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Page 1

1 C.U. B.Sc. BOTANY (HONOURS) SYLLABUS, 2010 PART I : 200 MARKS (THEORETICAL -150 and PRACTICAL – 50) PAPER I (THEORETICAL) 100 MARKS 4 Hours Algae 25 Marks (20 Periods) Microbiology 25 Marks (20 Periods) Fungi & Lichen 25 Marks (20 Periods) Plant Pathology 25 Marks (20 Periods) PAPER IIA (THEORETICAL) 50 MARKS 2 HOURS Bryophytes 20 Marks (16 Periods) Palaeobotany & Palynology 20 Marks (16 Periods) Embryology 10 Marks (8 Periods) PAPER IIB (PRACTICAL) 50 MARKS 4 HOURS 1. Work out on Algae 12 Marks 2. Work out on Fungi 12 Marks 3. Identification with reasons 3x5 = 15 Marks (Algae-1, Fungi-1, Lichen-1 & Bryophytes-2) 4. Laboratory Records (Laboratory note books– 4, Slides-2) 6 Marks 5. Viva 5 Marks Module I: Algae + Microbiology Module II: Fungi & Lichen + Plant Pathology Module III: Bryophyte+ Palaeobotany & Palynology+ Embryology Module IV: Work out on Algae & Fungi + Identification of Algae, Fungi, Lichen, Bryophytes + Laboratory Records + Viva.

Page 2

2 PART II : 200 MARKS (THEORETICAL -150 and PRACTICAL – 50) PAPER III (THEORETICAL) 100 MARKS 4 HOURS Pteridophytes 25 Marks (20 Periods) Gymnosperms 25 Marks (20 Periods) Ecology and Plant Geography 25 Marks (20 Periods) Anatomy 25 Marks (20 Periods) PAPER IVA (THEORETICAL) :50 MARKS 2 HOURS Morphology of Angiosperms 10 Marks (8 Periods) Taxonomy of Angiosperms 40 Marks (32 Periods) PAPER IVB (PRACTICAL): 50 MARKS 4 HOURS 1. Workout on Pteridophytes 8 Marks 2. Workout on Angiosperms 12 Marks 3. Spot Identification [1.5 x4] 6 Marks 4. Identification with reasons (2 x 4) = 8 Marks (Pteridophyte – 1, Gymnosperms – 2, Palaeobotany/Palynology–1,) 5. Laboratory Records 5 Marks 6. Field Records (Field note book–3, Herbarium specimens–3) 6 Marks 7. Viva 5 Marks Module V: Pteridophytes + Gymnosperms Module VI: Ecology & Plant Geography + Anatomy Module VII: Morphology of Angiosperms + Taxonomy of Angiosperms Module VIII: Work out on Pteridophytes & Angiosperms + Spot Identification of Angiosperms + Identification (Pteridophytes + Gymnosperms + Palaeobotany/Palynology) + Laboratory Records + Field Records (Field note book + Herbarium Specimens) + Viva.

Page 3

3 PART III : 400 MARKS (THEORETICAL -200 and PRACTICAL – 200) PAPER V (THEORETICAL): 100 MARKS 4 HOURS Biochemistry 35 Marks (28 Periods) Pharmacognosy 15 Marks (12 Periods) Plant Physiology 50 Marks (40 Periods) PAPER VI (THEORETICAL) : 100 MARKS 4 HOURS Cell Biology 20 Marks (16 Periods) Plant Breeding & Biometry 15 Marks (12 Periods) Plant Biotechnology 15 Marks (12 Periods) Genetics & Molecular Biology 50 Marks (40 Periods) Module IX: Biochemistry + Pharmacognosy Module X: Plant Physiology Module XI: Cell Biology + Plant Breeding & Biometry + Plant Biotechnology Module XII: Genetics & Molecular Biology

Page 4

4 PAPER VII (PRACTICAL):100 MARKS 6 HOURS 1. Plant Biochemistry (Quantitative & Qualitative)(20+10)= 30 Marks 2. Plant Physiology 25 Marks 3. Anatomy 10 Marks 4. Pharmacognosy 10 Marks 5. Identification (Anatomy-2.5 x 2) 5 Marks 7. Laboratory Records (Laboratory note books-8 & Slides-2) 10 Marks 8. Viva 10 Marks PAPER VIII (PRACTICAL) 1. Cell Biology and Genetics (20+10) = 30 Marks 2. Biometry 13 Marks 3. Microbiology 12 Marks 4. Plant Pathology 10 Marks 5. Identification (Cell Biology 4, Pathology - 2) (2.5X6 )= 15 Marks 6. Laboratory Records (Laboratory note books-8 & Slides-2) 10 Marks 7. Viva 10 Marks Module XIII: Biochemistry + Pharmacognosy + Laboratory Records + Viva Module XIV: Plant Physiology + Anatomy (work out + Identification) + Laboratory Records + Viva Module XV: Cell Biology & Genetics + Identification + Laboratory Records + Viva Module XVI: Biometry + Microbiology + Plant pathology + Identification + Laboratory Records + Viva

Page 5

5 PAPER I (THEORETICAL): 100 MARKS : 4 HOURS Algae 25 Marks (20 Periods) Microbiology 25 Marks (20 Periods) Fungi & Lichen 25 Marks (20 Periods) Plant Pathology 25 Marks (20 Periods) PAPER I (THEORETICAL) ALGAE 25 Marks (20 Periods) 1. General account : 1.1. Thallus organization, 1.2. Ultrastructure of Plastids and Flagella, 1.3. Origin and evolution of sex, 1.4. Life cycle patterns. 2. Classification : 2.1. Classification by Lee (1999) upto division (phylum) with examples, 2.2. Salient features of Cyanophyceae, Chlorophyceae, Charophyceae, Bacillariophyceae, Xanthophyceae, Phaeophyceae, Rhodophyceae. 3. Blue Green Algae : 3.1. Ultrastructure of cell, 3.2. Heterocyst - structure and function, 3.3. Renaming as Cyanobacteria. 4. Diatom : 4.1. Cell structure, 4.2. Cell division, 4.3. Auxospore formation in Centrales and Pennales. 5. Life History : 5.1. Oedogonium, 5.2. Chara, 5.3. Ectocarpus, 5.4. Polysiphonia. 6. Economic Importance : 6.1. Food, 6.2. Phycocolloid (Agar-agar, Algin, Carrageenan), 6.3. Diatomite, 6.4. Algal Biotechnology – potential of microalgae for SCP,  $\beta$ -carotene, Biofertilizer, Biodiesel; Principles of mass cultivation of microalgae; 6.5. Algal toxins. MICROBIOLOGY 25 Marks (20 Periods) 1. Virus : 1.1. Plant virus- types, 1.2. Transmission and translocation of Plant virus, 1.3. TMV- Physicochemical characteristics and Multiplication, 1.4. One step growth curve, 1.5. Lytic cycle (T4 phage) and Lysogenic cycle (Lambda phage), Significance of lysogeny, 1.6. Viroids and Prions. 2. Bacteria : 2.1. Distinguishing features of Archaea and Bacteria, 2.2. Characteristics of some major groups: Proteobacteria (Enterobacteria), Firmicutes, Mollicutes, Actinobacteria, Spirochaetes, Chlamydiae, 2.3. Glycocalyx- nature and function, 2.4. Flagella (ultrastructure) & Pili, 2.5. Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria, 2.6. Bacterial genome and plasmid, 2.7. Endospore - formation, structure and function, 2.8. 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. 3. Applied Microbiology : 3.1. Industrial Production of Vinegar and Streptomycin (brief outline), 3.2. Microbial sources and uses of Enzyme (Amylase, Protease), Amino acid (Glutamic acid, Lysine), Polysaccharides (Dextran), 3.3. Use of microbes as Biofertilizer and Biopesticides. FUNGI & LICHEN 25 Marks (20 Periods) 1. General Account : 1.1. Hyphal forms, 1.2. Fungal spore forms and mode of liberation, 1.3. Sexual reproduction and degeneration of sex, 1.4. Homothallism and heterothallism, 1.5. Life cycle patterns, 1.6. Anamorphic fungi and parasexuality, 1.7. Mycotoxins with emphasis on aflatoxin. 2. Classification : Classification of Fungi (Ainsworth, 1973) upto sub-division with

diagnostic characters and examples. 3. Life history : 3.1. Synchronium, 3.2. Rhizopus , 3.3. Ascobolus , 3.4. Agaricus . 4. Mycorrhiza : 4.1. Types with salient features , 4.2. Role in Agriculture & Forestry .

