PROGRAMME & COURSE OUTCOME

OF UG HONOURS COURSE (B.Sc.) IN BOTANY

UNDER CHOICE BASED CREDIT SYSTEM

INTRODUCED BY UNIVERSITY OF CALCUTTA, 2018

B.Sc. BOTANY (HONOURS)

PROGRAMME LEARNING OUTCOMES/PROGRAMME SPECIFIC OUTCOMES (PLO/PSO)

1. Demonstrate i) systematic, extensive and coherent knowledge of the discipline of Botany, its different branches such as core, applied and organismal, relate it with the general field of Biology as well as with other scientific disciplines, and identify its applications and future possibilities; including a thorough and critical understanding of the theories, principles, concepts, practical techniques, as well as advanced and emerging research areas. (ii) procedural and technical knowledge related to different professional areas related to Botany in particular and Biological sciences in general (iii) extensive knowledge in one's area of specialization, including advanced concepts, techniques and recent developments which translates to a spirit of scientific inquiry and an aptitude for research.

2. Demonstrate thorough knowledge about the materials and equipment used in the field of Botany, including biological specimens, chemicals and reagents, scientific instruments, scientific literature, information technology-based tools like softwares, databases etc. and the ability to apply such materials and equipment in practical situations.

3. Develop skills of collecting information and acquisition of qualitative and/or quantitative data related to Botany, both from experimental and field studies as well as from scientific literature, of analysis and interpretation of the data by appropriate methods, and the ability to draw conclusions from the data.

4. Demonstrate a thorough understanding and appreciation of the importance of plants in the environment and human life and show thorough knowledge of the application of plants in different spheres of life.

5. Develop skills of scientific communication related to the field of Botany including theories, experimental results and analyses in written, graphic, oral as well as electronic format.

6. Demonstrate theoretical and practical technical knowledge that translates to employable and transferable skills related to the field of Botany in particular and Biological Sciences in general, which will help in securing jobs and other employment opportunities in sectors such as academia, research and development, biotechnology industry, forestry, horticulture, environmental sciences, agri-business etc.

COURSE LEARNING OUTCOMES (CLO)

SEMESTER I

CORE COURSE 1- PHYCOLOGY AND MICROBIOLOGY

Phycology

1. Demonstrate an understanding of the specialties of Algae in terms of their thallus organization, structure of algal cell, ultrastructure of plastids and flagella, origin and evolution of sex, life cycle patterns. Review the significant contributions of important phycologists (Fritsch, Smith, R. N. Singh, T.V. Desikachary, H.D. Kumar, M.O.P. Iyengar).

2. Explain the criteria and basis of Fritsch's classification. Illustrate the systematic position of Algae according to the classification proposed by Lee (2008) up to phylum with examples. Describe and compare the salient features of Cyanobacteria, Rhodophyta, Chlorophyta, Charophyta, Bacillariophyta, Xanthophyta, Phaeophyta, Heterokontophyta.

3. Demonstrate an understanding of the specialties of Division Cyanobacteria in terms of their ultrastructure of cell, structure and function of heterocyst and ecology.

4. Demonstrate an understanding of the specialties of Division Bacillariophyta in terms of their Cell structure, Cell division, Auxospore formation in Centrales and Pennales.

5. Illustrate and compare the life cycles of genera of Algae belonging to different subdivisions, such as *Chlamydomonas*, *Oedogonium*, *Chara*, *Ectocarpus*, and *Polysiphonia*. Demonstrate an understanding of the evolutionary significance of *Prochloron*. Illustrate and identify the morphological features of selected algae in laboratory preparations and slides.

6. Participate in local excursions for the study and collection of algae and to acquire an introductory idea about plant diversity.

Microbiology

7. Demonstrate an understanding of the specialties of Virus in terms of their Discovery, Plant virus- types, Transmission and translocation of Plant virus, TMV- 7 Physicochemical characteristics and Multiplication.

8. Interpret the One step growth curve, Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage). Explain the Significance of lysogeny. Define and discuss the terms Viroids and Prions.

9. Distinguish Archaea and Bacteria. Illustrate the Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae,

10. Demonstrate an understanding of the specialties of Bacteria in terms of their Discovery, Bacterial growth curve and generation time, Flagella (ultrastructure) & Pilli, Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, Bacterial genome and plasmid, Endospore - formation, structure and function, Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation─ F-factor, F + X F − , Hfr X F − , concept of F', chromosome mobilization, (c) Transduction– Generalised and specialized.

11. Demonstrate the preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri-plates, Sub-culturing of bacterial culture, Gram staining from bacterial culture, Microscopic examination of bacteria from natural habitat (curd) by simple staining in laboratory condition.

