ANNEXURE IV

Department of Biological Sciences, Aliah University, Newtown, Kolkata

Syllabus for the 3 Years B.Sc. Honours Degree in Botany

(2018-19 onwards batches)

Overall Curriculum

Semester	Theory			Practical		
	Course Code	Course Title	Marks/ Credits	Course Code	Course Title	Marks/Credits
I	BB101	Fundamentals of Biochemistry	50/4	BB191	Practical I	50/4
	BB103	Phycology	50/4			
	BZ131	Subsidiary Theory	50/4			
	CH131	Subsidiary Theory	50/4			
	EN131	Subsidiary Theory	50/4			
II	BB102	Cell & Molecular Biology	50/4	BB192	Practical II	50/4
	BB104	Mycology & Phytopathology	50/4			
	BZ132	Subsidiary Theory	50/4			
	CH132	Subsidiary Theory	50/4			
	AI132	Subsidiary Theory	50/4			
III	BB201	Plant Physiology	50/4			
	BB203	Plant Systematics &Archegoniates	50/4			
	BZ231	SubsidiaryTheory	50/4	BZ261	SubsidiaryPractical	50/4
	CH231	SubsidiaryTheory	50/4	CH261	SubsidiaryPractical	50/4
IV	BB202	Biotechniques and Biostatistics	50/4	BB 292	Practical III	50/4
	BZ232	Subsidiary Theory	50/4	BZ262	SubsidiaryPractical	50/4
	CH232	Subsidiary Theory	50/4	CH262	SubsidiaryPractical	50/4
V	BB301	Immunology	50/4	BB391	Practical IV	50/4
	BB303	Plant Anatomy & Reproductive Biology of Angiosperms	50/4	BB393	Practical V	
	BB305	Plant metabolism	50/4			
	EN331	ENVS	50/4			
VI	BB302	Plant Biotechnology	50/4	BB392	Practical VI	50/4
	BB304	Economic Botany	50/4	BB394	Practical VII	50/4
	BB306	Genetics & Genomics	50/4			
	BB308	Ecology	50/4			
Total			1300/104			500/40
Grand Total	**1800 Marks / 144 Credits**					

ANNEXURE IV

Syllabus for the 3 Years B.Sc. Honours Degree
Subsidiary Botany
Overall Curriculum

Sl. No.	Course Structure	Sem	Course Code	Course Title	Full Marks	Credit
1	Botany (Sub)	I	BB 131	Plant Diversity	50	4
2	Botany (Sub)	II	BB 132	Plant Anatomy and Embryology	50	4
3	Botany (Sub)	III	BB 231	Plant Ecology and Taxonomy	50	4
4	Botany (Sub)	III	BB 261	Practical Plant Ecology and Taxonomy	50	4
5	Botany (Sub)	IV	BB 232	Economic Botany and Plant Tissue Culture	50	4
6	Botany (Sub)	IV	BB 262	Practical Economic Botany and Plant Tissue Culture	50	4

Detailed Syllabus

Semester I

BB101

Fundamentals of Biochemistry

Total Marks 50, Credits 4

Unit 1. Water and Buffer **Hours: 6**

Physical properties of water, structure of water molecules, Ionization of water, Bronsted – Lowry concept of acid and bases, Concept of pH of weak acids and weak bases, Henderson-Hasselbalch equation, concept of buffer, strength of buffer, buffer value, important biological buffers (with the help of numerical problems). Forces involved in biomolecular interactions with examples: Van der Waals interactions, electrostatic interactions, hydrogen bond and hydrophobic interaction. Configuration versus conformation.

Unit 2. Stereochemistry **Hours: 4**

General concepts on: Plane of symmetry, centre and axis of symmetry; Concepts of chirality; optical isomerism; geometrical isomerism; DL, RS nomenclature; Projection formula (Fischer &Howarth); Isomers: anomers, epimers; Stereochemistry of cyclohexane: idea of axial & equatorial bonds (related to chair form conformation).

Unit 3. Carbohydrates **Hours: 12**

Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses. Stereoisomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

Unit 4. Lipids **Hours: 8**

Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacylglycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

Unit 5. Proteins **Hours: 12**

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid; Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together.

Unit 6. Enzymes **Hours: 10**

Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism. Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Types of enzyme inhibition, competitive- sulfa drugs; non-competitive-heavy metal salts.

Unit 7. Nucleic acid **Hours: 6**
Purine, pyrimidine - definition and structure. Nucleoside, nucleotide: definition and structure. DNA: Double helical structure. A-DNA, B-DNA & Z-DNA (structure and differences). General structure and types of RNA (tRNA, mRNA, rRNA).

Unit 8. Vitamins **Hours: 2**
Classification and characteristics with suitable examples, sources and importance.