Page 6

6 5. Fungal Biotechnology : 5.1. Mushroom – Food value and cultivation of Pleurotus , 5.2. Cheese and Ethanol- Industrial production (brief outline), 5.3. Fungal sources and uses of Mycoprotein, Enzyme (Cellulase), Amino acid (Tryptophan), Vitamin (Riboflavin), Antibiotic( Griseofulvin), Pharmaceuticals (Cyclosporin-A). 6. Lichen : 6.1. Types , 6.2. Reproduction , 6.3. Economic and ecological importance

PLANT PATHOLOGY 25 Marks (20 Periods) 1. Terms and Definitions : 1.1. Disease concept, 1.2. Symptoms, 1.3. Etiology & causal complex, 1.4. Primary and secondary inocula, 1.5. Infection, 1.6. Pathogenicity and pathogenesis, 1.7. Necrotroph and Biotroph, 1.8. Koch's Postulates, 1.9. Endemic, Epidemic, Pandemic and Sporadic disease, 1.10. Disease triangle, 1.11. Disease cycle (monocyclic, polycyclic and polyetic). 2. Host – Parasite Interaction : 2.1. Mechanism of infection ( Brief idea about Pre-penetration ,Penetration and Post-penetration), 2.2. Pathotoxin (Definition,criteria and example), 2.3. Defence mechanism with special reference to Phytoalexin, 2.4. Resistance- Systemic acquired and Induced systemic. 3. Plant Disease Management : 3.1. Quarantine, 3.2. Chemical, 3.3. Biological, 3.4. Integrated. 4. Symptoms , Causal organism ,, Disease cycle and Control measures of : 4.1. Late blight of Potato, 4.2. Bacterial blight of rice, 4.3. Black stem rust of wheat, 4.4. Stem rot of jute. PAPER IIA ( THEORETICAL ) : 50 MARKS : 2 HOURS Bryophytes 20 Marks (16 Periods) Palaeobotany & Palynology 20 Marks (16 Periods) Embryology 10 Marks (8 Periods) PAPER IIA (THEORETICAL) BRYOPHYTES 20 Marks (16 Periods) 1. General Account : 1.1. Origin of bryophytes, 1.2. Amphibian nature, 1.3. Classification (Proskauer, 1957) upto class with diagnostic characters and examples . 2. Life History: Gametophyte structure and Reproduction, Development and Structure of sporophyte, Spore dispersal in: 2.1. Marchantia , 2.2. Anthoceros , 2.3. Funaria . 3. Phylogeny : 3.1. Origin of Alternation of Generations (Homologous and Antithetic theory), 3.2. Evolution of Sporophytes (Progressive and Regressive concept ). 4. Importance : Role of bryophytes in : 4.1. Plant succession , 4.2. Pollution Monitoring.

PALAEOBOTANY & PALYNOLOGY 20 Marks (16 Periods) 1. Plant Fossil : 1.1. Types: Body fossil (Micro- and Megafossils), Trace fossil, Chemical fossil, Index fossil, 1.2. Different modes of preservation (Schopf, 1975), 1.3. Conditions favouring fossilization, 1.4. Nomenclature and Reconstruction, 1.5 Importance of fossil study 2. Geological time scale with dominant plant groups through ages. 3. Indian Gondwana System - Three fold division with major megafossil assemblages . 4. Palynology :

Page 7

7 4.1. Spore and Pollen, 4.2. Pollen aperture types, 4.3. NPC classification (Erdtman). 4.4. Pollen wall- Sporopollenin, Stratification and Ornamentation (sculpturing), 5. Applied Palynology:- Basic concepts of : 5.1. Palaeopalynology, 5.2. Aeropalynology , 5.3. Forensic palynology, 5.4. Melissopalynology.

EMBRYOLOGY 10 Marks (8 Periods) 1. Pre-fertilisation changes : 1.1. Microsporogenesis and Microgametogenesis, 1.2. Megasporogenesis and Megagametogenesis (monosporic, bisporic and tetrasporic). 2. Fertilisation: 2.1. Pollen-ovule ratio and its significance, 2.2. Pollen germination, Pollen tube– growth, entry into ovule and discharge, 2.3. Double fertilization. 3. Post-fertilization changes : 3.1. Embryogenesis in Capsella, 3.2. Development of Endosperm ( 3 types ). 4. Apomixis & Polyembryony:

4.1. Apomixis- Apospory and Apogamy , 4.2. Polyembryony- different types. PAPER IIB ( PRACTICAL) : 50 MARKS : 4 HOURS 1. Work out on Algae 12 Marks 2. Work out on Fungi 12 Marks 3. Identification with reasons (3 x 5) = 15 Marks (Algae-1, Fungi-1, Lichen-1 & Bryophyte- 2) 5. Laboratory Records (Laboratory note books– 4, Slides-2) 6 Marks 6. Viva 5 Marks PAPER IIB ( PRACTICAL) ALGAE 1. Work out of the following algae with reproductive structure (Free hand drawing and drawing under drawing prism with magnification ) : Oedogonium , Chara, Ectocarpus. 2. Study of (a) Permanent slides : Gloeotrichia, Volvox, Vaucheria, Coleochaete, Polysiphonia, Centric and Pennate diatom; (b) Macroscopic specimens : Laminaria, Sargassum. FUNGI AND LICHEN 1. Work out of the following fungi with reproductive structures (including microscopic measurement of Reproductive structures ) : Rhizopus (asexual) , Ascobolus , Agaricus . 2. Study from permanent slides : Zygospore of Rhizopus , Conidia of Fusarium, Conidiophore of Penicillium. 3. Morphological study of Fungi (fruit body of Polyporus, Cyathus), Lichens (fruticose and foliose) . BRYOPHYTES 1. Morphological study of the plant body : Genera as mentioned in theoretical syllabus and Riccia , Porella. 2. Study from permanent slides : Riccia (V.S. of thallus with sporophyte), Marchantia ( L.S. through gemma cup, antheridiophore , archegoniophore ) , Anthoceros ( L.S. of sporophyte ) , Funaria ( L.S. of capsule ) . LABORATORY RECORDS 1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes . 2. Slides (permanent) prepared during practical classes.

Page 8

8 PART II : 200 MARKS (THEORETICAL -150 and PRACTICAL – 50) PAPER III (THEORETICAL) 100 MARKS : 4 HOURS Pteridophytes 25 Marks (20 Periods) Gymnosperms 25 Marks (20 Periods) Ecology and Plant Geography 25 Marks (20 Periods) Anatomy 25 Marks (20 Periods) PAPER III (THEORETICAL) PTERIDOPHYTES 25 Marks (20 Periods) 1. General Account : 1.1. Colonisation and rise of early land plants , 1.2. Classification of vascular plants by Gifford & Foster (1989) upto division (Rhyniophyta to Filicophyta) with diagnostic characters and examples. 2. Life History : Sporophyte structure, Reproduction and Structure of gametophyte in 2.1. Psilotum, 2.2. Selaginella, 2.3. Equisetum, 2.4. Dryopteris. 3. Fossil Pteridophytes : Structural features, Geological distribution and Evolutionary significance of 3.1. Rhynia, 3.2. Lepidodendron (Reconstructed) , 3.3. Calamites (Reconstructed). 4. Telome concept and its significance in the origin of different groups of Pteridophytes. 5. Heterospory and Origin of Seed habit. 6. Economic importance as food, medicine and Agriculture. GYMNOSPERMS 25 Marks (20 Periods) 1. Classification of vascular plants by Gifford & Foster (1989) upto division (Progymnospermophyta to Gnetophyta) with diagnostic characters and examples. 2. Progymnosperms : 2.1. Diagnostic characters of the group, 2.2. Vegetative and reproductive features of Archeopteris, 2.3. Phylogenetic importance. 3. Life History : Distribution in India; Vegetative and Reproductive structure of sporophyte, Development of gametophyte and Embryogeny in : 3.1. Cycas , 3.2. Pinus and 3.3. Gnetum . 4. Fossil gymnosperms : Structural features and Geological distribution of reconstructed genera: 4.1. Lyginopteris, 4.2. Williamsonia, 4.3. Cordaites. 5. Economic Importance with reference to Wood, Resins, Essential oils, and Drugs. ECOLOGY 1. Preliminary idea on : 1.1. Habitat and Niche, 1.2. Ecotone and edge–effect, 1.3. Microclimate, 1.4. Ecads, ecotype and ecoclines, 1.5. Carrying capacity. 2. Community ecology : 2.1. Community- Characteristics and diversity, 2.2. Ecological succession –Primary and

secondary, Seral stages (with reference to Hydrosere), autogenic and allogenic succession. 3. 3.1. Plant indicators (metalphytes); 3.2. Phytoremediation. 4. Conservation of Biodiversity:

Page 9

9 4.1. Level of Biodiversity: genetic, species & ecosystem diversity, 4.2. Biodiversity hot spots- criteria, Indian hotspots, 4.3. In- situ and ex-situ conservation, 4.4. Seed-banks, 4.5. Cryopreservation, 4.6. Geographic Information System and Remote Sensing (brief idea). PLANT GEOGRAPHY 5. Phytogeographical regions : 5.1. Phytogeographical regions of India (Chatterjee 1960); 5.2. Dominant flora of Eastern Himalaya, Western Himalaya and Sunderban. 6. Endemism : 6.1. Endemic types and Factors; 6.2. Age & Area hypothesis and Epibiotic theory; 6.3. Endemism in Indian flora. ANATOMY 25 Marks (20 Periods) 1. Cell wall: 1.1. Ultrastructure & Chemical constituents, 1.2. Plasmodesmata-ultrastructure, 1.3. Concept of Apoplast and Symplast, 1.4. Growth and Thickening of cell wall. 2. Stomata : 2.1. Types ( Metcalfe and Chalk, Stebbins and Khush ) , 2.2. Ontogeny. 3. Ontogeny of 3.1. Trachea and 3.2. Sieve-tube. 4. Stele : 4.1 Leaf-trace and leaf-gap, 4.2. Stellar types & evolution 5. Secondary growth: 5.1. Normal (intra- & extra-stelar), 5.2. Anomalous (stem of Bignonia, Boerhavia, Tecoma, Dracaena and root of Tinospora). 6. Mechanical tissues and the Principles governing their distribution in plants. 7. Developmental Anatomy : 7.1. Organisation of shoot apex (Tunica–Corpus) and Root apex (Korper-Kappe), 7.2. Plastochrone. 8. Ecological Anatomy: Adaptive anatomical features of 8.1. Hydrophytes , 8.2. Xerophytes . PAPER IVA (THEORETICAL): 50 MARKS : 2 HOURS Morphology of Angiosperms 10 Marks (8 Periods) Taxonomy of Angiosperms 40 Marks (32 Periods) PAPER IVA (THEORETICAL) MORPHOLOGY OF ANGIOSPERMS 10 Marks (8 Periods) 1. Inflorescence types with examples. 2. Flower : Corolla- forms, aestivation; Stamen- types; Placentation-types; Ovule - structure and forms. 3. Fruit - types with examples. TAXONOMY OF ANGIOSPERMS 40 Marks (32 Periods) 1. Introduction : 1.1. Components of Systematics: Nomenclature, Identification, Classification; 1.2. Taxonomy and its phases - Pioneer, Consolidation , Biosystematic and Encyclopaedic ; alpha- and omega- taxonomy . 2. Nomenclature : Elementary knowledge of ICBN: Principles; Rank of taxa, Retention and rejection of names; Type method; Principle of priority; Effective and valid publication; Author Citation. 3. Systems of classification : Broad outline of Bentham & Hooker (1862-1883), Cronquist's (1988) system of classification with merits and demerits 4. Systematics in Practice :

Page 10

10 4.1. Herbaria and Botanical Gardens – their role; important Indian Herbaria and Botanical Gardens; 4.2. Dichotomous keys – indented and bracketed. 5. Phenetics and Cladistics : Brief idea on Phenetics, Numerical taxonomy; Cladistics; Monophyletic, polyphyletic and paraphyletic groups; Plesiomorphy and apomorphy. 6. Data sources in Taxonomy: Supportive evidences from : 6.1. Phytochemistry, 6.2. Cytology, 6.3. Anatomy. 7. Diagnostic features, Systematic position (Bentham & Hooker and Cronquist), Economically important plants (parts used and uses ) of the following families: 7.1. Dicotyledons : Magnoliaceae, Malvaceae, Leguminosae (subfamilies), Euphorbiaceae, Umbelliferae (Apiaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae (Lamiaceae), Cucurbitaceae, Rubiaceae, Compositae (Asteraceae). 7.2. Monocotyledons: Alismataceae, Palmae (Arecaceae), Gramineae (Poaceae), Liliaceae, Zingiberaceae, Orchidaceae. PAPER IVB ( PRACTICAL ) : 50 MARKS : 4 HOURS 1.

Workout on Pteridophytes 8 Marks 2. Workout on Angiosperms 12 Marks 3. Spot Identification [4x 1.5] 6 Marks 4. Identification with reasons (4 x 2) = 8 Marks (Pteridophyte - 1, Gymnosperms - 2, Palaeobotany/Palynology-1,) 5. Laboratory Records 5 Marks 6. Field Records (Field note book-3, Herbarium specimens-3) 6 Marks 7. Viva 5 Marks PAPER IVB ( PRACTICAL) PTERIDOPHYTES 1. Morphological study of the sporophytic plant body: Genera as mentioned in the theoretical syllabus and Lycopodium, Ophioglossum, Marsilea and Pteris. 2. Workout of the reproductive structures : Selaginella , Equisetum , Pteris. 3. Study from permanent slides : Psilotum ( T.S. of synangium ), Lycopodium (L.S. of strobilus), Ophioglossum (L.S. of spike), Dryopteris ( gametophyte ), Marsilea (L.S. of sporocarp) ANGIOSPERMS 1. Study of types of inflorescence, flower and fruit with labeled sketches. 2. Work out, description, preparation of floral formula and floral diagram, identification up to genus with the help of suitable literature of wild plants from the following families: Malvaceae, Fabaceae (Papilionaceae), Solanaceae, Scrophulariaceae, Acanthaceae, Labiatae ( Lamiaceae ), Rubiaceae. 3. Spot identification (Binomial, Family) of plants from families included in the theoretical syllabus. FIELD WORK 1. At least four excursions including one long excursion to a specialized phytogeographical zone of India and one to Acharya Jagadish Chandra Bose Indian Botanic Garden (Shibpur, Howrah) and Central National Herbarium (CNH). 2. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion). FIELD RECORDS

Page 11

11 1. Field Note Book (authenticated) with ecological notes on the plants of the area of excursion and voucher specimen book. 2. 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. GYMNOSPERMS 1. Morphological study: Cycas (microsporophyll and megasporophyll), Pinus ( female and male cone), Gnetum (female and male cone). 2. Study from permanent slides: Cycas (L.S. of ovule), Pinus (L.S. of male and female cone ), Ginkgo (L.S. of female strobilus), Gnetum (L.S. of male cone and ovule). PALAEOBOTANY AND PALYNOLOGY 1. Morphological study : Ptilophyllum and Glossopteris leaf fossils. 2. Study from permanent slides : T.S. of stem of Rhynia, Lepidodendron, Calamites, Lyginopteris, Cordaites. 3. Study of Pollen types (colpate, porate and colpate) from permanent slides. Slides may be prepared from specimens: Colpate (Leonurus sibiricus/ Brassica sp.), Porate (Hibiscus rosa-sinensis), Colpate (Cassia sophera/ C.tora). LABORATORY RECORDS 1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes. 2. Slides (prepared during practical classes). PART III : 400 MARKS

Page 12

12 (THEORETICAL -200 and PRACTICAL – 200) PAPER V (THEORETICAL): 100 MARKS : 4 HOURS Biochemistry 35 Marks (28 Periods) Pharmacognosy 15 Marks (12 Periods) Plant Physiology 50 Marks (40 Periods) PAPER V (THEORETICAL) BIOCHEMISTRY 35 Marks (28 Periods) 1. Biochemical Foundations : 1.1. Covalent and non-covalent bonds ; hydrogen bond ; Van der Waal's forces ; 1.2. Structure and properties of water ; 1.3. pH and buffer ( inorganic and organic ); 1.4. Handerson-Hasselbalch equation;

