Paper 21- BTHT 610: PLANT METABOLISM AND BIOCHEMISTRY

THEORY **Marks: 100**

Unit 1: Enzymes (Ch 9 Salisbury & Ross, Ch 6 Nelson & Cox) (6 Periods)

Historical background, classification, nomenclature and importance of enzymes; role of enzymes as catalysts; physiochemical and biological properties; concept of holoenzymes; coenzyme; apoenzyme and prosthetic groups; mechanism and kinetics of enzyme action; enzyme inhibitors; isoenzymes; allosteric enzymes; industrial aspects of enzymology.

Unit 2: Carbon Assimilation (Ch 6 Hopkins & Huner, Ch 11 Salisbury & Ross) (10 Periods)

Role of chlorophylls and accessory pigments; antennae molecules and active center molecules; evidences for two photosystems; reduction of NADP; photophosphorylation; reduction of CO_2 into glucose; Benson and Calvin cycle; Hatch and Slack pathway; Crassulacean acid metabolism; energetics of CO_2 reduction; factors affecting CO_2 reduction.

Unit 3: Carbohydrate Metabolism (Ch 7 Nelson & Cox, Ch 13 Buchanan et al.) (6 Periods)

Structure, properties and importance of mono-, di- and polysaccharides; Synthesis of di - (sucrose) and polysaccharides (starch and cellulose).

Unit 4: Carbon Oxidation: (Ch 10 Hopkins & Huner, Ch 11 Salisbury & Ross) (10 Periods)

Glycolysis, anaerobic conversion of pyruvate into ethanol or lactate, energy balance, reversibility and inhibition of glycolysis, Pasteur effect, oxidative decarboxylation of pyruvate into acetyl CoA, TCA cycle, oxidative phosphorylation, oxidation of RuBP (photorespiration), factors affecting oxidative processes, regulation of TCA cycle, role of glyoxalate cycle.

Unit 5: Nitrogen and Protein Metabolism (Ch 3,4, 22 Nelson & Cox, Ch 4 Elliott) (8 Periods)

Biological nitrogen fixation and nitrogen cycle, Catabolism of amino acids, ammonia assimilation, transamination, deanimation, structure and general properties of amino acids and proteins (protein folding).

Unit 6: Lipid Metabolism (7 Periods)

Structure, properties, classification and functional significance of fatty acids, triglycerides and steroids; Synthesis and breakdown, formation of glycerides; oxidation of fatty acids, beta oxidation; energy balance. **(Ch 10 Buchanan et al, Ch 10, 21 Nelson & Cox)**

Unit 7: Intermediary Metabolism (Ch 15 Nelson & Cox), (Ch 11,12,13 Elliott) (4 Periods)

Interrelationship of carbohydrates, lipids and protein metabolism.

Unit 8: Regulation of Metabolism (Ch 6, 18 Nelson & Cox) (4 Periods)

Nature of integrated metabolism, role of acetyl CoA, control at the level of transcription and translation, control of enzyme action.

Unit 9: Secondary Metabolites and Plant Defense (Ch27 Hopkins & Huner) (5 Periods)

Introduction to alkaloids, phenolics, plant terpenes, phytoalexins, sesquiterpenes and sterols.

BTHP 610: PLANT METABOLISM AND BIOCHEMISTRY

PRACTICALS **Marks: 50**

1. Detection of the presence of plant enzymes amylase, catalase, nitrate reductase urease (*in vivo*)] in various sources.
2. To study properties (thermolability, proteinaceous nature and specificity) of any one of the enzymes (catalase/urease).
3. To study the effect of various factors (concentration, temperature, pH, inhibitor) on the activity of catalase enzyme.
4. Demonstration of dye reduction by isolated chloroplasts.
5. Study the effect of different factors on O_2 evolution during photosynthesis and demonstrate the Law of limiting factors.
6. Chemical separation of chloroplast pigments and determination of their absorption spectra.
7. To extract anthocyanin pigments and study the effect of pH on their absorption spectra.
8. Study of the rate of aerobic respiration and respiratory quotient in different plant parts/materials.
9. Identification tests for carbohydrates (Fehling's test, Benedicts test) and proteins (Ninhydrin test, Xanthoproteic test).
10. Preparation of standard curve for estimation of proteins and determination of total proteins in plant tissue extracts for example of control and GA_3 treated embryo-less wheat grains.
11. Separation and identification of amino acids by thin layer chromatography.