BB103
Phycology
Total Marks 50, Credits 4

Unit 1: Introduction **Hour: 6h**
Introduction to the microbial world, microbial nutrition, growth and metabolism

Unit 2: Algae **Hour: 8h**
General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food (of only groups represented in the syllabus), flagella; and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); significant contributions of important phycologists (F.E. Fritsch, G.M. Smith, R.N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar).

Unit 3: Cyanophyta **Hour: 6h**
Ecology and occurrence, range of thallus organization, cell structure, heterocyst, reproduction.economic importance; role in biotechnology. Morphology and life-cycle of Nostoc.

Unit 4: Chlorophyta **Hour: 10h**
General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Chlamydomonas, Volvox, Oedogonium, Coleochaete. Evolutionary significance of Prochloron.

Unit 5: Charophyta **Hour: 6h**
General characteristics; occurrence, morphology, cell structure and life-cycle of Chara; evolutionary significance.

Unit 6: Xanthophyta **Hour: 6h**
General characteristics; range of thallusorganization;Occurrence, morphology and life-cycle of Vaucheria.

Unit 7: Phaeophyta **Hour: 6h**
Characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of Ectocarpus and Fucus.

Unit 8: Rhodophyta **Hour: 6h**
General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycle of Polysiphonia.

Unit 9: Applied Phycology **Hour: 6h**

Role of algae in the environment, agriculture, biotechnology and industry

BB191
Practical I
Total Marks 50, Credits 4

Unit I

1. Good laboratory practices
2. Preparation of solutions based on molarity, normality, percentage, dilutions
3. Preparation of buffers
4. Qualitative tests for the detection of biomolecule:
   Glucose, Fructose (Benedict's Test); Sucrose (Acid hydrolysis & Benedict's Test); Starch (Iodine Test), Proteins (Biuret method); Amino acids (Ninhydrin); Lipids (Grease Spot Test, Red Test).
5. Estimation of amino acid (glycine) by formol titration.

Unit II

1. Morphological studies of lichen-Crustose, fruitcose& foliose, *Cyathus, Lycoperdon, Polyporus*
2. Study of pathological specimens of- late blight of potato, loose smut of heat, brown spot of rice, red rotof sugarcane, citrus canker
3. Study of vegetative and reproductive structures of
   a. Nostoc
   b. Chlamydomonas
   c. Volvox
   d. Oedogonium
   e. Coleochaete
   f. Chara
   g. Vaucheria
   h. Ectocarpus
   i. Fucus
   j. Polysiphonia
   k. Procholoron
   -through electron micrographs, temporary preparations and permanent slides.

Semester II

BB 102
Cell & Molecular Biology
Total Marks 50, Credits 4

Unit 1 Overview of Cell **Hours: 2**

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions

Unit 2 Structure of Cell **Hours: 8**

Plasma membrane: Structure and transport of small molecules; Cell Wall: Eukaryotic cell wall, Extracellular matrix; Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

Unit 3 Cell Organelles **Hours: 8**

Mitochondria, chloroplasts, lysosomes and peroxisomes; Nucleus: Nuclear envelope, nuclear pore complex, nucleolus and nuclear lamina; Chromatin; Endoplasmic Reticulum and Golgi Apparatus.

Unit 4 Cell Cycle, Cell Death and Cell Renewal **Hours: 8**

Cell cycle, Mitosis and Meiosis; Development of cancer, Programmed cell death, Stem cells: Embryonic stem cell, induced pluripotent stem cells.

Unit 5 Structures of DNA and RNA / Genetic Material **Hours: 4**

DNA structure: Salient features of double helix, Types of DNA, denaturation and renaturation, cot curves. DNA topology: linking number,twist and writhe. RNA Structure.

Unit 6 Replication of DNA (Prokaryotes and Eukaryotes) **Hours: 8**

Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends, and other accessory protein. Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication Mismatch and excision repair**.** Inhibitors of DNA Replication.

Unit 7 Transcription in Prokaryotes and Eukaryotes **Hours: 10**

Concept of Operon (lac and trp), Promoter and Operator; Mechanism of Transcription; RNA polymerase, transcription unit; Transcription in Eukaryotes: RNA polymerases, general Transcription factors. Inhibitors of Transcription. Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprintin

Unit 8 Post-Transcriptional Processing **Hours: 4**

Concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping.

Unit 9 Translation (Prokaryotes and Eukaryotes) **Hours 8**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Translational machinery, charging of tRNA, aminoacyltRNAsynthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation; Inhibitors of protein synthesis in prokaryotes and eukaryotes.

BB 104
Mycology & Phytopathology
Total Marks 50, Credits 4

Unit 1: Introduction to true fungi **Hours: 4h**
Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cellwall composition; Nutrition; Classification.