1.5. Isoelectric point. 2. Molecules of life : 2.1. Nucleic Acids – structure of nucleosides and nucleotides ; oligo- and poly nucleotides , B & Z form of DNA, RNA- different forms; nucleotide derivatives (ATP, NADP), 2.2. Proteins – structure and classification of amino acids; primary, secondary, tertiary and quaternary structure of proteins; 2.3. Carbohydrates - structure of mono-, di- and polysaccharide; stereoisomers, enantiomers and epimers; 2.4. Lipids - structure of simple lipid and compound lipid (phospholipids and glycolipids), fatty acids- saturated and unsaturated. 3. Energy flow and enzymology : 3.1. Bioenergetics-Thermodynamic principles; free energy; energy rich bonds- phosphoryl group transfer and ATP; redox potentials and Biological redox reactions, 3.2. Enzymes – classification and nomenclature (IUBMB); Co-factors and co-enzymes; isozymes, 3.3. Mechanism of enzyme action; enzyme inhibition; 3.4. Enzyme kinetics (Michaelis- Menten equation) and simple problems. 4. Cell membrane and Biosignalling : 4.1. Membrane chemistry, 4.2. Membrane transport (uniport, symport, antiport), mechanism of ion uptake 4.3. Signal transduction pathway and second messenger concept - G-protein and Ca<sup>2+</sup> as messenger. 5. Phosphorylation : ATP Synthesis- Chemiosmotic model, Oxidative and Photophosphorylation- Mechanism and differences. PHARMACOGNOSY 15 Marks (12 Periods) 1. General account : 1.1 Pharmacognosy and its importance in modern medicine , 1.2 Crude drugs, 1.3 Classification of drugs- chemical and pharmacological , 1.4 Drug evaluation – organoleptic , microscopic, chemical, physical and biological. 2. Secondary metabolites : 2.1 Definition of secondary metabolites and difference with primary metabolites , 2.2 Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only), 2.3 Major types–terpenoids, phenolics, flavonoids, alkaloids and their protective action against pathogenic microbes and herbivores. 3. Pharmacologically active constituents : Source plants (one example) parts used and uses of : 3.1 Steroids (Diosgenin, Digitoxin), 3.2 Tannin (Catechin), 3.3 Resins ( Gingerol, Curcuminoids), 3.4 Alkaloids (Quinine, Strychnine, Reserpine, Vinblastine). PLANT PHYSIOLOGY 50 Marks (40 Periods) 1. Plant-water relations: 1.1 Concept of water potential , components of water potential in plant system , 1.2 Soil-plant-Atmosphere continuum concept, Cavitation in xylem and embolism, 1.3 Stomatal physiology-mechanism of opening and closing, Role of carbon di-oxide, potassium ion, abscisic acid and blue light in stomatal movement, Antitranspirants. 2. Organic Translocation : 2.1 Phloem sap, P-protein, 2.2 Phloem loading and unloading, 2.3 Mass-flow (pressure flow) hypothesis and its critical evaluation. 3. Photosynthesis : 3.1 Chemical structure of chlorophyll a and b , absorption and action spectra, biological significance of carotenoid pigments, 3.2 Red drop and Emerson effect, Components of photosystems (light harvesting complex), Photochemical

Page 13

13 reaction centres, Cyclic and noncyclic electron transport, Water splitting mechanism, 3.3 Calvin cycle – Biochemical reactions & stoichiometry, 3.4 HSK Pathway– three variants of the pathway, 3.5. Photosynthetic efficiency of C<sub>3</sub> and C<sub>4</sub> plants and crop productivity, 3.6. Photorespiration – mechanism and significance, 3.7 Crassulacean acid metabolism – mechanism and ecological significance. 4. Respiration : 4.1 EMP pathway, regulation and its anabolic role , 4.2 Conversion of Pyruvic acid to Acetyl CoA, 4.3 TCA-cycle and its amphibolic role ,4.4. Oxidative pentose phosphate pathway and its significance, 4.5 β-oxidation of fatty acids and significance, 4.6 Mitochondrial electron transport system, uncouplers, 4.7 Oxidation of cytosolic NADH+H<sup>+</sup> 4.8 Stoichiometry of glucose oxidation (aerobic). 5.

Nitrogen Metabolism : 5.1 Assimilation of nitrate by plants, 5.2 Biochemistry of dinitrogen fixation in Rhizobium, 5.3. General principle of amino acid biosynthesis (including GS and GOGAT enzyme system). 6. Plant Growth Regulators : 6.1. Physiological roles of Auxin, Gibberellin, Cytokinin, Abscisic acid, Ethylene, 6.2 Chemical nature –IAA, GA<sub>3</sub>, Kinetin, 6.3. Biosynthesis and bioassay of IAA, 6.4 Mode of action of IAA, 6.5 Brassinosteroids and Polyamines as PGRs (brief idea). 7. Photomorphogenesis : 7.1 Concept of photomorphogenesis, 7.2 Photoperiodism and plant types, 7.3 Perception of photoperiodic stimulus, 7.4 Critical day length, concept of light monitoring, 7.5 Phytochrome – chemical nature, interconversion, function in flowering, 7.6 Role of GA in flowering, 7.7 Vernalisation – role of low temperature in flowering, 7.8 Concept of biological clock and biorhythm . 8. Seed dormancy : 8.1 Types; Causes and Methods of breaking seed dormancy, 8.2 Biochemistry of seed germination. 9. Physiology of Senescence and Ageing. 10. Stress Physiology: Plant responses to: 9.1 Water stress, 9.2 Temperature stress, 9.3 Salt stress PAPER VI (THEORETICAL) : 100 MARKS : 4 HOURS Cell Biology 20 Marks (16 Periods) Plant Breeding & Biometry 15 Marks (12 Periods) Plant Biotechnology 15 Marks (12 Periods) Genetics & Molecular Biology 50 Marks (40 Periods) PAPER VI (THEORETICAL) CELL BIOLOGY 20 Marks (16 Periods) 1. Origin and Evolution of Cells : 1.1. Concept of RNA world, Ribozymes, First cell, 1.2. Origin of eukaryotic cell, 1.3. Organellar DNA (cp-and mt- DNA). 2. Nucleus and Chromosome : 2.1. Nuclear envelope, Nuclear lamina and Nuclear pore complex, 3.2. Nucleolus-ultrastructure and ribosome biogenesis, 3.3. Chromatin ultrastructure and DNA packaging in eukaryotic chromosome, 3.4. Karyotype concept and its parameters. 3. Cell cycle and its regulation : 3.1. Centromere, kinetochore, spindle apparatus & telomere–structural organization and functions, 3.2. Dynamics of chromosome movement in anaphase, 3.3. Mechanism of cell cycle control in Yeast (checkpoints and role of MPF), Apoptosis (Brief idea). PLANT BREEDING & BIOMETRY 15 Marks (12 Periods) 1. Plant Breeding:

Page 14

14 1.1 Maintenance of germplasm, 1.2 Mass selection and Pure line selection, 1.3 Back cross method, 1.4. Heterosis and hybrid seed production, 1.5. Male sterility and its use in plant breeding, 1.6 Molecular Breeding (use of DNA markers in plant breeding). 2. Biometry: 2.1 Random sampling, Frequency distribution, 2.2. Central tendency– Arithmetic Mean, Mode and Median, 2.3. Measurement of dispersion – Standard Deviation, Standard error of Mean, 2.4. Test of significance: ‘t’- test; chi- square test for goodness of fit, 2.5 Probability ( Addition and Multiplication rules), 2.6 Measurement of gene frequency (Hardy-Weinberg equilibrium). PLANT BIOTECHNOLOGY 15 Marks (12 Periods) 1. Plant tissue culture –Introduction: 1.1. Cellular totipotency, 1.2. Tissue culture media, 1.3. Aseptic manipulation. 2. Callus culture : 2.1. Callus initiation, growth and maintenance, 2.2. Applications. 3. Micropropagation : 3.1. Organogenesis (direct and indirect), 3.2. Somatic embryogenesis, Artificial seed, 3.3. Significance. 4. Haploid Culture : 4.1. Anther and Pollen culture methods, 4.2. Significance . 5. Protoplast Culture : 5.1. Protoplast isolation and culture, 5.2. Protoplast fusion (somatic hybridization), 5.3. Significance. 6. Plant Genetic Engineering : 6.1. Brief concept of different gene transfer methods, special emphasis on Agrobacterium mediated gene transfer, Role of Reporter gene, 6.2. Achievements in crop biotechnology (suitable examples of transgenic plants). GENETICS & MOLECULAR BIOLOGY 50 Marks (40 Periods) 1. Linkage, Crossing over and Gene Mapping : 1.1. Complete and incomplete linkage, linkage group, 1.2 Detection of crossing over (McClintock’s experiment), 1.3 Molecular mechanism of crossing over