SUGGESTED READINGS

1. Conn, E.E., Stumpf, P.K. and Bruening, G. (2006) Outlines of Biochemistry, 4th Edition, John Wiley and Sons Inc.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Elliot (2009) Biochemistry and Molecular Biology. Oxford Publishers.
4. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
5. Taiz, L. and Zeiger, E. (2006) Plant Physiology, 4th Edition Sinauer Associates Inc. Publishers, Massachusetts, USA
6. Dennis, D.T., Layzell, D.B., Lefebre, D.D. and Turpin, D.H. (1997) Plant Metabolism. Addison Wesley Longman.
7. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
8. Kaul RP (2009) Plant Metabolism. Swastik Publishers and Distributors.
9. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

Paper 22-BTHT 611: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

THEORY **Marks: 100**

Unit 1: Introduction **(Ch 1 Bhojwani & Bhatnagar) (3 Period)**

History and scope.

Unit 2: Anther **(Ch1 Shivanna) (5 Periods)**

Structure, ontogeny; tapetum; structure and functions; micro-sporogenesis; callose deposition and its significance.

Unit 3: Pollen Biology **(8 Periods)**

Microgametogenesis, pollen wall development, MGU (male germ unit) structure, NPC system, pollen wall proteins; pollen viability, storage and germination; pollen tube structure. **(Shivanna, Ch 2-4)**

Unit 4: Ovule **(8 Periods)**

Structure, ontogeny, types; special structures – endothelium, operculum, obturator, aril, arillode, caruncle, hypostase, epistase: female gametophyte – megasporogenesis and megagametogenesis: organization and ultrastructure of mature embryo sac. **(Ch 7 Bhojwani & Bhatnagar)**

Unit 5: Pollination and Fertilization **(8 Periods)**

Pollination types and significance; adaptations; pollination biology; pollen-pistil Interaction; structure of stigma and style; double fertilization. **(Ch 9,11 Raghavan)**

Unit 6: Self Incompatibility **(6 Periods)**

Basic concepts; methods to overcome self incompatibility. **(Ch 9 Shivanna, Ch Raghavan)**

Unit 7: Endosperm **(7 Periods)**

Types, development and functions; endosperm haustoria. **(Ch 11 Bhojwani & Bhatnagar)**

Unit 8: Embryogenesis **(6 Periods)**

Classification, development, organization and differentiation of crucifer and Najas embryo; embryo – endosperm relationship; physiological and genetical control. **(Raghavan)**

Units 9: Polyembryony and Apomixis **(7 periods)**

Introduction; classification; causes and applications. **(Ch 13,14 Bhojwani &Bhatnagar)**

BTHP 611: REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

PRACTICALS **Marks: 50**

1. Photographs of eminent embryologists.
2. Anther: wall and its ontogeny; tapetum; microsporogenesis, stages; psuedomonads, massulae (slides and fresh material).
3. Pollen grains: fresh and acetolysed, ornamentation and aperture; pollen viability: tetrazolium test.
4. Pollen germination: in different media; calculation of percentage germination; male germ unit (MGU): through photographs.
5. Ovule: types; unitegmic, bitegmic; tenuinucellate and crassinucellate; special structures-endothelium, operculum, obturator, hypostase and epistase; caruncle and aril (permanent slides/ specimens/photographs).
6. Female gametophyte through permanent slides/ photographs: types and ultrastructure of mature embryo sac.
7. Style and stigma through suitable preparations: unpollinated and pollinated stigma and style; wet and dry stigma; hollow and solid styles; tracing and path of pollen tube.
8. Intra-ovarian pollination; test tube pollination/ fertilization: through photographs.
9. Endosperm: dissections of developing seeds for free-nuclear endosperm with haustoria; types (permanent slides).
10. Embryogenesis: study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various developmental stages; study of suspensor through electron micrographs.

SUGGESTED READINGS

1. Raghavan, V. 2000 Developmental Biology of Flowering plants, Springer, Netherlands.
2. Raghavan, V. 1997 Molecular embryology of flowering plants. Cambridge, University Press.
3. Shivanna, K.R. 2003 Pollen Biology and Biotechnology, Science Publishers.
4. Bhojwani, S.S. and Bhatnagar SP 2004 The Embryology of Angiosperms, Vikas Publishing House
5. Johri, B.M. l;1984 Embryology of Angiosperms, Springer-Verlag, Netherlands.

Paper 23-BTHT 612: PLANT BIOTECHNOLOGY

THEORY **Marks: 100**

Unit 1: Plant Tissue Culture (Ch 1, 3, 5-7,12, 17, 18 Bhojwani & Razdan) (12 Periods)

Historical perspective; composition of media; nutrient and hormone requirement; totipotency; organization; physic-chemical conditions for propagation of plant cells and tissues; somatic embryogenesis; protoplast isolation culture and fusion; cybrids micropropogation; androgenesis. Tissue Culture Applications

Unit 2: **Tools and Techniques of Genetic Engineering**

(Brown, Sambrook & Russel- "Introduction" section of relevant chapters) (12 periods)

Restriction Endonucleases (history, types and role); Gel Electrophoresis; PCR; Restriction Mapping; DNA Sequencing (Sanger's method); Southern, Northern and Western blotting; construction of genomic library; DNA Fingerprinting (RAPD, RFLP); FISH.