Unit 2: Chytridiomycota **Hours: 4h**
General account

Unit 3: Zygomycota **Hours: 6h**
General characteristics; Ecology; Thallusorganisation; Life cycle with reference to Rhizopus.

Unit 4: Ascomycota **Hours: 6h**
General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Heterokaryosis and parasexuality; life cycle and classification with reference to Saccharomyces, Aspergillus,Penicillium, Alternaria and Neurospora, Peziza.

Unit 5: Basidiomycota **Hours: 8h**
General characteristics; Ecology; Life cycle and Classification with reference to black stem rust on wheat Puccinia (Physiological Specialization), loose and covered smut (symptoms only), Agaricus; Bioluminescence, Fairy Rings and Mushroom Cultivation.

Unit 6: Allied Fungi **Hours: 6h**
General characterises; Status of Slime molds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

Unit 7: Oomycota **Hours: 6h**
General characteristic; Ecology; Life cycle and classification with reference to PhytophthoraAlbugo.

Unit 8: Symbiotic associations **Hours: 4h**
Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction.Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance.

Unit 9: Applied Mycology **Hours: 6h**
Role of fungi in biotechnology, Application of fungi in food industry (Flavour& texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agriculture (Biofertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

Unit 10: Phytopathology **Hours: 10h**
Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host-Pathogen relationships;disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases – Citrus canker and angular leaf spot disease of Cotton.Viral diseases – Tobacco Mosaic viruses, vein clearing. Fungal diseases – Early blight of potato, Black stem rust of wheat, white rust of crucifers

BB 192
Practical II
Total Marks 50, Credits 4

Unit I

1. Introduction to the world of fungi (Unicellular, coenocytic/septate mycelium, asocarps&basidiocarps)
2. Rhizopus: study of asexual stage from temporary mounts and sexual structures through permanent slides
3. Aspergillus and Penicillium: study of asexual stage from temporary mounts. Study ofSexual stage from permanent slides/photographs
4. Ascobolus/Peziza: sectioning through ascocarp.
5. Alternaria: Specimens/photographs and temporary mounts
6. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberryleaves; sections/ mounts of spores on wheat and permanent slides of both the hosts
7. Agaricus: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus/ Termitomyces, fairy rings and bioluminescent mushrooms to be shown
8. Study of phaneroplasmodium from actual specimens and /or photograph. Study of Stemonitis sporangia
9. Albugo: Study of symptoms of plants infected with Albugo; asexual phase study throughsection/ temporary mounts and sexual structures through permanent slides
10. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates. Study of thallus and reproductive structures (soredia and apothecium) through permanent slides. Mycorrhizae: ectomycorrhiza and endomycorrhiza (Photographs)
11. Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Angular leaf spot of cotton, Viral diseases: TMV, Vein clearing, Fungal diseases: Early blight of potato, Black stem rust of wheat and White rust of crucifers.Bacterial blight of rice.

Unit II

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs.
3. Cytochemical staining of DNA – Feulgen.
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Study of different stages of Mitosis & Meiosis by permanent slides.
7. Study of different types of DNA and RNA using micrographs and model/schematic representations.
8. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent)
9. Estimation of RNA using colorimeter (orcinol reagent)
10. Resolution and visualization of DNA by Agarose Gel Electrophoresis.

Semester III

BB201
Plant Physiology
Total Marks 50, Credits 4

Unit 1: Plant Physiology **Hours: 4h**

Plant-water relations: Concept of water potential, components of water potential in plant system, Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants.

Unit 2: Organic Translocation **Hours: 4h**

Phloem sap, P-protein, Phloem loading and unloading, Mass-flow (pressure flow) hypothesis and its critical evaluation.

Unit 3: Photosynthesis **Hour: 12h**

Chemical structure of chlorophyll a and b, absorption and action spectra, biological significance of carotenoid pigments, Red drop and Emerson effect, Components of photosystems (light harvesting complex), Photochemical reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, Calvin cycle – Biochemical reactions & stoichiometry, HSK Pathway– three variants of the pathway, Photosynthetic efficiency of C3 and C4 plants and crop productivity, Photorespiration – mechanism and significance, Crassulacean Acid metabolism– mechanism and ecological significance.

Unit 4: Respiration **Hours: 10h**

EMP pathway, regulation and its anabolic role, Conversion of Pyruvic acid to Acetyl CoA, TCA-cycle and its amphibolicrole, Oxidative pentose phosphate pathway and its significance, ß-oxidation of fatty acids and significance, Mitochondrial electron transport system, uncouplers, Oxidation of cytosolic NADH+H+ Stoichiometry of glucose oxidation (aerobic).