(Holliday model), 1.4 Gene mapping (three point test cross), 1.5 Co-efficient of coincidence and interference, Mapping function, 1.6 Problems on gene mapping, 1.7 Molecular mapping – ISH, FISH (brief idea). 2. Epistasis and Polygenic inheritance in plants. 3. Aneuploidy and Polyploidy: Types, examples, meiotic behaviour and importance of: 3.1 Aneuploidy, 3.2 Polyploidy. 4. Chromosomal aberration: Types and meiotic behaviour of: 4.1 Deletion, 4.2 Duplication, 4.3 Translocation, 4.4 Inversion. 5. Mutation : 5.1 Point mutation-Transition, Transversion and Frame shift mutation, 5.2 Molecular mechanism (tautomerisation, alkylation, deamination, base analogue incorporation, dimerisation), 5.3 DNA repair (brief idea). 6. Structural organisation of Gene : 6.1 One Gene—one polypeptide concept, 6.2 Complementation test (rII locus), 6.3 Split gene, 6.4 Overlapping gene, 6.5 Repetitive DNA-tandem and interspersed, 6.6 Transposon (Ac-Ds system), 6.7 Homoeotic gene in plants (ABC model in Arabidopsis). 7. DNA Replication, Transcription and Translation (Prokaryotes & Eukaryotes): 7.1 Central Dogma, 7.2 Semiconservative replication – mechanism, 7.3 Transcription, 7.4 RNA processing, 7.5 Aminoacylation of tRNA, 7.6 Translation. 8. Gene Regulation : 8.1 Concept of Lac-operon, 8.2 Positive and negative control. 9. Genetic Code : 9.1 Properties-evidences & exceptions, 9.2 Decipherance of codon (Binding technique) . 10. Recombinant DNA Technology: 10.1 Enzyme (Restriction endonuclease, ligase), 10.2 Vector (plasmid pBR 322) 10.3 Marker gene, 10.4. Steps of cloning technique, 10.5 PCR and its application 10.6 Genomic DNA and cDNA library. 11. Bioinformatics : Brief concept on 11.1 Genomics, 11.2 Proteomics. PAPER VII (PRACTICAL):100 MARKS : 6 HOURS 1. Plant Biochemistry (Quantitative & Qualitative)(20+10)= 30 Marks

Page 15

15 2. Plant Physiology 25 Marks 3. Anatomy 10 Marks 4. Pharmacognosy 10 Marks 5. Identification (Anatomy-2x2.5) 5 Marks 7. Laboratory Records (Laboratory note books-8 & Slides-2) 10 Marks 8. Viva 10 Marks PAPER VII ( PRACTICAL) PLANT BIOCHEMISTRY Qualitative : 1. Detection of organic acids: citric , tartaric, oxalic and malic from laboratory samples. 2. Detection of carbohydrate and protein from plant samples. 3. Detection of the nature of carbohydrate – glucose, fructose , sucrose and starch from laboratory samples. 4. Detection of Ca, Mg, Fe, S from plant ash sample. Quantitative : 1.Estimation of amino-nitrogen by formol titration method (glycine) . 2. Estimation of glucose by Benedicts quantitative reagent. 3. Estimation of titratable acidity from lemon. 4. Estimation of catalase activity in plant samples. 5. Estimation of urease activity in plant samples. 6. Colorimetric estimation of protein by Folin phenol reagent. PLANT PHYSIOLOGY 1. Determination of loss of water per stoma per hour. 2. Relationship between transpiration and evaporation. 3. Rate of photosynthesis under varying HCO<sup>-3</sup> concentration in an aquatic plant using bicarbonate and to find out the optimum and toxic concentration . 4. Separation of plastidial pigments. 5. Measurement of oxygen uptake by respiring tissue (per g/hr.) 6. Determination of the RQ of germinating seeds. 7. Measurement of osmotic pressure of storage tissue by weighing method. 8. Measurement of osmotic pressure of Rhoeo leaf by plasmolytic method. 9. Effect of temperature on absorption of water by storage tissue and determination of Q10. 10. Comparison of imbibitions of water by starchy, proteinaceous and fatty seeds. ANATOMY 1. Microscopic studies on: Types of stomata, sclereids, raphides (Colocasia), cystolith (Ficus leaf) starch grains, aleurone grains, laticiferous ducts, oil glands. 2. Study of anomalous secondary structure in stem of Bignonia, Boerhaavia, Tecoma, Dracaena and root of Tinospora 3. Study of adaptive anatomical

features : Hydrophytes ( Nymphaea – petiole ) and Xerophytes ( Nerium – leaf). PHARMACOGNOSY 1. Chemical tests for (a) Tannin (Camellia sinensis / Terminalia chebula ), (b) Alkaloid ( Catharanthus roseus) . 2. Powder microscopy – Zingiber and Holarrhena . 3. Histochemical tests of (a) Curcumin ( Curcuma longa ) , (b) Starch in non-lignified vessel ( Zingiber), (c) Alkaloid (stem of Catharanthus and bark of Holarrhena ). LABORATORY RECORDS 1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes. 2. Slides (permanent) prepared during practical classes. PAPER VIII (PRACTICAL) : 100 MARKS : 6 HOURS

Page 16

16 1. Cell Biology and Genetics (20+10) = 30 Marks 2. Biometry 13 Marks 3. Microbiology 12 Marks 4. Plant Pathology 10 Marks 5. Identification (Cell Biology - 4, Pathology - 2) (2.5X6) = 15 Marks 6. Laboratory Records (Laboratory note books-8, Slides-3) 10 Marks 7. Viva 10 Marks PAPER VIII (PRACTICAL) CELL BIOLOGY AND GENETICS 1. Introduction to chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides. 2. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa. 3. Study of mitotic chromosome : Metaphase chromosome preparation , free hand drawing under high power objective, drawing with drawing prism under oil immersion lens, determination of 2n number, comment on chromosome morphology of the following specimens from root tips: Allium cepa , Aloe vera , Lens esculenta. 4. Study of meiotic chromosome: 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. 5. Identification 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, fragmentation, (ii) pollen mitosis. BIOMETRY 1. Determination of goodness of fit in normal and modified mono-and dihybrid ratios ( 3:1, 1:1, 9:7, 13:3, 15:1, 9:3:3:1, 1:1:1:1 ) by Chi-square analysis and comment on the nature of inheritance . 2. Univariate analysis of statistical data : Statistical tables , mean , mode , median , standard deviation and standard error (using seedling population / leaflet size ) . MICROBIOLOGY 1. Preparation of bacterial media – (a) Nutrient agar and nutrient broth, (b) Preparation of slants and pouring Petri- plates. 2. Sub-culturing of bacterial culture. 3. Gram staining from bacterial culture. 4. Microscopic examination of bacteria from natural habitat (curd ) by simple staining. PLANT PATHOLOGY 1. Preparation of fungal media (PDA). 2. Sterilization process. 3. Isolation of pathogen from diseased leaf. 4. Inoculation of fruit and subculturing. 5. Identification : Pathological specimens of Brown spot of rice, Bacterial blight of rice , Loose smut of wheat, Stem rot of jute, Late blight of potato; Slides of uredial, telial, pycnial & aecial stages of Puccinia graminis. LABORATORY RECORDS 1. Laboratory Note Book of each section must be signed by the respective teacher with date during practical classes. 2. Slides (permanent) prepared during practical classes. QUESTION PATTERN OF BOTANY (Honours), C.U.