CORE COURSE 2(CC2) - MYCOLOGY AND PHYTOPATHOLOGY

Mycology

1. Illustrate the systematic position of Fungi as a taxon within eukaryotes and classify them into different divisions like Myxomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota.

2. Demonstrate an understanding of the specialities of Fungi in terms of their hyphal forms, spore forms and liberation, sexual reproduction and degeneration of sex, life cycle patterns, parasexuality and sexual compatibility (heterothallism and homothallism).

3. Describe, illustrate and compare the life cycles of genera of Fungi belonging to different subdivisions, such as *Synchytrium*, *Rhizopus*, *Ascobolus* and *Agaricus*; Illustrate and identify the morphological features of selected fungi in laboratory preparations and slides.

4. Demonstrate an understanding of symbiotic associations of Fungi such as Mycorrhizae and Lichens and their economic, ecological and agri-silvicultural applications. Identify laboratory specimens of foliose and fruticose lichens.

5. Participate in local educational excursions for the collection and identification of fungi.

Phytopathology

5. Define important terminology and explain fundamental principles of phytopathology; Demonstrate basic phytopathological techniques in laboratory experiments.

6. Interpret host-parasite interaction in phytopathology in terms of mechanism of infection, role of pathotoxins, defence mechanisms with special reference to phytoalexins, and resistance mechanisms such as systemic acquired (SAR) and induced systemic (ISR).

7. Demonstrate an understanding of plant disease management including application of Quarantine, Chemical, Biological and Integrated disease management techniques.

8. Describe the symptoms, causes, disease cycles and control measures of selected plants diseases such as Late Blight of Potato, Brown Spot of Rice, Black Stem Rust of Wheat and stem Rot of Jute; identify the diseases from laboratory specimens and slides.

SEMESTER II

CORE COURSE 3(CC3): PLANT ANATOMY

1. Illustrate and describe the anatomical details of cell walls, classify stomata and stele, illustrate and distinguish nodal anatomies. Identify specific anatomical structures from laboratory preparations and permanent slides.

2. Illustrate, describe and distinguish between primary anatomies of dicot and monocot stem, root and leaves, describe and recognize the distinctive features of normal and anomalous secondary growth. Illustrate and identify the anatomical features of primary as well as normal and anomalous secondary growth in laboratory preparations and slides.
3. Illustrate and describe the different types of mechanical tissues and recognize the principles behind their distribution.
4. Discuss the developmental concepts of plant anatomy such as Tunica-Corpus Theory, Korper-Kappe Theory and Plastochron.
5. Recognise and illustrate the adaptive anatomical features of hydrophytes and xerophytes with the help of laboratory preparations, wherever possible, and interpret their anatomical significance.
6. Demonstrate knowledge and understanding of the applications of plant anatomy in systematics, forensics and pharmacognosy.

CORE COURSE 4: ARCHEGONIATE

Bryophytes

1. Illustrate the general characteristics and demonstrate an understanding of the adaptations to land habit of Bryophytes. Explain the classification of Strotler and Crandle Strotler, 2009 upto different class with diagnostic characters and examples.
2. Illustrate and compare the life cycles of genera of Bryophytes belonging to their gametophytic structure, reproductive mechanism, sporophytic structure as well as the complete development of sporophytic plant body and spore dispersal mechanism of *Marchantia*, *Anthoceros* and *Funaria*,
3. Illustrate the unifying characteristic features of Archegoniates and their transition to land habit. Explain the origin of Alternation of generation, evolution of sporophytes and origin of bryophytes.
4. Describe the importance of bryophytes economically and ecologically and illustrate their roles according to different aspects like plant succession, Pollution monitoring etc.

Pteridophytes

5. Illustrate and discuss the general characteristics, colonisation and rise of early land plants of pteridophytes. Explain the classification according to Gifford & Foster(1989) upto different

divisions like Rhyniophyta, Zosterophyllophyta, Trimerophytophyta, Psilophyta, Lycophyta, Sphenophyta, Filicophyta.

6. Illustrate and compare the life cycles of genera of Pteridophytes belonging to their gametophytic structure, reproductive mechanism, sporophytic structure as well as the complete development of sporophytic plant body of Selaginella, Pteris, Psilotum and Equisetum.
7. Explain the Telome concept and discuss the significance in origin of Different groups of Pteridophytes like Sphenophyta, Lycophyta, Pterophyta etc.
8. Explain the concept of heterospory and understanding the origin of seed habit.
9. Describe the importance of pteridophytes economically according to different aspects like food value, medicine and agriculture industries.

