SEMESTER VIII

Paper I
MBCR4801

Plant Biotechnology II (50 marks)

Unit I. Application of plant transformation for productivity and performance: (A) Herbicide resistance, glyphosate, glufosinate, atrazine (B) Insect resistance, Bt genes, protease inhibitors, alpha amylase, lectins (C) Virus resistance and PDR (D) Disease resistance (E) Bacterial and fungal resistance: chitinase, 1-3 beta glucanase, R genes (F) Transgenic Male sterility (G) Marker elimination from transgenic plants, terminator technology (9 lectures)
(H) Post-harvest losses, long shelf life of fruits, antisense RNA technology, use of ACC synthase, polygalactouronase, ACC oxidase, ethylene-responsive genes, promoter elements (ERE), MADS box and transcription factors (I) Abiotic stress (water, temperature and salt) resistance (response & tolerance): LEA genes, promoters (ABRE, DRE and coupling elements), transcription factors, osmolytes, antioxidants and antioxidative enzymes, polyamines, membrane transporters and SOS pathway, channel proteins and symporters/antiporters, heat shock proteins, cross talk between ABA dependent and ABA independent pathway, kinases in stress signaling (J) Application of small RNA, micro RNA, RNAi and microarray in crop biotechnology (brief outline) (14 lectures)
Unit II. Global status of approved genetically modified plants: Global GM crop database, Biosafety aspects of transgenic plants: environmental risk assessment, food safety assessment, substantial equivalence, toxicological assessment, allergenic potential assessment, discontinued transgenic products (3 lectures)
Unit III. Chloroplast transformation: chloroplast genome, advantages of chloroplast transformation, marker genes, transformation methods, designing of plastid transformation vectors and expression cassettes, homoplastomic and heteroplastomic lines, applications and limitations (3 lectures)
Unit IV. Molecular farming, metabolic engineering and Industrial products: (A) Advantages and disadvantages of transgenic plants as bioreactors (B) Phenyl propanoid pathway and shikimate pathway (C) Engineering for improved nutrition: amino acid content, carotenoids, Golden rice, iron and ferritin, vitamins (vitamin E) (D) Metabolic engineering of carbohydrates and lipids, ADP-glucose pyrophosphorylase (E) Polyhydroxybutyrate and Bioplastics (F) Production of industrial enzymes (G) Production of plantibodies, edible vaccines and other therapeutic proteins (H) alkaloid production (I) Oleosin technology for purification of pharmaceutical proteins (7 lectures)

Teachers involved:
Dr. D. Chakraborti [Unit I (A) to (G) and II]
Dr. A. Roy Choudhury [Units I (H) to (J), III and IV]

Recommended Texts:
1) Plant Biotechnology: The Genetic Manipulation of Plants - Adrian Slater, Nigel W. Scott, Mark R. Fowler – Chapters 5, 6, 7, 8, 9, 10, 11, 12, 13; 2) Introduction to Plant Biotechnology – H.S. Chawla – Chapters 24, 25, 27; 3) Plant Physiology, Taiz and Zeiger (4^{th} Ed) – Chapters 22, 23, 26; 4) Relevant research papers will be provided on selective topics

MBCR4851

Plant Biotechnology Practical II (50 marks)

Physiology: Determination of transpiration rate per unit area of leaf
Biochemistry:

i) Colorimetric estimation of IAA
ii) Assay of enzymes: catalase, peroxidase
iii) Detection of phenolics

Protein profiling from plant tissues:
i) SDS-PAGE for qualitative detection
ii) In-gel analysis of isoenzymes
Biochemical analyses of plant metabolites:
i) Qualitative: detection of carbohydrates, amino acids, proteins and tannins
ii) Quantitative: estimation of total carbohydrates, total amino acids and proline

Teachers involved
Dr. R. Nag Chaudhuri (Physiology and Biochemistry experiments)
Dr. A. Roy Choudhury (Protein profiling from plant tissues; Biochemical analyses of plant metabolites)

Paper II
MBCR4802

Animal Biotechnology II (50 marks)

Unit I: Techniques for cell and tissue culture: Standard techniques and equipment for animal cell and tissue culture, the role of carbon dioxide, culture media and its components, the role of serum, serum and serum free cultures. (3 lectures)
Unit II: Mammalian cell culture: Primary and established cell line cultures, measurement of growth and viability, contamination, establishment of a primary culture and sub culturing, maintenance of attached and suspended cell lines. (3 lectures)
Unit III: Cancer and tumour progression: (a) Stages of cancer and tumour progression, carcinogens, metastasis and formation of secondary tumours, models for cancer propagation, stem cells and cancer.
(b) Proteases in invasion with reference to the matrixmetalloproteinases (MMPs), their mechanism of activation and role in cancer. (8 lectures)
Unit IV: Genetic basis of cancer: (a) Oncogenes and proto-oncogenes, retroviral oncogenes.
(b) Tumour suppressor genes, the role of pRb and p53. (5 lectures)
Unit V: Cancer cell signalling: Signal transduction cascades in cancer with reference to integrin and growth factor mediated signalling, role of focal adhesion kinase. (3 lectures)
Unit VI: Molecular markers in detection of cancer: molecular diagnosis of Burkitt's lymphoma, chronic myeloid leukemia and carcinomas. (2 lectures)

