SEMESTER VI

Paper I
MBCR4601

Part A: Ecology and Environmental Science (50 marks)

Unit I: The Environment: physical and biotic environment; biotic and abiotic interactions with model examples [4 lectures]
Unit II: Ecosystem: Components of ecosystem, energy flow in ecosystem; ecosystem productivity, food chain and food web, tropic levels and ecological pyramids, concept of terrestrial and aquatic ecosystems. (8 lectures)
Unit III: Habitat and niche: Concept of habitat and niche; fundamental and realized niche; niche overlap; resource partitioning; character displacement. (4 lectures)
Unit IV: Ecological succession: Types; mechanisms; changes involved in succession; seral types; concept of climax. [3 lectures]
Unit V: Community ecology: Nature and types of communities; community structure and attributes; various approaches for community study and statistical parameters: levels of species diversity and its measurement; edges and ecotones [5 lectures]
Unit VI: Population ecology: Characteristics of a population, survivorship curves, population growth curves, r and K selection, deme, concept of metapopulation. Population regulation: concept of density dependant and independent factors, role of extrinsic and intrinsic factors, Gause's principle. (9 lectures)
Unit VII: Species interactions: Types of interactions, interspecific competitions, symbiosis. (3 lectures)

Teachers involved:
Dr. A. Banerji (Units VI, VII)
Dr. A. Roy Choudhury (Units I, IV and V)
Dr. P. De (Units II and III)

Recommended texts:
1) Ecology: Principles and Applications. J.L. Chapman and M.J. Reiss (2^{nd} ed.). Chapters 4, 5 (Unit VI), 8, 10, 19 (Unit VII)
2) Fundamental of Ecology. M.C. Dash (2^{nd} ed.). Chapter 6 (Unit VI)
Units I, IV and V:
Ecology and Environment – P.D. Sharma (Chapters 2, 3, 4, 8, 9)
Environmental Biology – P.S. Verma and V.K. Agarwal (Chapters 8-11, 13, 14)
Unit II & III:
1) Fundamental of Ecology – M.C. Dash (2^{nd} Ed)- Unit II (Ch 2-4), Unit III (Ch 1).
2) Ecology-E.P.Odum (2^{nd} Ed) – Unit II (Ch 2-4).
3) Ecology: Principles and Applications – J.L. Chapman and M.J. Reiss (2nd Ed)- Unit II (Ch 11, 12, 15), Unit III (Ch 10)
4) Ecology And Environment - P.D. Sharma (10^{th} ed)- Unit I (Ch 10,11)

Part B: Bioinformatics II [50 Marks: 20(Th)+10 (CIA)+20(Project)]

Simulation and Protein-Protein interactions: Molecular-Force-Field Model, Energy Minimization, Molecular Dynamics, Solvent-Accessible Surface of a Protein, Protein-protein interaction. [10 lectures]

Overview of RNA Structure prediction: Structure Prediction, Types of RNA Structures, Secondary Structure Prediction Methods (Ab Initio & Comparative Approaches), RNA Tertiary Structure. [6 lectures]

Phylogenetic Analysis and Prediction: Relationship of phylogenetic analysis to sequence alignment, Genome complexity and phylogenetic analysis, The concept of evolutionary trees, methods: Maximum parsimony, Distance, Fitch and Margoliash, neighbor-joining, unweighted pair and other methods, converting sequence similarity to distance scores, application to nucleic acid & protein sequences, Reliability of phylogenetic predictions, Complications from phylogenetic analysis, Molecular Evolution and Molecular Phylogenetics, Gene Phylogeny versus Species Phylogeny, Forms of Tree Representation. [8 lectures]

Practical: Bioinformatics project

Teachers involved:
Dr. J. Dasgupta (Structural Bioinformatics and Overview of RNA Structure prediction)
Guest Professor (Phylogenetic Analysis and Prediction)

Recommended texts:
1. Instant notes in Bioinformatics by DR Westhead, JH Parish, RM Twyman: Chaper: Section G
2) Bioinformatics by Mount: Chapter 8

Paper II
MBCR4602

Recombinant DNA Technology I (50 marks)

Cloning – cloning overview-general scheme **[RNC: 2 classes]**
Enzymes in cloning - DNA Polymerases (DNA Pol 1, T4, T7, Taq), nucleases (DNases, exonucleases, RNases), restriction endonucleases, ligases, alkaline phosphatase, glycosylases, polynucleotidekinases, transferases, topoisomerases, reverse transcriptases, RNA polymerases, ribonuclease inhibitors **[RNC: 6 classes]**
Polymerase Chain Reaction (outline) **[RNC: 2 classes]**
Inserts - Genomic DNA, cDNA, PCR products **[RNC: 4 classes]**
Cloning and subcloning strategies - Construction of recombinant DNA – linkers, adapters, homopolymer tailing, TA cloning. Competent cells preparation- transformation, transfection, transduction. **[RNC: 6 classes]**
Recombinant DNA screening and detection - drug resistance, blue-white screening, colony hybridization, plasmid isolation. Recombinant DNA clone confirmation by restriction digestion, PCR. Sequencing the recombinant DNA **–** Sanger dideoxy method**.[RNC: 4 classes]**
Vectors – plasmid biology (plasmids as vectors), pBR322, an early example of a cloning vector; bacteriophage λ derived vectors – insertional (λgt10 and λgt11) and replacement (EMBL3 and EMBL4) vectors; special purpose vectors – phasmid λZAP and BAC vectors (outline) for cloning large DNA segments; M13 derived ss-DNA vectors (pBluescript SK^+) for DNA sequencing;