Gymnosperms

10. Classify the Gymnosperms according to Gifford & Foster (1989) upto different divisions like Progymnospermophyta, Pteridospermophyta, Cycadophyta, Cycadeoidophyta, Ginkgophyta, Coniferophyta, Gnetophyta.
11. Illustrate and revise the diagnostic characteristic features of Progymnosperm. Discuss and understanding the vegetative and reproductive features of Archeopteris and state their phylogenetic importance accordingly.
12. Illustrate and compare the life cycles of genera of Gymnosperms belonging to their vegetative structure, reproductive mechanism, development of gametophytes, sporophytic structure as well as the complete development of sporophytic plant body of Cycas, Pinus, Gnetum.
13. Describe the economic importance of Gymnosperms according to different aspects like wood, Resin, Essential oils and Drugs.
14. Study and understand the morphology and plant body of Bryophytes like Marchantia, Anthoceros, Funaria, Riccia, Porella; Pteridophytes like Selaginella, Pteris, Psilotum, Equisetum, Lycopdium, Ophioglossum, Marsilea; and Gymnosperms like Cycas, Pinus, Gnetum for practical purpose. Microscopic study, and understanding the different genera of Bryophytes, Pteridophytes and Gymnosperms from the permanent slides for identification purpose. Demonstrate practically and understanding the reproductive structures of Selaginella, Pteris and Equisetum.

SEMESTER III

CORE COURSE 5: PALEOBOTANY AND PALYNOLOGY

1. Illustrate and explain the geological time scale with different dominant plant groups through ages.

2. Define and explain the different types of fossils like body fossil, trace fossil, chemical fossil, index fossil. Demonstrate an understanding of the different modes of preservation and illustrate the various conditions favouring fossilization. Explain the whole procedure of nomenclature and reconstruction of fossil.

3. Illustrate the principles of fossil dating procedures and the importance of fossil study.

4. Explain and demonstrate an understanding of specialities of fossils in terms of their structural features, geological distributions, evolutionary significance of different fossil Pteridophytes like *Rhynia, Lepidodendron*, *Calamites* and fossil gymnosperms like *Lyginopteris, Williamsonia, Cordaites*.

5. Illustrate the three fold division with major megafossil collection of Indian Gondwana system.

6. Define and explain the basic idea of spore and pollen. Define and compare the different types of pollen apertures with proper diagrams. Explain the concept of sporopollenin, stratification and ornamentation of pollen wall. Illustrate and explain the classification of pollen and spores based on their number, position, characters (NPC) of apertures by Erdtman with proper diagrams.

7. Illustrate and explain the applications of pollen study according to the different concepts like Paleopalynology, Aeropalynology, Melissopalynology, Forensic palynology.

CORE COURSE 6: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

1. Define and illustrate the different types of inflorescence, flowers, fruits and seeds with proper diagram and examples. Demonstrate an understanding the procedure of flower induction and development with proper explanation.

2. Illustrate and explain the procedure of Microsporogenesis, Microgametogenesis, Megasporogenesis and Megagametogenesis of Pre-fertilization changes in ovule with diagram.

3. An overview and demonstrate an understanding the procedure occurs during the fertilization of ovule, like pollen germination, pollen tube- growth, their entry into ovule and

discharge mechanism properly with diagram. Define and illustrate the procedure of double fertilization.

4. Demonstrate an understanding the embryogenesis in cypsella and 3 different types of development in endosperm with illustrations.

5. Define and explain the concept of Apomixis. Define and illustrate the different types of Polyembryony with examples.

CORE COURSE 7: PLANT SYSTEMATICS

1. Illustrate the components of systematics like nomenclature, identification, classification. Define and explain the different phases of taxonomy like pioneer, consolidation, biosystematic and encyclopaedic phases. Define alpha and omega taxonomy with explanation.

2. Define and explain the different type methods, publication, rank of taxa, rules of priority of Nomenclature. Illustrate the different rules of retention and rejection of names, author Citation, effective and valid publication of taxonomic studies. Illustrate the ICN- principles.

3. Illustrate and explain the classification of Bentham-Hooker, Cronquist and Taktajan with their advantages and disadvantages of taxonomic studies. Define and explain the Angiospermic Phylogenic Group (APG III) classification.

4. Explain the different roles in teaching and research of herbaria and botanical Gardens. Illustrate the concept dichotomous key in taxonomy.

5. Illustrate and explain the concepts of phenetics, cladistics, numerical taxonomy, monophyletic, polyphyletic and paraphyleyic groups of taxonomy.