Unit 5: Nitrogen Metabolism **Hours: 8h**

Assimilation of nitrate by plants, Biochemistry of dinitrogen fixation in Rhizobium, General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

Unit 6: Plant Growth Regulators **Hours: 8h**

Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, Chemical nature –IAA, GA3, Kinetin, Biosynthesis and bioassay of IAA, Mode of action of IAA, Brassinosteroids and Polyamines as PGRs

Unit 7: Photomorphogenesis **Hours: 6h**

Concept of photomorphogenesis, Photoperiodism and plant types, Perception of photoperiodic stimulus, Critical day length, concept of light monitoring, Phytochrome – chemical nature, interconversion, function in flowering, Role of GA in flowering, Vernalisation – role of low temperature in flowering, Concept of biological clock and biorhythm .

Unit 8: Seed dormancy **Hours: 4h**

Types, Causes and Methods of breaking seed dormancy, Biochemistry of seed germination.

Unit 9: Physiology of Senescence and Ageing **Hours: 4h**

Physiology and molecular biology of stress: Plant responses to: Water stress, Temperature stress, Salt stress.

BB203
Plant Systematics &Archegoniates
Total Marks 50, Credits 4

Section A: Plant Systematics

Unit 1: Introduction **Hours: 4h**

Plant identification, Classification, Nomenclature; Biosystematics

Unit 2: Identification **Hours: 4h**

Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access

Unit 3: Systematics **Hours: 6h**

Systematics - an interdisciplinary science, Evidence from palynology, cytology, phytochemistry and molecular data. Taxonomic hierarchy, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit 4: Systems of classification **Hours: 6h**

Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Section B: Archegoniates

Unit 5: Introduction **Hours: 4h**

Unifying features of archegoniates; Transition to land habit; Alternation of generations.

Unit 6: Bryophytes **Hours: 12h**

General characteristics; Adaptations to land habit; Classification; Range of thallus organization. Classification (up to family).Riccia, Marchantia, Pellia, Porella, Anthoceros, Sphagnum and Funaria; Reproduction and evolutionary trends in Riccia, Marchantia ,Anthoceros and Funaria (developmental stages not included).Ecological and economic importance of bryophytes with special reference toSphagnum.

Unit 7: Pteridophytes **Hours: 12h**

General characteristics, classification, early land plants (Cooksonia and Rhynia). Classification (up to family), morphology, anatomy and reproduction of Psilotum, Selaginella, Equisetum and Pteris.(Developmental details not to be included).Apogamy, and apospory, heterosporyandseed habit, telome theory, stelarevolution.Ecological and economic importance.

Unit 8: Gymnosperms **Hours: 12h**

General characteristics, classification (up to family), morphology, anatomy and reproduction of Cycas, Pinus and Gnetum.(Developmental details not to be included).Ecological and economic importance.

Semester IV

BB202
Biotechniques& Biostatistics
Total Marks 50, Credits 4

Unit 1. Bioenergetics **Hours: 4**

First and Second Laws of Thermodynamics; Definition of Gibb's Free Energy, Enthalpy, and Entropy; Mathematical Relationships Among Them; Standard Free Energy Change and Equilibrium Constant; Coupled Reactions And Additive Nature of Standard Free Energy Change; Energy Rich Compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP.

Unit 2. Microscopy: Principles and applications. **Hours: 8**

Principles and applications of - Light microscopy: brightfield and darkfield, Phase contrast microscopy, Fluorescence Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy); Micrometry.

Unit 3. Electromagnetic radiation and Spectrophotometry. **Hours: 8**

Basic principles of electromagnetic radiation: Energy, wavelength, wave numbers and frequency, review of electronic structure of molecules.
UV-visible spectrophotometry: Beer Lambert law, light absorption and its transmittance, factors affecting absorption properties of a chromophore, Principle and use of study of absorption spectra of biomolecules; structural analyses of DNA/ protein using absorption of UV light. Colorimetry and turbidometry
Fluorescence spectroscopy: Theory of fluorescence, static and dynamic quenching, resonance energy transfer, fluorescent probes in the study of protein and nucleic acids.
Mass spectrometry (MALDI-TOF): Physical basis and uses of MS in the analysis of proteins/ nucleic acids.

Unit 4. Radiation Biology. **Hours: 6h**

Concept of radioisotopes, types of radioactive decay (gamma and beta emitter), half-life, detection and measurement of radioactivity: methods based upon ionization (GM counter), methods based upon excitation (scintillation counter). Autoradiography, radioisotopes in diagnosis and radiotherapy. Effect of radiations (ionizing and non-ionizing) on living systems, precautions and safety measures in handling radioisotopes.

