Mishra : Essentials of Palaeobotany.

PLANT TAXONOMY AND SYSTEMATIC BOTANY

1. Mitra, J.N. : An Introduction to Systematic Botany and Ecology.
 2. Mondal, A.K. : Advanced Plant Taxonomy.
 3. Mukherjee, S.K. : College Botany (Vol. III).

4. Pandey, P.B : Taxonomy of angiosperms (Systematic Botany)
 5. Vashista, P.C : Taxonomy of Angiosperms.

FOURTH SEMESTER

PAPER: E 401

PLANT PHYSIOLOGY

1. Mitra J. N., Mitra D & Chaudhuri S. K.: Studies in Botany (Vol.II)
 2. Mukherji, S, & A.K. Ghosh : Plant Physiology.
 3. Verma, V. : A Text Book of Plant Physiology.

FIFTH SEMESTER

PAPER: E 501

PLANT ANATOMY

1. Mitra J. N., Mitra D & Chaudhuri S. K: Studies in Botany (Vol.I)
 2. Pandey, B.P. : Plant Anatomy.
 3. Vashista, P.C. : A text Book of plant Anatomy.

EMBRYOLOGY OF ANGIOSPERMS

1. Bhojwani, S.S & S.P. Bhatnagar : The Embryology of Angiosperms.
 2. Dwivedi, J. N. : Embryology of Angiosperms.
 3. Johri, B.D. : Embryology of Angiosperms.
 4. Maheshwari, P. : An Introduction to the Embryology of Angiosperms.
 5. Pandey, B.P. : Embryology of Angiosperms.
 6. Pandey, S.N. & A. Chadha : Plant Anatomy & Embryology.

SIXTH SEMESTER

PAPER: E 601

ECOLOGY

1. Samba Murty, S. : Ecology
 2. Sharma, P.D : Ecology and Environment.
 3. Shukla, R.S & I.P.S. Chandel : Plant Ecology and Soil Science.
 4. Shukla, R.S. & P.S. Chandel : A Text Book of Plant Ecology
 5. Samba Murty, S. : Ecology
 6. Vashista, P.C. : Plant Ecology.
 7. Verma, V. A. : Text Book of plant Ecology.

ECONOMIC BOTANY

1. Govind Prakash and S.K. Sharma : Introductory Economic Botany.
 3. Nehra, S. : Economic Botany.
 4. Pandey, B.P. : Economic Botany.
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 6. Subramanyam, Samba Murty : Economic Botany