6. Appraise the different data sources in taxonomy with related evidence from cytology, molecular biology, palynology and biochemistry.

7. Illustrate and explain the diagnostic features, systematic positions, economical importance of different dicot families like Nymphaeaceae, Magnoliaceae, Leguminosae (subfamilies), Polygonaceae, Euphorbiaceae, Malvaceae, Umbelliferae (Apiaceae), Labiatae (Lamiaceae), Scrophulariaceae, Acanthaceae, Rubiaceae, Cucurbitaceae, Compositae (Asteraceae); and monocot families like Alismataceae, Gramineae (Poaceae), Cyperaceae, Palmae (Arecaceae), Liliaceae, Musaceae, Zingiberaceae, Cannaceae, Orchidaceae.

8. Examine at the field to give an idea about the plant specimen of different regions, their taxonomic value, their environmental effect and preserve them with the help of herbarium preparation for further analysis in future studies.

9. Demonstrate and prepare the dissected slide of flower from different plants belonging the different families like Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Rubiaceae and write the description, floral formula, draw the floral diagram properly, identify the genus of dissected flower with the help of some suitable literature like “Bengal Plants" by David Prain in laboratory condition.

SKILL ENHANCEMENT COURSE (SEC–A) - ELECTIVE - APPLIED PHYCOLOGY, MYCOLOGY AND MICROBIOLOGY

1. Illustrate and explain applied phycology including Algae as food and source of phycocolloid (Agar-agar, Algin, Carrageenan), Diatomite, Algal toxin, Algal Biotechnology – potential of microalgae for SCP, β-carotene, Biodiesel, bioplastics from algae.

2. Illustrate and explain applied mycology including Fungi as food, Cheese and Ethanol- Industrial production (brief outline), Fungal sources and uses of Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic (Griseofulvin), Pharmaceuticals (Cyclosporin-A), and Aflatoxin.

3. Illustrate and explain applied microbiology including Industrial Production of Vinegar and Streptomycin, Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), use of microbes as Biofertilizer and Biopesticides, and use of microbes in mineral processing.

SEMESTER IV

CORE COURSE 8: PLANT GEOGRAPHY, ECOLOGY AND EVOLUTION

1. Explain and illustrate the different phytogeographical regions of India according to D. Chatterjee (1960) including the different dominant vegetation of Eastern Himalayas, Western Himalayas and Sundarban.

2. Define and illustrate endemism in Indian flora, different types of endemic and their factors. Explain the age-area hypothesis and epibiotic theory of endemism.
3. Explain the idea on habitat, niche, microclimate, ecotone, edge-effect, ecads, ecotypes, ecoclines and carrying capacity of ecology.
4. Define community ecology, mentioning their characters and explain the diversity. Explain the ecological succession and demonstrate an understanding the different seral stages of it with reference to hydrosere. Define and explain the autogenic and allogenic succession.
5. Explain the roles of different indicators of plants specially metallophytes. Define and illustrate phytoremediation.
6. Illustrate the level of biodiversity, like genetic, species & ecosystem diversity. Explain the different hotspots of biodiversity with their various criteria. Define and describe the different modes of conservation like in-situ, ex-situ, seed bank, cryopreservation etc.
7. Illustrate and explain the different theories of evolution like natural selection, group selection and neutral theory of molecular evolution. Define and explain the concept on phyletic gradualism, punctuated equilibrium, stasis, stabilizing directional, disruptive and sexual selection, coevolution, adaptive radiation, reproductive isolation and speciation(sympatric, allopatric).
8. Demonstrate an understanding the simplified phylogeny of bacteria, algae, fungi, bryophyte, pteridophyte and gymnosperm. Define and illustrate the phylogenetic tree.

CORE COURSE 9- ECONOMIC BOTANY

1. Illustrate and explain the origin of cultivated crops: concepts of centre of origin, their importance with reference to Vavilov's work. Explain with examples of major plant introductions; crop domestication and loss of genetic diversity; evolution of new crops/ varieties, importance of germplasm diversity.

2. Demonstrate an understanding of origin, morphology, processing, uses and importance of Cereals: Rice and wheat, Legumes: gram and mung bean, Sugar and starches: sugarcane and potato, Beverages: Tea, Spices, Oil and fats: mustard, soybean, coconut and essential oils, Drug-

yielding plants: *Cinchona*, *Digitalis*, *Papaver*, *Cannabis* and Tobacco, Timber: Sal and Teak, Fibers: Cotton and Jute. Illustrate and identify the morphological features of selected specimen in laboratory preparations and slides. Evaluate the quality of selected specimens by chemical tests.