Unit 5. Chromatography. **Hours: 10**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography, Column chromatography: packing and fraction collection. Gel filtration chromatography, ionexchange chromatography and affinity chromatography; GLC, HPLC.

Unit 6. Electrophoresis. **Hours: 6**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, Isoelectric focusing, 2D gel electrophoresis; Zymogram preparation; Principle and applications of Agarose gel electrophoresis.

Unit 6. Hydrodynamic methods & Centrifugation **Hours: 10**

Viscosity: Methods of measurement of viscosity, specific and intrinsic viscosity, relationship between viscosity and molecular weight, measurement of viscoelasticity of DNA.
Sedimentation: Principle of centrifugation; Svedberg equation, RCF and sedimentation coefficient; relationship between RPM and RCF; Fixed angle and swinging bucket rotors; differential and density gradient centrifugation, preparative and analytical ultracentrifugation techniques, fractionation of cellular components using centrifugation with examples.
Flow Cytometry: Basic principle of flow cytometry and cell sorting, detection strategies in flow cytometry.

Unit 8. Biostatistics. **Hours: 8**

Data in Biology: samples and populations, techniques of sampling (random and stratified), sampling and non-sampling errors, variables in biology, accuracy, precision, univariate and bivariate frequency distributions and their graphical representations.

Measures of Central Tendency: Arithmetic, geometric and harmonic means, mode, median and partition values. Measures of Dispersion: Range, standard deviation, coefficient of variance and covariance. Skewness and Kurtosis.

Probability: Basic concepts, addition and multiplication rules of probability, conditional probability, Binomial distribution, Poisson distribution, normal distribution and exponential distribution along with their properties and relationships. Test of Hypothesis: Chi square, t Test

BB292
Practical III
Total Marks 50, Credits 4

Unit I

1. Paper and thin layer chromatography: separation of plant pigments
2. Demonstration of Agarose and SDS Page electrophoresis
3. Effect of different solvents on UV absorption spectra of proteins.
4. Study of structural changes of proteins at different temperature using UV spectrophotometry.
5. Determination of melting temperature of DNA.
6. Study the effect of temperature on the viscosity of a macromolecule (Protein/DNA).
7. Use of viscometry in the study of ligand binding to DNA/protein.

Unit II

1. Determination of osmotic potential of plant cell sap by plasmolytic method
2. Determination of water potential of given tissue (potato tuber) by weight method
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophytes
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces)
6. To study the phenomenon of seed germination (effect of light)
7. To study the effect of different concentrations of IAA on Avena coleoptile elongation (IAA Bioassay)
8. To study the induction of amylase activity in germinating barley grains.

Unit III

1. Morphological study of the sporophytic plant body: Lycopodium, Ophioglossum, Marsilea and Pteris
2. Workout of reproductive structures: Selaginella, Equisetum, Pteris
3. Study of permanent slides: Psilotum (T.S. of synangium), Lycopodium (L.S. of strobilus), Ophioglossum (L.S. of spike), Marsilea (L.S. of sporocarp)
4. Study of types of inflorescence, flower and fruit with labeled sketches
5. Work out, description, preparation of floral formula and floral diagram: Malvaceae, Fabaceae, Solanaceae, Acanthaceae, Labiatae, Rubiaceae
6. Spot identification (binomial, family) of plants from families included in the theoretical syllabus
7. Morphological study of gymnosperms: Cycas (microsporophyll and megasporophyll), Pinus (male & female cone), Gnetum (L.S. of male cone and ovule)
8. At least four excursions including one long excursion to a specialized phytogeographical zone of India.

9. Study of community structure by quadrat method and determination of (i) minimal size of quadrat (ii) frequency, density, and abundance of components (to be done during excursion
10. Herbarium specimen: preparation of 25 angiospermic specimens (identified with author citation, voucher number and arranged following Bentham & Hooker's system of classification) to be submitted in the University examination

Semester V

BB301
Immunology
Total Marks 50, Credits 4

Unit 1 Introduction **Hours: 4**
Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

Unit 2 Immune Cells and Organs **Hours: 8**
Structure, Functions and Properties of: ImmuneCells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT.

Unit 3 Antigens **Hours: 4**
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

Unit 4 Antibodies **Hours: 6**
Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies.

Unit 5 Major Histocompatibility Complex **Hours: 4**
Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).

Unit 6 Complement System **Hours: 4**
Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation

Unit 7 Generation of Immune Response **Hours: 10**
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.Principle of vaccination.