Unit 3: Plant Transformation Technology (Ch 3, 4 Slater et al.; Ch 10 Raven) (12 periods)

Obtaining gene of interest by different methods; Gene constructs; Gene transfer – prokaryotic and eukaryotic vectors; *Agrobacterium*-mediated transformation; Direct gene transfer methods– Electroporation, Microinjection, Gene-gun; Selection of transgenics - marker and reporter genes.

Unit 4: Role of Plant Biotechnology in Agriculture, Environment and Industry

(Ch 7 Chrispeel & Sadava, Ch 10 Raven) (18 periods)

Pest resistant plants (Bt-cotton); herbicide resistance; disease and stress resistant plants; transgenic crops with improved quality traits (Flavr savr tomatoes, Golden rice); Role of transgenics in degradation of pollutants (Superbug) leaching out of minerals; Application of plant biotechnology for production of quality oil, industrial enzymes, edible vaccines and planti-bodies.

BTHP 612: PLANT BIOTECHNOLOGY

PRACTICALS **Marks: 50**

1. Preparation of media MS (1962), Nistch (1969) and White's medium
2. Aseptic culture of different explants, methods of *in vitro* sterilization, inoculation and subculture methods
3. Construction of Restriction Map from the data provided.
4. Study of Genetic engineering Techniques (photographs): FISH , DNA Fingerprinting, DNA Sequencing , Gene gun, Ti plasmid.
5. Calculation of percentage similarity between different cultivars of a species using RAPD profile (by binary method) and study of Dendrogram.
6. Demonstration of Southern, Northern and Western Blotting
7. Study of steps of genetic engineering techniques from photographs (Bt cotton, Golden rice, Flavr savr tomatoes)

SUGGESTED READINGS

1. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.
2. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
3. Chrispeel, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones and Barlett Publishers.
4. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Narosa Publishing House.
5. Smith, R. 2000 Plant Tissue Culture: Techniques and Experiments, 2nd edition, Academic
6. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
7. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rd edition. Benjamin Co.
8. Raven, P.H., Johnson, GB., Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
9. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
10. Sambrook & Russel. Molecular Cloning: A laboratory manual. (3rd edition)

Paper 24- GGHT 602: GENETICS AND GENOMICS II

THEORY **Marks: 100**

Unit 1. Genetic Analysis and Mapping in Bacteria and Bacteriophages (Ch 6, Klug and Cummings/ Ch 5, Griffith *et al.*)

Conjugation; Transformation; Transduction, Recombination.

Unit 2. Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses (Ch 22, Klug and Cummings/ Ch 14, Griffith *et al.*)

Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in *Drosophila*; Uses of transposons; Eukaryotic Viruses.

Unit 3. Developmental Genetics and Model System (Ch 19, Klug and Cummings*)*

Study of model systems in developmental genetics- *Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana,* and *Xenopus laevis*.

Unit 4. Genomics, Bioinformatics and Proteomics (Ch 21, Klug and Cummings/Ch 8-9, Russell/ Ch2, 3, 4 Ghosh, Z. and Mallick,V.)

Genomes of bacteria, *Drosophila* and Humans*;* Human genome project; Evolution and Comparative Genomics.

Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification.

Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

Unit 5. Genomic Analysis- Dissection of Gene Function (Ch 23, Klug and Cummings)

Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology.

Unit 6. Population Genetics (Ch 27, Klug and Cummings)

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Unit 7. Evolutionary Genetics (Ch 28, Klug and Cummings)

Genetic variation and Speciation.

GGHP 602: GENETICS AND GENOMICS II

PRACTICALS **Marks: 50**

1. Genomic DNA isolation from *E.coli* (without plasmid*)*.
2. Restriction enzyme digestion of genomic DNA from *E.coli*.
3. Isolation of plasmid DNA and genomic DNA together from *E.coli*. and restriction enzyme digestion.
4. Restriction enzyme digestion (*EcoR*I) of genomic and plasmid DNA (obtained from Expt.3).
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED BOOKS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. 2006 Principles of Genetics. 8th edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. 2009 Principles of Genetics. 5th edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. 2009 Concepts of Genetics. 9th Edition. Benjamin Cummings.
4. Russell, P. J. 2009 Genetics- A Molecular Approach. 3rd edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. 2003 Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. 2009 Bioinformatics and Functional Genomics. 2nd edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. 9th Edition. Introduction to Genetic Analysis.
8. Ghosh, Z. and Mallick,V. 2008 Bioinformatics-Principles and Applications. Oxford Univ. Press