Page 17

17 A-Type-Objective type question each of 1 or 2 marks, no optional question. B-Type-Short note/ short answer type question each of 5 marks; no part marking. C-Type-Long answer type question each of 15 marks may be split into 2 to 4 relevant parts, avoiding the pattern of A and B type questions. Paper-I

Module I (50 Marks). Q.1. 'A' Type Questions- 10 marks Algae-(2x2) + (1x1) = 5 Microbiology-(2x2) + (1x1) = 5 Q.2. 'B' Type Questions-10 marks (a). Algae- (one out of two) - 5x1= 5 (b). Microbiology – (one out of two) - 5x1= 5 Q.3. 'C' Type Questions-30 marks (a). Algae- (one out of two) - 15x1= 15 (b). Microbiology – (one out of two) - 15x1= 15 Module II (50 Marks) Q.1. 'A' Type Questions- 10 marks Fungi & Lichen-(2x2) + (1x1) = 5 Plant Pathology-(2x2) + (1x1) = 5 Q.2. 'B' Type Questions-10 marks (a). Fungi & Lichen - (one out of two) - 5x1= 5 (b). Plant Pathology – (one out of two) - 5x1= 5 Q.3. 'C' Type Questions-30 marks (a). Fungi & Lichen - (one out of two) - 15x1= 15 (b). Plant Pathology – (one out of two) - 15x1= 15 Paper-IIA

Page 18

18 Module III (50 Marks) Q.1. 'A' Type Questions- 10 marks Bryophyte-(2x2) + (1x1) = 5 Paleobotany & Palynology-(2x2) + (1x1) = 5 Q.2. Bryophyte- C Type-15 Marks Or B Type-5x3= 15 Marks Q.3. Paleobotany & Palynology - C Type-15 Marks Or B Type-5x3=15 Marks Q.4. Embryology - B Type (Two to be answered out of 4) 5x2=10 Marks Paper-IIB Module IV (Practical) Paper-III Module V (50 Marks) Q.1. 'A' Type Questions- 10 marks Pteridophytes-(2x2) + (1x1) = 5 Gymnosperms-(2x2) + (1x1) = 5 Q.2. 'B' Type Questions-10 marks (a). Pteridophytes- (one out of two) - 5x1= 5 (b). Gymnosperms – (one out of two) - 5x1= 5 Q.3. 'C' Type Questions-30 marks (a). Pteridophytes - (one out of two) - 15x1= 15 (b). Gymnosperms – (one out of two) - 15x1= 15 Module VI (50 Marks) Q.1. 'A' Type Questions- 10 marks Ecology & Plant Geography-(2x2) + (1x1) = 5 Anatomy-(2x2) + (1x1) = 5

Page 19

19 Q.2. 'B' Type Questions-10 marks (a). Ecology & Plant Geography - (one out of two) - 5x1= 5 (b). Anatomy - (one out of two) - 5x1= 5 Q.3. 'C' Type Questions-30 marks (a). Ecology & Plant Geography - (one out of two) - 15x1= 15 (b). Anatomy – (one out of two) - 15x1= 15 Paper-IVA Module VII Q.1. 'A' Type Questions- 10 marks Angiosperms-(2x4)+(1x2)=10 Q.2. Morphology of Angiosperms Type B-(Two to be answered out of four) =5x2=10 marks Q.3. Taxonomy of Angiosperms Type C--(One to be answered out of two) =15 marks Q.4. Angiosperms Type C--(15 marks) Or Type B--(5x3=15 marks) Paper-IVB Module VIII (Practical) Paper-V Module IX (50 Marks) 1. 'A' Type Biochemistry-(2x4) + (1x2) =10 marks 2. Biochemistry-'B' Type (Two to be answered out of four)-5x2=10 marks 3. Biochemistry-'C' Type (One to be answered out of two)-15x1=15 marks 4. Pharmacognosy C Type-15 marks Or B Type-5x3=15 marks

Page 20

20 Module X (50 Marks) 1. 'A' Type Physiology-(2x4) +(1x2)=10 marks 2. 'B' Type (Physiology) (Two to be answered out of four)-5x2=10 marks 3. 'C' Type (Physiology) (Two to be answered out of four)-15x2=30 marks Paper-VI Module XI (50 Marks) 1. 'A' Type Questions- 10 marks Cell Biology-(2x2) + (1x1) = 5. Plant Breeding & Biometry-(2x2) + (1x1) = 5. 2. Cell Biology 'C' Type-15 x 1=15 marks Or 'B' Type-5x3=15 marks 3. Plant Breeding & Biometry 'B' Type (Two out of four)-5x2=10 marks 4. Plant Biotechnology 'C' Type-15 x 1=15 marks Or 'B' Type-5x3=15 marks Module XII (50 Marks) 1. 'A' Type Questions- 10 marks Genetics & Molecular Biology (2x4)+(1x2)=10 2. 'B' Type -10 Marks (Two out of four)-5x2=10 3. 'C' Type-30 Marks (Two out of four)-15x2=30 Suggested Readings Same as 2006

Page 21

21 UNIVERSITY OF CALCUTTA SYLLABUS FOR THREE-YEAR B.Sc. GENERAL COURSE UNDER 1+1+1 SYSTEM OF EXAMINATION BOTANY 2010 Syllabus for three-year B.Sc. Botany General Course (With effect from 2010-2011) PART-I : Full Marks-100

Page 22

22 Paper-I (Theoretical) Marks-100 Module I: [50 marks] Microbiology, Algae, Fungi, Plant Pathology, Bryophytes. Module II: [50 marks] Pteridophytes, Gymnosperms, Palaeobotany & Palynology, Angiosperms (Morphology & Embryology), Taxonomy. PART II : Full Marks-200 (Theoretical-100 & Practical-100) Paper-II (Theoretical) Marks-100 Module III: 50 Marks Anatomy, Cell Biology and Genetics. Module IV: 50 marks Biochemistry and Plant Physiology, Economic Botany, Ecology. PAPER-III (Practical) Full Marks-100 (Each module to be conducted on separate days) Module V 4 Hours: Marks 50 1. Work out on Algae/Fungi (anyone) 9 2. Work out on Angiosperms 12 3. Identification: (2 x 7) 14 Algae/Fungi-1, Bryophyte-1, Pteridophyte-1, Gymnosperm-1, Morphology-1, Taxonomy-2 (species and family). 4. Submission: Laboratory records (laboratory note-book, slides) and Field records (field note book, herbarium sheets). (5+5) = 10 5. Viva-voce 5 Module VI 4 Hours: Marks 50

Page 23

23 1. Plant Physiology Experiment 12 2. Anatomy 12 3. Cell Biology 10 4. Identification: (3x2) Anatomy-1, Cytology-1 6 5. Submission: Laboratory records 5 5. Viva-voce 5 PART III : Full Marks-100 (Theoretical-70 & Practical-30) Paper-IVA (Theoretical) 3 Hours: Marks 70 Module VII Marks- 70 Biofertilizer, Mushroom, Plant Disease Control, Plant Breeding, Biometry, Plant Tissue Culture, Recombinant DNA Technology, Pharmacognosy PAPER – IVB (Practical) Marks-30 Module VIII 3 Hours: Marks-30 1. Microbiology 5 2. Biometry 8 3. Demonstration of a laboratory instrument 4 4. Identification of medicinal plants (2 x 2) 4 5. Submission (Laboratory note book & Field report) 4 6. Viva-voce 5