Unit 8 Immunological Disorders and Tumor Immunity **Hours: 10**
Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Unit 9 Immunological Techniques **Hours: 10**
Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

BB303
Anatomy & Reproductive Biology of Angiosperms
Total Marks 50, Credits 4

Unit 1: Introduction and scope of Plant Anatomy **Hours: 2h**
Applications in systematics, forensics and pharmacognosy

Unit 2: Tissues **Hours: 8h**
Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements;Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

Unit 3: Stem, leaf and root **Hours: 10h**
Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meri`stematic residue, cytohistological zonation); Types of vascular bundles; Structure of dicot and monocot stem. Structure of dicot and monocot leaf, Kranz anatomy. Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Root cap; Structure of dicot and monocot root; Endodermis, exodermis and origin of lateral root.

Unit 4: Vascular Cambium **Hours: 4h**
Structure, function and seasonal activity of cambium; Secondary growth in root and stem.

Unit 5: Wood **Hours: 2h**
Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.

Unit 6: Adaptive and Protective Systems **Hours: 4h**
Epidermal tissue system, cuticle, epicuticular waxes, trichomes(uni-and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

Unit 7: Introduction to angiosperms **Hours: 2h**
History (contributions of G.B. Amici, W. Hofmeister, E. Strasburger, S.G. Nawaschin, P. Maheshwari, B.M. Johri, W.A. Jensen, J. Heslop-Harrison) and scope.

Unit 8: Anther **Hours:2h**
Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance.

Unit 9: Pollen biology **Hours: 4h**
Microgametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit 10: Ovule **Hours: 4h**
Structure; Types; Special structures–endothelium, obturator, aril, caruncle and hypostase; Female gametophyte–megasporogenesis (monosporic, bisporic and tetrasporic) and megagametogenesis (details of *Polygonum*type); Organization and ultrastructure of mature embryo sac.

Unit 11: Pollination and fertilization **Hours: 4h**

Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization

Unit 12: Self incompatibility **Hours: 4h**

Basic concepts (interspecific, intraspecific, homomorphic, heteromorphic, GSI and SSI); Methods to overcome self-incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and *in vitro* pollination; Modification of stigma surface, parasexual hybridization; Cybrids, *in vitro* fertilization.

Unit 13: Endosperm **Hours: 4h**

Types, development, structure and functions.

Unit 14: Embryo **Hours: 6h**

Six types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed: Structure, importance and dispersal mechanisms,Polyembryony and apomixes**:** Introduction; Classification; Causes and applications.

BB305
Plant metabolism
Total Marks 50, Credits 4

Unit 1: Concept of metabolism **Hours: 2h**

Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).

Unit 2: Carbon assimilation **Hours: 10h**

Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors affecting CO2 reduction.

Unit 3: Carbohydrate metabolism **Hours: 8h**

Synthesis and catabolism of sucrose and starch.

Unit 4: Carbon Oxidation **Hours: 12h**

Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors affecting respiration.

Unit 5: ATP-Synthesis **Hours: 6h**

Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit 6: Lipid metabolism **Hours: 10h**

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its role in mobilisation of lipids during seed germination, α oxidation.

Unit 7: Nitrogen metabolism **Hours: 8h**

Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.

Unit 8: Mechanisms of signal transduction **Hours: 4h**

Concept of Signal transduction; Calcium, phospholipids, cGMP and NO mediated signaling.

BB391
Practical IV
Total Marks 50, Credits 4

Unit I

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.

Unit II

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

BB393
Practical V
Total Marks 50, Credits 4

Unit I

1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/ museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchyma and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: monocot, dicot, secondary growth.
9. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
10. Leaf: isobilateral, dorsiventral, C4 leaves (Kranz anatomy).

Unit II

1. Chromatographic separation of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photosynthesis.
5. To compare the rate of respiration in different parts of a plant.
6. To demonstrate activity of Nitrate Reductase in germinationg leaves of different plant sources.
7. To study the activity of lipases in germinating oilseeds and demonstrate mobilization of lipids during germination.
8. Demonstration of absorption spectrum of photosynthetic pigments.

Semester VI

BB302
Plant Biotechnology
Total Marks 50, Credits 4

Unit 1: Plant Tissue Culture **Hours: 15h**

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

Unit 2: Recombinant DNA technology **Hours: 30h**

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC).Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning); Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes-oligonucleotide, heterologous, PCR; Methods of gene transfer- *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit 3: Applications of Biotechnology **Hours: 15h**

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

BB304
Economic Botany
Total Marks 50, Credits 4

Unit 1: Origin of Cultivated Plants **Hours: 6h**

Concept of Centres of Origin, their importance with reference to Vavilov's work, examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasmdiversty.

Unit 2: Cereals **Hours: 6h**

Wheat and Rice (origin, morphology, processing &uses), brief account of millets, Green revolution.

Unit 3: Legumes **Hours: 4h**

General account, importance to man and ecosystem

Unit 4: Sugars & Starches (4 lectures) **Hours: 4h**

Morphology and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, propagation & uses.