Unit VII: Pest control and management: (a) Introduction to pests, types of pests (b) Insecticides, biological and chemical control of insect pests (c) Integrated pest management: principles and significance. (6 lectures)

Unit VIII: Parasitology and vector biology: (a) Parasitism, types of parasites and hosts, concept of host parasite interaction (b) Overview of major parasitic diseases and management (c) Role of insects as vectors of human diseases. (6 lectures)

Teachers involved:
Dr. A. Banerji (Units I-VI)
Dr. P. De (Units VII,VIII)

Recommended Texts:
1) Culture of Animal Cells – a Manual of Basic Techniques. R.I. Freshney (6th ed.). Chapters 3, 4, 8, 11, 12 (Units I, II)
2) The Biology of Cancer. R.A. Weinberg (1^{st} ed.). Chapters 2 (Unit III), 4 (Unit IV), 5 (Unit V), 8, 9 (Unit IV), 14 (Unit III).
3) The Cell – A Molecular Approach. G.M. Cooper, R.E. Hausman (5^{th} ed.) Chapter 18 (Units III, IV)
4) Relevant scientific literature (Units III – VI).
5) Introduction to Insect Pest Management- Robert L. Metcalf, William H. Luckmann- Ch 1, 2, 5, 6 (Unit VII).
6) Insect Pest Management- David Dent-Ch 1,4,6,10 (Unit VII).
7) Human Parasitology-Burton J. Bogitsh, Clint E. Carter, Thomas N. Oeltmann (4^{th} Ed)- Ch 1 (Unit VIII)
8) Kuby Immunology - Kindt, Goldsby & Osborne (6^{th} Edition): Ch 17 (Unit VIII)
9) Medical Parasitology- Bhatia (3^{rd} Ed)-Ch 3-6, 9, 14,15, 28, 30,31. (Unit VIII)

MBCR4852

Animal Biotechnology Practical II (50 marks)

Unit I: Study of blood: study of leucocytes, estimation of haemoglobin, determination of blood groups.
Unit II: Cell and tissue culture: preparation of media, adhesion culture techniques, separation of lymphocyes and suspension culture techniques, maintenance of cell cultures, cell count and determination of viability.
Unit III: Estimation of cellular proteins and enzymes: Estimation of total protein, visualization of proteins by SDS-PAGE, determination of enzyme activity.
Unit IV: Analytical detection of physiologically important substances: Qualitative detection of physiologically important substances e.g. glycerol, urea, bile salts, acetone, HCl, lactic acid, uric acid.
Unit V: Chromosome studies: Study of meiotic chromosomes, visualization of Barr bodies.

Teachers involved:
Dr. A. Banerji
Dr. P. De

Paper III
MBCR4803

Environmental Biotechnology

Unit I: Phytoremediation: Different processes; Plant species used; hyperaccumulators, phytochelatins and their regulation. [5 lectures]
Unit II: Plant Toxicology: toxins produced during plant pathogen attack; classifications; their mode of actions with examples; diseases caused by toxins; mycotoxins and aflatoxin. [3 lectures]
Unit III: Pharmacognosy: Preparation of drugs; drug evaluation: organoleptic, microscopic, biological, chemical and physical; Drug adulteration; Active principles of drugs and their uses; representative examples from some medicinal plants (4 lectures]
Unit IV: Animal Toxicology: (a) Overview of ecotoxicology, types of toxicity (for example, hepatotoxicity, cardiovascular toxicity, neurotoxicity) (b) Levels of toxicity (acute, subacute, chronic). (c) Drug toxicity in humans: Toxicokinetics and toxicodynamics. (5 lectures)
Unit V: Air Pollution: (a) Global warming (causes, effects and management) (b) Ozone depletion, ground level ozone pollution (c) Acid rain and photochemical smog (c) Air quality management and control. (5 lectures)
Unit VI: Water Pollution and Water Treatment: (a) Eutrophication: causes and remediation (b) Groundwater pollution with reference to arsenic pollution (c) Water treatment – (1) treatment of municipal drinking water supplies (in cities and towns), (2) treatment of waste water: (i) large scale sewage treatment by municipalities in cities and towns, including primary, secondary (aerobic – trickling filter and activated sludge digestion, anaerobic – anaerobic sludge digestion) and tertiary treatments; and (ii) small scale sewage treatment in small homes in towns and rural areas (septic tank and oxidation ponds / lagoons); (d) Ganga Action Plan. (PD-2 lectures + SR - 9 lectures)