3. Participate in field visits to examine and acquire an idea about cultivation of crops like rice, jute, mustard, tea, potato.

CORE COURSE 10: GENETICS

1. Demonstrate an understanding of the important concepts of Genetics such as Mendelian genetics and its extension, Linkage, Crossing over and Gene Mapping, Epistasis and Polygenic inheritance in plants.

2. Recognise and explain cytogenetic abnormalities such as a) Aneuploidy and Polyploidy in terms of Types, examples, meiotic behaviour and importance; recognize the phenomena of speciation and evolution through polyploidy. b) Chromosomal aberration in terms of Types and meiotic behaviour of: Deletion, Duplication, Translocation, and Inversion. c) Point mutation-Transition, Transversion and Frame shift mutation, Explain molecular mechanisms (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation). Demonstrate a brief understanding of the mechanisms of DNA repair.

3. Demonstrate an understanding of the structural organisation of Genes illustrated in One Gene–one polypeptide concept, Review different specialized features of genes such as Split gene, Overlapping gene, Repetitive DNA- tandem and interspersed, Transposon (Ac-Ds system), Homoeotic gene in plants (ABCE Quartet model of flowering).

4. Employ and practice chromosome preparation techniques: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides; Determine mitotic index and frequency of different mitotic stages in pre-fixed root tips of *Allium cepa*.

5. Apply preparation and analytical techniques to study and illustrate a) mitotic chromosome from root tips of *Allium cepa, Lens esculenta and Aloe vera* specifically in terms of Metaphase chromosome preparation, free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, and comment on chromosome morphology. b) meiotic chromosome in terms of Smear preparation of meiotic cells, identification

of different stages and free hand drawing of the following specimens from flower buds: *Allium cepa* and *Setcreasea* sp.

6. Induce, identify and illustrate chromosomal aberrations developed due to exposure to any two pollutants/ pesticides etc.

7. Identify normal and abnormal meiotic and mitotic stages from permanent slides : Meiosis – (i) normal stages (ii) abnormal stages – laggard, anaphase bridge, ring chromosome (*Rhoeo discolor*); Mitosis – (i) normal stages, (ii) abnormal stages- early separation, late separation, multipolarity, sticky bridge, laggard, fragmentation, (ii) pollen mitosis.

SKILL ENHANCEMENT COURSE- (SEC – B) - ELECTIVE – PLANT BREEDING

1. Define and explain the plant breeding including introduction and objectives, breeding systems-modes of reproduction in crop plants, important achievements and undesirable consequence of plant breeding.

2. Illustrate and explain the methods of crop improvement including centres of origin and domestication of crop plants, plant genetics resources; acclimatization, selection methods- for self pollination, cross pollinated and vegetatively propagated plants, hybridization- for self, cross and vegetatively propagated plants, procedure, advantages and limitations.

3. Illustrate the maintenance of germplasm. Explain and distinguish the mass selections and pure line selection, and back cross method.

4. Define and explain the Heterosis and hybrid seed production, male sterility and its use in plant breeding, inbreeding and inbreeding depression, effect of outcrossing, molecular breeding and use of DNA markers in plant breeding.

5. Illustrate and explain the role of mutations, polyploidy, distant hybridization and role of biotechnology in crop improvements.

SEMESTER V

CORE COURSE 11- CELL AND MOLECULAR BIOLOGY

Cell Biology

1. Demonstrate an understanding of origin and evolution of cells: Evolution of nucleic acid (from PNA to DNA), Concept of RNA world, Ribozymes, First cell, origin of eukaryotic cell (endosymbiotic theory), Small RNA- riboswitch, RNA interference, si RNA, mi RNA- brief idea, Organellar DNA (cp- and mt- DNA). Calculate and compare the cell size by the technique of micrometry and record the cells per unit volume with the help of haemocytometer (Yeast/pollen grains) in laboratory preparations.2. Demonstrate an understanding of nucleus and chromosome: Nuclear envelope, Nuclear lamina and Nuclear pore complex, Nucleolus-ultrastructure and ribosome biogenesis, Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, Centromere: types, structure and function.

3. Illustrate the cell cycle and its regulation: Kinetochore and spindle apparatus-structural organization and functions, Microtubules- structure, organization and function, Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis.

Molecular Biology

4. Demonstrate an understanding of DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes): Central Dogma, Semiconservative DNA replication – mechanism, enzymes involved in DNA replication- DNA polymerase, DNA gyrase, Helicase, Ligase, primase and other accessory proteins, Eukaryotic replication with special reference to replication licensing factor, assembly of new nucleosome, replication at the end chromosome telomere, telomerase concept, Fidelity of DNA replication- prokaryote: nucleotide selection, proof reading, mismatch repair; eukaryote: through selection of error prone DNA polymerase, Transcription, RNA processing, Aminoacylation of tRNA, Translation.