Page 24

24 Syllabus for three-year B.Sc. Botany General Course (With effect from 2010-2011) PART-I Full Marks-100 Paper-I (Theoretical) Marks-100 Module I: [50 marks] Microbiology, Algae, Fungi, Plant Pathology, Bryophytes. Module II: [50 marks] Pteridophytes, Gymnosperms, Palaeobotany & Palynology, Angiosperms (Morphology & Embryology), Taxonomy. Module I: 50 Marks 1. Domains of life: Archaea, Bacteria and Eukarya. 2. Microbiology: 2.1 Plant virus - general characteristics, 2.2 Transmission and Translocation of plant virus, 2.3 Lytic cycle (T4 phase) and Lysogenic cycle (Lambda phage), 2.4 Chemical nature of cell wall of Gram positive and Gram negative bacteria, 2.5 Genetic recombination in bacteria (Conjugation, Transformation, Transduction), 2.6 Industrial uses of bacteria. 3. Algae: 3.1. Diagnostic characters and examples of Cyanophyceae, Rhodophyceae, Chlorophyceae, Charophyceae and Phaeophyceae (Lee 1999), 3.2 Life histories of Chara and Ectocarpus, 3.3 Economic importance. 4. Fungi: 4.1 Diagnostic characters and examples of Oomycotina, Mastigomycotina, Zygomycotina, Ascomycotina Basidiomycotina, Deuteromycotina (Ainsworth, 1973). 4.2 Life histories of Rhizopus and Ascobolus: 4.3. Economic importance of fungi, 4.4 Fungal symbioses: Mycorrhiza, Lichen and their importance. 5. Plant

Pathology : 5.1 Symptoms - necrotic, hypoplastic and hyperplastic, 5.2 Koch's postulates, 5.3 Biotrophs and Necrotrophs, 5.4 Disease triangle, 5.5 Pathotoxins and phytoalexins (brief concept), 5.6 Symptoms, causal organism, disease cycle and control measures of plant diseases (Late blight of potato, Black stem rust of wheat). 6. Bryophytes: 6.1 Amphibian nature, 6.2 Diagnostic characters and examples of Hepaticopsida, Anthocerotopsida and Bryopsida (Proskauer 1957), 6.3 Life histories of Marchantia and Funaria. 6.4 Ecological importance.

Page 25

25 Module II: 50 Marks 7. Pteridophytes: 7.1 Diagnostic characters and examples of Psilophyta, Lycophyta, Sphenophyta & Filicophyta (Gifford & Foster 1989), 7.2 Life histories of Selaginella and Dryopteris. 7.3 Economic importance. 8. Gymnosperms: 8.1 Progymnosperms (brief idea), 8.2 Diagnostic characters and examples of Cycadophyta, Coniferophyta and Gnetophyta (Gifford & Foster 1989), 8.3 Life histories of Cycas and Pinus. 8.4 Economic importance of Gymnosperms. 9. Paleobotany & Palynology: 9.1 Importance of fossil study, 9.2 Modes of Preservation. 9.3 Geological time scale. 9.4 Williamsonia (Reconstructed), 9.5 Palynology - Definition, spore & pollen (brief idea), Applications. 10. Angiosperm Morphology & Embryology: 10.1 Inflorescence types with examples, 10.2 Corolla forms, aestivation, 10.3 Placentation types, 10.4 Sporogenesis & Gametogenesis, 10.5 Embryo development in Capsella, 10.6 Endosperm development. 11. Taxonomy of Angiosperms : 11.1 Artificial, Natural and Phylogenetic systems of classification, 11.2 Principles of ICBN, 11.3 Bentham and Hooker's system of classification, 11.4 Phenetics- Brief concept. 11.5 Diagnostic features of following families- Malvaceae, Leguminosae (Fabaceae), Cucurbitaceae, Solanaceae, Labiatae (Lamiaceae), Acanthaceae, Rubiaceae, Compositae (Asteraceae), Gramineae (Poaceae), Orchidaceae. PART II Full Marks-200 (Theoretical-100 & Practical-100) Paper-II (Theoretical) Marks-100 Module III: 50 Marks Anatomy, Cell Biology and Genetics. Module IV: 50 marks Biochemistry and Plant Physiology, Economic Botany, Ecology. Module III: 50 Marks 1. Anatomy: 1.1 Stomata - Types (Metcalf & Chalk), 1.2 Mechanical Tissues - Principle and distribution, 1.3 Stellar types and evolution, 1.4 Shoot apex (Tunica-Corpus) and Root apex

Page 26

26 (Körper-Kappe), 1.5 Secondary growth – normal in dicot stem and anomaly in stem of Tecoma & Dracaena. 2. Cell Biology and Genetics: 2.1 Ultrastructure of nuclear envelope, nucleolus and their functions, 2.2 Molecular organisation of metaphase chromosome (Nucleosome concept), 2.3 Chromosomal aberrations- deletion, duplication, inversion & translocation, 2.4 Aneuploidy & Polyploidy- types, importance and role in evolution, 2.5 Central Dogma, 2.6 DNA replication -mechanism in prokaryote, 2.7 Transcription, Processing of mRNA and Translation, 2.8 Genetic Code- properties, 2.9 Epistasis, 2.10 Linkage group and Genetic map (three-point test cross), 2.11 Mutation - Point mutation (tautomerisation; transition, transversion and frame shift), Mutagen- physical and chemical, 2.12 Brief concept of Split gene, Transposons. Module IV Marks: 50 3. Biochemistry and Plant Physiology: 3.1 Proteins - Primary, secondary and tertiary structure, 3.2 Nucleic acid- DNA structure, RNA types, 3.3 Enzyme- Classifications with examples (IUBMB), Mechanism of action. 3.4 Transport in plants - ascent of sap and Xylem cavitation , Phloem transport and source-sink relation, 3.5 Transpiration- Mechanism of stomatal movement, significance 3.6 Photosynthesis- Pigments, Action spectra and Enhancement effect,

Electron transport system and Photophosphorylation, C<sub>3</sub> and C<sub>4</sub> photosynthesis, CAM- Reaction and Significance 3.7 Respiration- Glycolysis & Krebs cycle— Reactions and Significance, ETS and oxidative phosphorylation 3.8 Nitrogen metabolism –Biological dinitrogen fixation, Amino acid synthesis (reductive amination and transamination) 3.9 Plant Growth regulators – Physiological roles of Auxin, Gibberellin, Cytokinin, Ethylene, ABA 3.10 Photoperiodism (Plant types, Role of phytochrome and GA in flowering) and Vernalization 3.11 Senescence (brief idea). 4. Economic Botany: Study of the following economically important plants (scientific names, families, parts used and importance) : 4.1 Cereals-rice, wheat, 4.2 Pulses- mung, gram, 4.3 Spices - ginger, cumin, 4.4 Beverages - tea, coffee, 4.5 Medicinal Plants - cinchona, neem, ipecac, vasaka, 4.6 Oil yielding plants- mustard, groundnut, coconut, 4.7 Vegetables-potato, radish, bottlegourd, cabbage, 4.8 Fibre yielding plants-cotton, jute, 4.9 Timber yielding plants- teak, sal 4.10 Fruits- mango, apple, 4.11 Sugar yielding plant- sugarcane. 5. Ecology: 5.1 Ecotypes and microclimate, 5.2 Plant succession - stages of succession (hydrosere) 5.3 Ecological adaptation of hydrophytes, halophytes and xerophytes, 5.4 Biodiversity - Definition, levels of biodiversity (genetic, species and ecosystem), methods of in-situ & ex-situ conservation, 5.5 Phytoremediation (brief idea). Paper-III (Practical) Marks-100 Module V 50 Marks