Unit 5: Spices **Hours: 4h**
Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper

Unit 6: Beverages **Hours: 4h**
Tea, Coffee (morphology, processing & uses)

Unit 7: Oils & Fats **Hours: 4h**
General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and *Brassica* andCoconut (Botanical name, family & uses)

Unit 8: Essential Oils **Hours: 4h**
General account, extraction methods, comparison with fatty oils & their uses.

Unit 9: Natural Rubber **Hours: 4h**
Para-rubber: tapping, processing and uses.

Unit 10: Drug-yielding plants **Hours: 6h**
Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver*and *Cannabis*

Unit 11: Tobacco **Hours: 4h**
Tobacco (Morphology, processing, uses and health hazards)

Unit 12: Timber plants **Hours: 4h**
General account with special reference to teak and pine

Unit 13: Fibres **Hours: 6h**
Classification based on the origin of fibres, Cotton and Jute (morphology, extraction and uses).

BB 306
Genetics & Genomics
Total Marks 50, Credits 4

Unit 1: Mendelian genetics and its extension **Hours: 10h**
Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

Unit 2: Extrachromosomal Inheritance **Hours: 5h**

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

Unit 3: Linkage, crossing over and chromosome mapping **Hours: 10h**
Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

Unit 4: Variation in chromosome number and structure **Hours: 5h**
Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

Unit 5: Gene mutations **Hours: 10h**
Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB method. Role of Transposons in mutation.DNA repair mechanisms.

Unit 6: Fine structure of gene **Hours: 10h**
Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

Unit 7: Population and Evolutionary Genetics **Hours: 10h**
Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection mutation, genetic drift.Genetic variation and Speciation.

BB 308
Ecology
Total Marks 50, Credits 4

Unit 1: Introduction **Hours: 6h**
Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

Unit 2: Soil **Hours: 6h**
Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

Unit 3: Water **Hours: 6h**
Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit 4: Light, temperature, wind and fire **Hours: 6h**
Variations; adaptations of plants to their variation.

Unit 5: Population ecology **Hours: 8h**
Characteristics and Dynamics .Ecological Speciation

Unit 6: Plant communities **Hours: 6h**

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.

Unit 7: Ecosystems **Hours: 6h**

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids

Unit 8: Functional aspects of ecosystem **Hours: 8h**

Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus

Unit 9: Phytogeography **Hours: 8h**

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

BB 392
Practical VI
Total Marks 50, Credits 4

Unit I

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

Unit II

1. Cereals: Wheat (habit sketch, L. S/T.S. grain, starch grains, micro-chemical tests) Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Soya bean, Groundnut, (habit, fruit, seed structure, micro-chemical tests).
3. Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Fennel and Clove (habit and sections).
5. Beverages: Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).
6. Oils & Fats: Coconut- T.S. nut, Mustard–plant specimen, seeds; tests for fats in crushedseeds.
7. Essential oil-yielding plants: Habit sketch of*Rosa*, V*etiveria, Santalum*and *Eucalyptus* (specimens/photographs).
8. Rubber: specimen, photograph/model of tapping, samples of rubber products.
9. Drug-yielding plants: Specimens of *Digitalis, Papaver*and *Cannabis.*

10. Tobacco: specimen and products of Tobacco.
11. Woods: Tectona, Pinus: Specimen, Section of young stem.
12. Fibre-yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fibre and test for cellulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fibre).

Unit III

1. Meiosis through temporary squash preparation.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4)
6. Blood Typing: ABO groups & Rh factor.
7. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
8. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
9. Study of human genetic traits: Sickle cell anemia, XerodermaPigmentosum, Albinism, red-green Colour blindness, Widow's peak, Rolling of tongue, Hitchhiker's thumb and Attached ear lobe.

BB 394
Practical VII
Total Marks 50, Credits 4

Unit I **Credits 2**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovi bond comparator and pH paper)
3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests.
4. Determination of organic matter of different soil samples by Walkley& Black rapid titration method.
5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats.
6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources
7. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
   (b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes, Predation (Insectivorous plants).
8. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
9. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
10. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.
11. Field visit to familiarise students with ecology of different sites

Unit II **Credits 2**

A student has to do a project work / review work in a topic given by his/her supervisor (to be decided by lottery amongst all the teachers present for that Semester) and submit the report/review within a stipulated time. During examination the work has to be presented before an evaluation team (one external member may be invited) and the student will be credited based on the quality of the report and presentation.