5. Explain and describe Gene Regulation: Concept of Lac-operon, Positive and negative control, Genetic Code: Properties-evidences & exceptions, Deciphering of codon by Binding technique.

6. Demonstrate an understanding of recombinant DNA technology: Restriction endonuclease, -types and roles, Vector (plasmid pBR 322), Marker gene, Steps of cloning technique, PCR and its application, Genomic DNA and cDNA library.

7. Illustrate the development and causes of Cancer, tumor suppressor gene and oncogene.

8.Design and demonstrate the different experiments mentioned in syllabus like Cytochemical staining of DNA- Pyronine-methyl green staining, Estimation of DNA content through DPA staining, Estimation of RNA through orcinol method, Study of nucleolus through hematoxylin/ orcein staining and determination of nucleolar frequency. Construct models/ charts for better understanding of rolling circle, theta replication, semi-discontinuous replication, prokaryotic RNA polymerase and eukaryotic RNA polymerase II, assembly of spliceosome mechinery, splicing mechanism in group I and group II introns, ribozyme and alternative splicing.

CORE COURSE 12- BIOCHEMISTRY

1. Demonstrate an understanding of the biochemical foundations including Covalent and non-covalent bonds; hydrogen bond; Van der Waal's forces; structure and properties of water; pH and buffer (inorganic and organic); Handerson-Hasselbalch equation; and Isoelectric point.

2. Illustrate and explain the molecules of life including Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), . Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated.

3. Interpret and explain energy flow and enzymology including Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, Mechanism of enzyme action; enzyme inhibition; Enzyme kinetics (Michaelis- Menten equation) and simple problems.

4. Demonstrate an understanding of the cell membrane including membrane chemistry, membrane transport (uniport, symport, antiport), and mechanism of ion uptake. Explain the concept of phosphorylation including ATP Synthesis- chemiosmotic model, oxidative and photophosphorylation- mechanism and differences.

5. Setup and analyse different experiments mentioned in the syllabus such as i)Detection of organic acids: citric, tartaric, oxalic and malic from laboratory samples, ii)Detection of carbohydrate and protein from plant samples, iii)Detection of the nature of carbohydrate – glucose, fructose , sucrose and starch from laboratory samples, iv)Detection of Ca, Mg, Fe, S from plant ash sample, v)Preparation of solutions and buffers, vi)Estimation of amino-nitrogen by formol titration method (glycine), vii)Estimation of glucose by Benedict's quantitative reagent, viii) Estimation of titratable acidity from lemon, ix)Estimation of catalase activity in plant samples and effect of substrate, enzyme concentration and pH on enzyme activity, x) Estimation of urease activity in plant samples, xi) Colorimetric estimation of protein by Folin phenol reagent.

DISCIPLINE SPECIFIC ELECTIVE COURSE A (DSE-A) - BIOSTATISTICS

1.Discuss statistical methods and basic principles, functions, limitations and uses of statistics. Define and measure variables.

2. Define Data, Sample, Population, Random sampling, Frequency distribution

3. Define and measure a) Central tendency: Arithmetic Mean, Mode and Median and b) Dispersion – Coefficient of variation, Standard Deviation, Standard error of Mean. Solve problems on all of the above from experimental data.

4.Demonstrate the ability to perform Test of significance: chi- square test for goodness of fit. Solve problems based on experimental data based on normal and modified monohybrid and dihybrid ratios and comment on the nature of inheritance.

5. Demonstrate knowledge of Probability- multiplicative and additive rules of probability: application and importance. Calculation of 'F' value and find out the probability value for the F value

6. Demonstrate knowledge of measurement of gene frequency: Hardy-Weinberg equilibrium-conditions applied for its implications. Solve simple problems to calculate genotypic and allelic frequencies.

7. Demonstrate basic idea of computer programmes for statistical analysis of correlation coefficient, 't' test, standard error, standard deviation.

DISCIPLINE SPECIFIC ELECTIVE COURSE B (DSE-B) - PLANT BIOTECHNOLOGY

1. Demonstrate an understanding of plant tissue culture including the basic concepts and milestones, cellular totipotency, tissue culture media, aseptic manipulation, cyto-differentiation and dedifferentiation. Demonstrate the preparation of basal media and different sterilization techniques in the laboratory. Demonstrate the use of basic equipment in plant tissue culture.