Page 27

27 1. Cryptogams: Work out, microscopic preparation, drawing and labeling, description and identification of the following cryptogams: Chara, Ectocarpus, Rhizopus, Ascobolus. 2. Angiosperms: Dissection, drawing and labeling, description of angiospermic plants and floral parts, floral formula and floral diagram, identification (family) from the following families: Leguminosae (Fabaceae), Malvaceae, Solanaceae, Labiatae (Lamiaceae), Acanthaceae. 3. Identification with reasons: Cryptogamic specimens (macroscopic/microscopic) as prescribed in the theoretical syllabus. Gymnosperms: Macroscopic - male and female strobilus of Cycas, and Pinus Anatomical slides (stelar types, transfusion tissue, sieve tube, sunken stomata, lenticel). Morphology: Inflorescence types. 4. Spot identification (Scientific names and families) of the following Angiospermic plants: Sida rhombifolia (Malvaceae), Abutilon indicum (Malvaceae), Thespesia populnea (Malvaceae), Cassia sophera (Fabaceae), Tephrosia hamiltonii (Fabaceae), Crotalaria pallida (Fabaceae), Leucaena leucocephala (Fabaceae), Coccinia grandis (Cucurbitaceae), Solanum sisymbriifolium (Solanaceae), Nicotiana glauca (Solanaceae), Physalis minima (Solanaceae), Leucas aspera (Lamiaceae), Leonurus sibiricus (Lamiaceae), Anisomeles indica (Lamiaceae), Parthenium hysterophorus (Asteraceae), Tridax procumbens (Asteraceae), Mikania scandens (Asteraceae), Eclipta prostrata (Asteraceae), Eragrostis tenella (Poaceae), Chrysopogon aciculatus (Poaceae), Eleusine indica (Poaceae), Vanda tasellata (Orchidaceae). 5. Laboratory Records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination. 6. Field Excursion: Local Excursions (at least two including one to Acharya Jagadish Chandra Bose Indian Botanic Garden, Shibpur, Howrah). 7. Field Records: Field note-book and 15 herbarium sheets of common angiospermic weeds are to be prepared and submitted at the time of Practical Examination. Module VI 50 Marks 1. Plant Physiology: i) Experiment on Plasmolysis. ii) Measurement of leaf area (graphical method) and determination of transpiration rate per unit area by weighing method. iii) Imbibition of water by dry seeds - proteinaceous and fatty seeds. iv) Evolution of O<sub>2</sub> during photosynthesis (using graduated tube). v) Evolution of CO<sub>2</sub> during aerobic respiration and

measurement of volume. 2. Anatomy: Anatomical studies (following double-staining method) of: i) Stem: Cucurbita, Maize. ii) Root: Gram, Orchid. iii) Leaf: Nerium, Tuberose. 3. Cell Biology: i) Staining (Aceto-orcein) and squash preparation of onion root tip: study of mitotic stages. ii) Determination of mitotic index (from onion root tip). 4. Identification with reasons: i) Cytological slides of different mitotic and meiotic stages. 5. Laboratory Records: Laboratory note books (regularly signed) and slides (prepared in class) are to be submitted at the time of Practical Examination.

Page 28

28 DISTRIBUTION OF MARKS (PAPER-III) Time : 6 Hours Full Marks-100 Module V 50 Marks 6. Work out on Algae/Fungi (anyone) 9 7. Work out on Angiosperms 12 8. Identification: (2 x 7) 14 Algae/Fungi-1, Bryophyte-1, Pteridophyte-1, Gymnosperm-1, Morphology-1, Angiosperms-2 (species and family). 9. Submission: Laboratory records (laboratory note-book, slides) and Field records (field note book, herbarium sheets). (5+5) = 10 10. Viva-voce 5 Module VI 50 Marks 6. Plant Physiology Experiment 12 7. Anatomy 12 8. Cell Biology 10 9. Identification: (3x2) Anatomy-1, Cytology-1 6 10. Submission: Laboratory records 5 5. Viva-voce 5 PART III Full Marks-100 (Theoretical-70 & Practical-30) Paper-IVA (Theoretical) Marks-70 Module VII 1. Biofertilizer: 1.1 Sources 1.2 Production, 1.3 Application. 2. Mushroom: 2.1 Food value, 2.2 Cultivation technique of Pleurotus. 3. Plant disease control: 3.1 Quarantine, 3.2 Biological control, 3.3 Chemical Control. 4. Plant Breeding: 4.1 Mass and Pure line selection, 4.2 Heterosis and hybrid seed production.

Page 29

29 5. Biometry: 5.1 Measures of Central Tendency (Mean, Mode and Median), 5.2 Goodness of fit (Chi-square test). 6. Plant tissue culture: 6.1 Callus culture and plant regeneration, 6.2 Micropropagation, 6.3 Somatic embryogenesis and Artificial seed, 6.4 Protoplast culture and applications. 7. Recombinant DNA Technology: 7.1 Recombinant DNA, restriction enzymes, plasmids as vector, 7.2 Gene cloning (basic steps), 7.3 Transgenic plants. 8. Pharmacognosy: 8.1 Scope and importance, 8.2 Secondary metabolites-alkaloids, terpenoids, phenolics and their functions, 8.3 Organoleptic evaluation of crude drugs. Paper-IVB (Practical) 30 Marks Module VIII 1. Acquaintance with laboratory instruments - Autoclave, Incubator, Clinical centrifuge, Analytical balance, pH Meter, Colorimeter, Water bath, Distillation plant. 2. Sterilization technique by autoclaving. 3. Preparation of PDA medium (slants, pouring of plates). 4. Bacteria staining by simple staining method (methylene blue/crystal violet) from curd. 5. Acquaintance with common medicinal plants and their useful parts : Terminalia arjuna, Centella asiatica, Saraca asoca, Adhatoda vasica, Andrographis paniculata, Asteracantha longifolia, Eclipta alba, Aloe barbadensis, Rauwolfia serpentina, Vitex negundo, Herpestis monieria, Holarrhena antidysenterica, Boerhaavia repens. 6. Determination of Goodness of fit of normal monohybrid ratios (3: 1 and 1: 1) by Chi-square analysis. 7. Visit to a Medicinal Plant Garden. DISTRIBUTION OF MARKS (PAPER - IVB) Module VIII Time : 3 Hours Full Marks-30 7. Microbiology 5 8. Biometry 8 9. Demonstration of a laboratory instrument 4 10. Identification of medicinal plants (2 x 2) 4 11. Submission (Laboratory note book & Field report) 4 12. Viva-voce 5

Page 30

30 QUESTION PATTERN OF BOTANY (GENERAL), C.U. Type ('A', 'B', 'C') of questions of 1, 5, 10 marks each, respectively. Paper-I Module I (50) Q.1. 'A' Type Questions- 10 marks (10 to be answered out of 15)  $1 \times 10 = 10$  (3 questions to be set from each group) Q.2. 'B' Type Questions-10 marks (2 to be answered out of 5)  $5 \times 2 = 10$  (1 question to be set from each group) Q.3. 'C' Type Questions-30 marks (3 to be answered out of 5)  $10 \times 3 = 30$  (1 question to be set from each group) Module II (50) Q.1. 'A' Type Questions- 10 marks (10 to be answered out of 15)  $1 \times 10 = 10$  (3 questions to be set from each group) Q.2. 'B' Type Questions-10 marks (2 to be answered out of 5)  $5 \times 2 = 10$  (1 question to be set from each group) Q.3. 'C' Type Questions-30 marks (3 to be answered out of 5)  $10 \times 3 = 30$  (1 question to be set from each group) Paper-II Module III (50) Q.1. 'A' Type Questions- 10 marks (10 to be answered out of 15)  $1 \times 10 = 10$  (5 questions to be set from Anatomy &

Page 31

31 10 questions to be set from Cell Biology & Genetics) Q.2. 'B' Type Questions-10 marks (2 to be answered out of 5)  $5 \times 2 = 10$  (1 question to be set from Anatomy & 4 questions to be set from Cell Biology & Genetics). Q.3. 'C' Type Questions-30 marks. a. Anatomy-1 question to be answered out of two..... $10 \times 1 = 10$  b. Cell Biology & Genetics -2 question to be answered out of three.. $10 \times 2 = 20$  Module IV (50) Q.1. 'A' Type Questions- 10 marks. (10 to be answered out of 15.  $1 \times 10 = 10$ , (10 questions to be set from Plant Physiology & Biochemistry and 5 questions to be set from Ecology+ Economic Botany) Q.2. 'B' Type Questions-10 marks. (2 to be answered out of 5)  $5 \times 2 = 10$ , (1 question to be set from Ecology, 1 question to be set from Economic Botany and 3 questions to be set from Plant Physiology & Biochemistry) Q.3. 'C' Type Questions-30 marks. a. Ecology + Economic Botany-1 question to be answered out of two..... $10 \times 1 = 10$  b. Plant Physiology & Biochemistry -2 questions to be answered out of three.. $10 \times 2 = 20$  Paper-III (Practical) Module V & VI Paper-IVA Module VII (70 Marks) Q.1. 'A' Type Questions-  $1 \times 15 = 15$  marks (15 to be answered out of 20) Q.2. 'B' Type Questions- $5 \times 3 = 15$  marks (3 to be answered out of 5) Q.3. 'C' Type Questions- $10 \times 4 = 40$  marks (4 to be answered out of 6) Paper-IVB Module VIII (30 Marks) - Practical Suggested Readings Like 2007