expression vectors – specialized vectors with strong controllable promoters like λP_L, T7, (pET vector in host BLDE3) *trc*, *tac*, *BAD*; *lac* promoter leakiness – *lacIQ* and *lacISQ*; optimizion of translation and increasing protein stability (BL21 host); usage of purification tag – *myc*, His, GST, CBP (pBADHis, pGEX,pCAL-n-EK); protein solubility - inclusion bodies; signal peptide sequence for recombinant protein export (pBAD/*gIII* A,B,C); the Gateway cloning system; cloning in *B. subtilis* (pMUTIN). **[US:12 classes]**

Teachers involved:
Dr. U Siddhanta (Vectors only)
Dr. R. Nag Chaudhuri

Recommended texts:
1) Principles of Gene Manipulation & genomics-Primrose & Twyman; Chapters 2-5; Chapter 6-7, 10
2) Molecular Cloning- Sambrook et al; Chapters:1, 6, 8-11.

MBCR4652

Recombinant DNA Technology Practical I (50 marks)

Preparation of competent cells (bacteria – XL1Blue) by $CaCl_2$ method
Transformation of competent cells by plasmid. Calculation of transformation efficiency.
Isolation and agarose gel electrophoresis of plasmid DNA
Restriction digestion of plasmid DNA
Genomic DNA from bacteria (PCR from genomic DNA to amplify an insert (Demonstration)
Genomic DNA from Blood
Recombinant expression of protein in bacteria: Preparation of competent cell (BL21) and their transformation. IPTG induction and SDS PAGE.
Plasmid isolation from *Agrobacterium tumefaciens*
Transformation of *Agrobacterium tumefaciens* with binary vector

Teachers involved:
Dr. C. Barat
Dr. R.N. Chaudhuri
Dr. D. Chakraborti

Paper III
MBCR4603

Plant Biotechnology I (50 marks)

Unit I. Plant Breeding: Mass selection and Pure line selection; Bulk method, Pedigree method and Back cross method; Heterosis; Male sterility and its use in plant breeding. (4 lectures)
Unit II. Plant cell tissue and organ cultures: (A) Concept, scope and culture media; (B) Totipotency; (C) Micropropagation (D) Initiation and maintenance of callus and suspension culture, (E) single cell clone; (F) Aspects of cellular differentiation, morphogenesis, organogenesis and adventative embryogenesis; (G) Shoot-tip culture: rapid propagation and production of virus free

plants. (H) Embryo culture and embryo rescue (I) endosperm culture and triploid plants (J) Cryopreservation (8 lectures)
(K) Somatic embryogenesis and application, artificial seeds; (L) Anther and pollen culture for production of haploid plant, homozygous lines, (M) ovary culture, (N) Somaclonal variation: Causes, types and application (O) Protoplast culture: somatic cell hybridization, fusion methods, selection and applications (P) Production of natural products in tissue culture; (Q) Plant secondary metabolites (biosynthesis of terpenes, phenols and nitrogenous compounds and their roles) (6 lectures)

Unit III. Gene transfer methods: (A) marker genes and selectable markers (B) use of reporter genes, reporter gene with introns (C) constitutive and inducible promoters (D) Chimeric gene vectors (E) Vector mediated plant transformation by *Agrobacterium*: basis for tumor formation, hairy root, features of Ti and Ri plasmid, mechanism of gene transfer, role of virulence genes, use of Ti and Ri as vectors, disarmed, cointegrate and binary vectors (F) particle bombardment (6 lectures)
(G) methods of nuclear transformation, vectorless and direct DNA transfer, electroporation, microinjection (H) viral vectors and their applications (I) use of scaffold attachment regions (J) multiple gene transfers (K) Transgene stability and gene silencing (L) molecular analysis of transgenic plants (M) Generation of homozygous transgenic lines (7 lectures)

Unit IV. Molecular-marker aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR, SSCP, AFLP, molecular marker assisted selection (MAS) (5 lectures)

Teachers involved:
Dr. D. Chakraborti [Unit I, II (A) to (J) and (M); III (G) to (M) and IV]
Dr. A. Roy Choudhury [Unit II – (K), (L), (N), (O), (P), Q; Unit III – (A) to (F)]