2. Explain and demonstrate an understanding of callus culture including callus induction, maintenance and application, suspension culture, organogenesis (direct and indirect), somatic embryogenesis, significance of organogenesis and somatic embryogenesis, and artificial seed production.

3. Explain and demonstrate an understanding of haploid culture including anther and pollen culture methods, and applications.

4. Illustrate and demonstrate an understanding of protoplast culture including protoplast isolation and culture, protoplast fusion (somatic hybridization), and significance.

5. Illustrate and demonstrate an understanding of the plant genetic engineering including the concept of different gene transfer methods, special emphasis on *Agrobacterium* mediated gene transfer, and role of reporter gene.

6. Discuss and explain the achievements in crop biotechnology, environment and industry with suitable examples like pest resistant plants (BT cotton), herbicide resistance, disease and stress tolerance, transgenic crop with improved quality (flavr savr tomato, golden rice), role of transgenic in population degradation (super-bug), leaching of minerals, production of industrial enzymes, oil, and edible vaccine.

7. Design and create charts/models of anther culture, somatic embryogenesis, endosperm and embryo culture, and micropropagation.

8. Participate in a visit to a plant tissue culture lab for demonstration of the different tissue culture techniques.

SEMESTER VI

CORE COURSE 13-PLANT PHYSIOLOGY

1. Demonstrate an understanding of Plant-water relations in terms of 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. Review Antitranspirants. Experimentally i) determine loss of water per stoma per hour ii) demonstrate the relationship between transpiration and evaporation iii) Measure osmotic pressure of storage tissue by weighing method. iv)Measure osmotic pressure of *Rhoeo* leaf by plasmolytic method. v) determine the effect of temperature on absorption of water by storage tissue and calculate of Q10.iv) compare rate of imbibition of water by starchy, proteinaceous and fatty seeds and effect of seed coat.

2. Describe plant mineral nutrition in terms of essential and beneficial elements, macro- and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

3. Demonstrate an understanding of Organic Translocation: in terms of Phloem sap, P-protein, Phloem loading and unloading; Explain Mass-flow (pressure flow) hypothesis and evaluate it critically.

4. Describe Plant Growth Regulators in terms of physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene; Chemical nature of IAA, GA3, Kinetin, Biosynthesis and bioassay of IAA, Discuss the mode of action of IAA, Review briefly the roles of Brassinosteroids and Polyamines as PGRs Experimentally assess the effect of different concentrations of IAA on *Avena* coleopotile elongation (IAA bioassay).

5. Demonstrate an understanding of Photomorphogenesis in terms of the Concept of photomorphogenesis, Photoperiodism and plant types; Perception of photoperiodic stimulus, Critical day length, concept of light monitoring ; Discuss Phytochrome, cryptochrome and phototropins in terms of their chemical nature and role in photomorphogenesis; explain role of GA in flowering, Review Vernalisation – role of low temperature in flowering. Discuss the concept of biological clock and biorhythm.

6. Review the phenomenon of seed dormancy in terms of Types, Causes and Methods of breaking seed dormancy; Explain the biochemistry of seed germination. Experimentally i) study the phenomenon of seed germination and effect of light ii) study the induction of amylase activity in germinating grains.

7. Discuss the physiology of Senescence and Ageing.

CORE COURSE 14- PLANT METABOLISM

1. Illustrate the concept of metabolism including Anabolic and catabolic metabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes).

2. Illustrate and demonstrate an understanding of the photosynthesis including 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 31 productivity, Photorespiration – mechanism and significance, Crassulacean Acid Metabolism– mechanism and ecological significance.

3. Illustrate and demonstrate an understanding of the respiration including EMP pathway, regulation and its anabolic role, Conversion of Pyruvic acid to Acetyl CoA, TCA-cycle and its amphibolic role, Oxidative pentose phosphate pathway and its significance, Mitochondrial electron transport system, uncouplers, Oxidation of cytosolic $NADH+H^+$, Stoichiometry of glucose oxidation (aerobic).

4. Illustrate and demonstrate an understanding of the nitrogen Metabolism including Assimilation of nitrate by plants, Biochemistry of dinitrogen fixation in Rhizobium, General principle of amino acid biosynthesis (including GS and GOGAT enzyme system).

5. Illustrate and demonstrate an understanding of the lipid metabolism including synthesis and breakdown of triglycerides, ß-oxidation, glyoxalate cycle, gluconeogenesis and its role in mobilization of the lipids during seed germinations, α- oxidation.

6. Explain and illustrate the mechanism of signal transduction including receptor-ligand interactions, second messenger concept, calcium-calmodilin, G protein, MAP-kinase cascade.