Teachers involved:
Dr. A. Roy Choudhury (Units I, II and III)
Dr. P. De (Units IV, V, VI-a & b)
Prof. S. Roy (Units VI-c & d)

Recommended texts:
Unit I: 1) Ecology and Environment – P.D. Sharma Ch. 20
2) Review articles will be provided on the sub-topics
Unit II: Plant Pathology – R.S. Singh (3^{rd} Ed) – Ch. 11
Unit III: Studies in Botany – D. Mitra, J. Guha, S.K. Chaudhuri (Section IV) – Ch. 1, 2
Unit IV & V & VIa &V b:
1) Fundamental of Ecology – M.C. Dash (2nd Ed) - Ch 8 (Unit V, Va & Vb), Ch 9 (Unit IV)
2) Ecology: Principles and Applications – J.L. Chapman and M.J. Reiss (2nd Ed) - Ch 13(Unit V).
3) Environmental Biology (2^{nd} Ed) - P.D. Sharma - Ch 6 (Unit V).
4) Ecology And Environment - P.D. Sharma (10^{th} Ed)- Ch 16, 17 (Unit V), Ch 18 (Unit VIa & Vb) Ch-19 (Unit IV).
5) Biochemical Pharmacology Lecture Notes - Michael Palmer (3rd Ed)- Ch 1-3 (Unit IV)

Unit VI-c:
1) Brock Biology of Microorganisms – Madigan, Martinko, Dunlap and Clark (12^{th} Edition) – Chapter 36.
2) Prescott's Microbiology - Willey, Sherwood and Woolverton (8^{th} Edition) – Chapter 42.

3) Fundamental Principles of Bacteriology – Salle (7th Edition) (Reference) –Chapter 21.

Unit VI-d:

Relevant scientific literature.

MBCR4813

Annual viva voce

Course material covered in Semesters I-VIII.

Paper IV

MBCR4804

X-ray Crystallography + Lab Visit (60 + 10 marks)

I. Crystallography: X-rays and detectors, Crystals and crystal growth, X-ray scattering by atoms and unit cells, Review of Fourier transforms, Scattering by crystals, Bragg's Law. point groups, Bravais lattices, indexing of lattice planes, space groups, A geometric approach to understand the fundamental symmetry elements. (12 lectures)

II. Overview of protein crystallography: Laue conditions, Ewald construction, The Patterson function, Difference electron density maps: 2Fo-Fc, Fo-Fc, omit maps, Isomorphous replacement, Molecular replacement, Refinement, model accuracy. (12 lectures)

III. Sequence – Structure – function Paradigm: Structural motifs in regulatory proteins (DNA recognition, ATPase activity), Receptor families (G proteins in signal transduction), ABC transporters and Multidrug resistance; lac repressor of *E.Coli*, T4 lysozyme and lambda repressor, Virus capsid structure; Recognition of foreign molecules by Immune system (Antibodies and T-cell receptors), Moonlighting. (10 lectures)

Teachers involved:

Dr. J. Dasgupta

Recommended texts:

1. Crystallography made crystal clear by Gale Rhodes: Chapter 1-7
2. Atomic and Nuclear Physics by SN Ghoshal: Chapter- X-rays
3. Crystallization of Nucleic Acids and Proteins: A Practical Approach by Arnaud Ducruix and Richard Giegé: Chapters: Crystallization of protein.

MBCR4814

Protein Folding and Chaperones (30 marks)

Seminar Presentations on the following topics:

1. Molten globules and protein folding: Importance of is molten globule for correct protein folding, the molten globule state: the physical picture and biological significance, implications in disease.

2. Protein misfolding and disease: Functional amyloid--from bacteria to humans, the biological and chemical basis for toxicity of amyloid.
3. Co-translational protein folding: The ribosome as a platform for co-translational processing, folding and targeting of newly synthesized, Cotranslational protein folding at codon resolution.
4. Protein Engineering: A general overview of biotechnology applications, A faster-acting and more potent form of tissue plasminogen activator, Control of oligomeric enzyme thermostability by protein engineering. [CB =24 lectures]

5. Protein folding: Theory of Protein folding, The protein folding problem, From Levinthal to pathways to funnels.
6. Heat shock protein and molecular chaperone: Molecular chaperone functions of heat shock proteins, Chaperones in control of protein disaggregation.
7. α-Crystallin as molecular chaperone: A review of its structure and function, Temperature-induced exposure of hydrophobic surfaces and its effect on the chaperone activity of α-crystallin, Oligomerization and chaperone function.
8. GroEL-GroES as molecular chaperone: Chaperonin, Effect of divalent cations on the exposure of hydrophobic surfaces and hydrophobic binding interactions. [SS =12 lectures]

Teachers involved:
Dr. C. Barat
Dr. S. Saha