ANNEXURE IV

Syllabus for the 3 Years B.Sc. Honours Degree
Subsidiary Botany
Overall Curriculum

Sl. No.	Course Structure	Sem	Course Code	Course Title	Full Marks	Credit
1	Botany (Sub)	I	BB 131	Plant Diversity	50	4
2	Botany (Sub)	II	BB 132	Plant Anatomy and Embryology	50	4
3	Botany (Sub)	III	BB 231	Plant Ecology and Taxonomy	50	4
4	Botany (Sub)	III	BB 261	Practical Plant Ecology and Taxonomy	50	4
5	Botany (Sub)	IV	BB 232	Economic Botany and Plant Tissue Culture	50	4
6	Botany (Sub)	IV	BB 262	Practical Economic Botany and Plant Tissue Culture	50	4

Semester I

BB131

Plant Diversity

Total Marks 50, Credits 4

Unit 1: Algae **Hours: 12h**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria, Fucus, Polysiphonia*. Economic importance of algae.

Unit 2: Fungi **Hours: 12h**

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus*(Zygomycota) *Penicillium,Alternaria*(Ascomycota), *Puccinia, Agaricus*(Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhizaandendomycorrhiza and their significance

Unit 3: Introduction to Archegoniate **Hours: 2h**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 4: Bryophytes **Hours: 12h**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia*and *Funaria*.(Developmental details not to be included).Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5: Pteridophytes **Hours: 12h**

General characteristics, classification, Early land plants (*Cooksonia*and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included).Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes.

Unit 6: Gymnosperms **Hours: 10h**

General characteristics, classification.Classification (up to family), morphology, anatomy and reproduction of *Cycas*and *Pinus*.(Developmental details not to be included). Ecological and economical importance.

Semester II

BB132

Plant Anatomy & Embryology

Total Marks 50, Credits 4

Unit 1: Meristematic and permanent tissues **Hours: 8**

Root and shoot apical meristems; Simple and complex tissues

Unit 2: Organs **Hours: 4**

Structure of dicot and monocot root stem and leaf.

Unit 3: Secondary Growth **Hours: 8**

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood)

Unit 4: Adaptive and protective systems **Hours: 8**
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: Structural organization of flower **Hours: 8**
Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Unit 6: Pollination and fertilization **Hours: 8**
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: Embryo and endosperm **Hours: 8**
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship

U nit 8: Apomixis and polyembryony **Hours: 8**
Definition, types and Practical applications

Semester III

BB231

Plant Ecology & Taxonomy

Total Marks 50, Credits 4

Unit 1: Introduction **Hours: 2**

Unit 2: Ecological factors **Hours: 10**
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes

Unit 3: Plant communities **Hours: 6**
Characters; Ecotone and edge effect; Succession; Processes and types

Unit 4: Ecosystem **Hours: 8**
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Phytogeography **Hours: 4**
Principle biogeographical zones; Endemism

Unit 6 Introduction to plant taxonomy **Hours: 2**
Identification, Classification, Nomenclature.

Unit 7 Identification **Hours: 4**
Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. **Hours: 6**

Unit 9 Taxonomic hierarchy **Hours: 2**
Ranks, categories and taxonomic groups

U nit 10 Botanical nomenclature **Hours: 6**
Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 Classification **Hours: 6**
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Unit 12 Biometrics, numerical taxonomy and cladistics **Hours: 4**
Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Semester III

BB261

Practical I

Total Marks 50, Credits 4

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
   (b)Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite (*Orobanche*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law
7. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Brassicaceae - *Brassica,Alyssum / Iberis;* Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanumnigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Semester IV
BB232
Economic Botany & Plant Tissue Culture

Total Marks 50, Credits 4

Unit 1: Origin of Cultivated Plants **Hours: 6**
Concept of centres of origin, their importance with reference to Vavilov's work.

Unit 2: Cereals **Hours: 6**
Rice & Wheat -Origin, morphology, cultivation, varieties; Green Revolution

Unit 3: Legumes **Hours: 8**
General account with special reference to Gram and soybean

Unit 4: Spices **Hours: 8**
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

U nit 5: Beverages **Hours: 6**
Tea (morphology, processing, uses)

Unit 6: Oils and Fats **Hours: 6**
General description with special reference to groundnut

Unit 7: Fibre Yielding Plants **Hours: 6**
General 4description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8: Introduction to biotechnology **Hours: 2**

U nit 9: Plant tissue culture **Hours: 12**
Micropropagation ; haploid production through androgenesis and gynogenesis; brief account of embryo and endosperm culture with their applications

Semester IV
BB262
Practical II

Total Marks 50, Credits 4

1. Calculation of leaf area using graphical method
2. Demonstration of plasmolysis and deplasmolysis in epidermal cells of onion
3. Calculation of stomatal index in upper and lower epidermis of plant leaf
4. Demonstration of mitosis from onion root tips
5. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove,, Tea, Cotton, Groundnut through specimens, sections and microchemical tests
6. Familiarization with basic equipments in tissue culture.
7. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.