7. Design and setup the different experiments mentioned in syllabus like paper chromatography and column chromatography; demonstration of column chromatography, separation of plastidial pigments by solvent and paper chromatography, Estimation of total chlorophyll content from different chronologically aged leaves (young, mature and senescence) by Arnon method, Effect of HCO_3 concentration on oxygen evolution during photosynthesis in an aquatic plant and to find out the optimum and toxic concentration (either by volume measurement or bubble counting), Measurement of oxygen uptake by respiring tissue (per g/hr.), Determination of the RQ of germinating seeds, Test of seed viability by TTC method.

DISCIPLINE SPECIFIC ELECTIVE-A (DSE-A) –MEDICINAL AND ETHNOBOTANY

1. Demonstrate knowledge of medicinal botany in terms of its history, scope and importance of medicinal plants, Demonstrate a brief idea about indigenous medicinal sciences- Ayurveda, Siddha and Unani. Discuss Polyherbal formulations.
2. Demonstrate knowledge of Pharmacognosy- Pharmacognosy and its importance in modern medicine, Crude drugs, Classification of drugs- chemical and pharmacological, Drug evaluation– organoleptic, microscopic, chemical, physical and biological. Major pharmacological groups of plant drugs and their uses. Microscopically analyse and identify powder dugs – *Zingiber* and *Holarrhena;*
3. Define Secondary metabolites and differentiate them from primary metabolites. Discuss interrelationship of basic metabolic pathways with secondary metabolite biosynthesis in outlines Describe major types of secondary metabolites –terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores.
4. Recognise pharmacologically active constituents: Source plants (one example) parts used and uses of: Steroids (Solasodin, Diosgenin, Digitoxin), Tannin (Catechin), Resins (Gingerol, Curcuminoids), Alkaloids (Quinine, Atropine. Pilocarpine, Strychnine, Reserpine, Vinblastine), Phenols (Sennocide and Capsaicin). Perform chemical tests for (a) Tannin from *Camellia sinensis* / *Terminalia chebula*, (b) Alkaloid from *Catharanthus roseus*. Perform histochemical tests of (a)

Curcumin *from Curcuma longa*, (b) Starch in non-lignified vessel of *Zingiber*), (c) Alkaloid from stem of *Catharanthus* and bark of *Holarrhena*).

5. Demonstrate knowledge of Ethnobotany and folk medicine: in terms of their Definition, methods of study, application, Indian scenario, national interacts, Palaeo-ethnobotany, folk medicines in ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Recognise application of natural products to certain diseases- Jaundice, cardiac disease, infertility, diabetics, blood pressure and skin diseases.

DISCIPLINE SPECIFIC ELECTIVE-B (DSE-B)- RESEARCH METHODOLOGY

1. Demonstrate understanding of and differentiate between basic concepts of research: definition and types of research (Descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, conceptual vs. empirical), research methods vs. methodology; Discuss literature review and its consolidation; Describe and distinguish between library research, field research and laboratory research.

2. Demonstrate knowledge of general laboratory techniques: common calculations in botany laboratories; understanding the details on the label of reagent bottles; molarity and normality of common amino acids and bases; preparation of solutions. Define and perform calculations on dilution, percentage, molar, molal and normal solutions. Know and employ techniques of handling micropipettes; Demonstrate knowledge about common toxic chemicals and safety measures in their handling.

3. Demonstrate knowledge and ability of data collection and documentation of observations: i) Maintaining of laboratory records, ii) Tabulation and generation of graphs. iii) Imaging of tissue specimens and application of scale bars. Demonstrate knowledge of and practice the art of field photography.

4. Overview biological problems: demonstrate idea about key research areas in plant science, Discuss model organisms in research.

5. Demonstrate knowledge of and employ methods to study plant cells/ tissue structure: whole mounts, peal mounts, squash preparations, clearing, maceration and sectioning, tissue preparation-fixation, dehydration etc., paraffin and plastic infiltration, preparation of thin and ultra-thin sections.

6. Demonstrate knowledge of and employ plant micro-techniques: i) staining procedures, ii) classification and chemistry of stains, iii) staining equipments. iv)Cytogenetic techniques with squashed plant material

7. Know and employ the art of scientific writing and its presentation such as a) numbers, units, abbreviations and nomenclature used in scientific writing. b) Writing references. Design MS-Power point presentations and Poster presentations. Demonstrate understanding of and ability to employ scientific writing ethics. Demonstrate basic knowledge of copyright and academic misconduct/ plagiarism.