Recommended Texts:
Unit I. Plant Breeding - Principles and Methods – B. D. Singh, Seventh edition (Chapter 3, 6, 13, 14, 15, 16, 17, 18)
Unit II. Plant Tissue Culture: Basic and Applied - T.B. Jha and B. Ghosh, First edition (Chapter 1-10; Introduction to Plant Biotechnology – H.S.Chawla, Third Edition (Chapter 1-11) Plant Physiology – Raiz and Zeiger, Fourth edition (Chapter 13); Introduction to Plant Tissue Culture – Razdan, Second edition (Chapter 1-15); Review articles will be provided
Unit III. Introduction to Plant Biotechnology – H.S.Chawla, Third Edition (Chapter 23); The Genetic Manipulation of Plants - Adrian Slater, Nigel W. Scott, Mark R. Fowler, Second edition (Chapter 3, 4)
Unit IV: Plant Breeding: Principles and Methods – B. D. Singh (Chapter 36 and Review articles)

MBCR4653

Plant Biotechnology Practical I (50 marks)

Isolation of plant DNA: Genomic DNA isolation from plant tissues using different methods (Dellaporta, CTAB and TE) and their quantification
Biochemical tests: Organic acids and plant ash analysis
Plant Tissue Culture: Preparation of plant tissue culture media. Sterilization of explants and seeds, Preparation of different explants and initiation of culture, study of direct and callus-mediated organogenesis

Biometry: Chi-square method for testing 'goodness of fit' of seed samples; Calculation of mean, standard deviation and standard error

Teachers Involved:
Dr. A. Roy Choudhury
Dr. D. Chakraborti

Paper IV
MBCH4604

Chemistry VI

Unit I: Oxidation Reactions: Epoxidation; Hydroxylation; Ozonolysis; Oxidation of alcohols with Cr(VI) oxide, $Pb(OAc)_4$, HIO_4.
Reduction Reactions: Catalytic hydrogenation, Birch reduction, Clemensen reduction, Wolff-Kishner reduction, $LiAlH_4$ reduction, $NaBH_4$ reduction.
Rearrangement Reactions: Pinacol-pinacolone rearrangement, Schmidt rearrangement, Hofmann rearrangement, Beckmann rearrangement, Lossen rearrangement, Curtius rearrangement, Wagner rearrangement, Allylic rearrangement, Cumene-peroxide phenol rearrangement, Benzidine rearrangement. (14 lectures)
Unit II: Synthesis of Organic Molecules: Disconnection approach- Concepts of synthons, Synthetic equivalents, Functional group interconversion (FGI), Protection and deprotection of common functional groups in synthetic route, Disconnection of 1,3, 1,4 and 1,5-dioxygenated compounds. Synthesis of some simple drugs- Paracitamol, Aspirin, Brufene, Phenobarbitol, Sulphanilamide, Sulphadiazine. (8 lectures)
Unit III: Bioinorganic Chemistry: Elements of life; Essential major, trace and ultratrace elements; Role of metal ions in biological functions (Na^+, K^+, Ca^{2+}, Mg^{2+}, $Fe^{3+/}Fe^{2+}$, Cu^{2+}/Cu^+, Zn^{2+}); Metal ion transport across biological membrane; Ionophores; Metalloproteins and Metalloenzymes; Oxygen carrying proteins- structure and physiological role of haemoglobin, myoglobin; Electron transport proteins- iron-sulfur proteins, cytochromes; Redox enzymes- Mo, Fe, Cu, Zn-containing redox enzymes; Hydrolytic enzymes- carboxypeptidase A, carbonic anhydrase; Electron transport in respiratory chain; Nitrogen fixation (biological and abiological); Phosphate transfer and metabolic energy; Metal-induced toxicity and chelation therapy; Pt and Au complexes as drugs; Metal dependent diseases; Biochemical effects of some inorganic pollutants. (14 lectures)

Teachers involved:
Dr. S. Saha (Units I and III)
Ms. Moumita Rakshit (Guest Lecturer) (Unit II)

Recommended texts:
1. Advanced General Organic Chemistry- A Modern Approach (Part-I). Sachin Kr. Ghosh (3rd Edition), Chapter 13, 14, 16.
2. Organic Synthesis - the disconnection approach. Stuart Warren, Wiley Student Edition
3. Inorganic Chemistry (Biological and Environmental Aspects) Asim Kr. Das (1st Edition), Chapter 1-9, 12.
4. Elements of Bioinorganic Chemistry- G. N. Mukherjee and Arabinda Das (3rd Edition), Chapter 3, 5-10.

MBCH4654

Chemistry Practical III + Lab-visit

Physicochemical Experiments
(i) Determination of viscosity coefficient and concentration of a given solution with Ostwald's viscometer.
(ii) Determination of the pH of a given buffer solution by colour matching of an indicator.
(iii) Determination of the partition coefficient of iodine between water and an organic solvent.
(iv) Determination of the rate constant of a first order reaction (acid hydrolysis of ester) by titrimetric method.

Lab Visit: **Denaturion of protein:** Calculation of ΔG by unfolding of protein in different concentrations of urea fluorimetrically.

Teacher involved:
Dr. S. Saha
Dr. P. De
Recommended text:
An Advanced Course in Practical Chemistry- A.K.Nad, B.Mahapatra and A.Ghoshal

Paper V

MBCR4615

Part A: Term Paper (50 marks)

(To be declared at the beginning of the semester)

MBCR4616

Part B: Annual viva voce (50 marks)

Course material covered in Semesters I-VI.