SEMESTER IV

Paper I
MBCR4401

Molecular Biology II (100 marks)

Eukaryotic Replication: Differences from prokaryotic replication; DNA polymerases: types; PCNA; ARS; control and regulation; end replication problem; telomeres and telomerase.

[10 lectures]

DNA Damage-Repair: Mismatch repair; damage and mutation – sites and agents; repair systems – photolyase, O^6-methylguanine methyl transferase, base excision, and nucleotide excision (NER in prokaryotes and eukaryotes – GG-NER and TC-NER); double strand break repair; error-prone bypass (SOS) mechanisms. [RNC: 8-10 classes]

DNA Recombination: branch migration; Holliday intermediate; homologous recombination in bacteria – RecBCD, RecA; recombinational DNA repair of stalled replication fork; site-specific recombination (e.g λ integration); transposon – direct and replicative, (e.g. briefly Ig genes assembly); application of homologous and site-specific recombination – targeted gene disruption, and Cre/loxP sysem. [US:10 classes]

Eukaryotic gene transcription and its regulation: [CB =12 lectures]
Promoters, enhancers, transcription factors and regulation of their activities, RNA Polymerases, different structural motifs in DNA binding proteins involved in transcription.
Molecular mechanisms of transcription activation and repression: Gene silencing at telomere, Histone deacetylation and hyperacetylation and chromatin remodeling in transcription control, Actvator/Coactivator interaction, regulation of transcription factor activity, Control at the stages of elongation and termination, RNA interference (a brief outline)

Post-transcriptional gene control and Nuclear transport: RNA processing enzymes, post transcriptional modification of RNA: 5'-cap, 3'end processing and polyadenylation. RNA Splicing, Editing, regulation of pre-mRNA processing, Different modes of splicing of mRNA and tRNA, Nuclear export of mRNA (outline) **[RNC: 12-14 classes]**

Eukaryotic translation and its control; Post-translational processing. [CB =12 lectures]

Teachers involved:
Dr. A. Roy Choudhury (Eukaryotic Replication)
Dr. C.Barat (Eukaryotic gene transcription and its regulation, Eukaryotic translational control)
Dr. U. Siddhanta (DNA Recombination)
Dr. R. Nag Chaudhuri (DNA Damage-Repair, Post-transcriptional gene control and Nuclear transport)

Recommended Text:
Eukaryotic Replication: 1) Lehninger Principles of Biochemistry - Nelson & Cox (5th Ed) Ch. 25
2) Biochemistry - Voet & Voet (4th Ed) – Ch.29
3) Molecular Biology – R.F. Weaver (5th Ed) – Ch 21
DNA Recombination: 1) Lehninger Principles of Biochemistry - Nelson & Cox (5th Ed) Ch.25 (p1003-1012)
2) Biochemistry - Voet & Voet (4th Ed) – Ch.30 (p1225-1236)

Eukaryotic transcription and translation: Molecular Biology (Weaver; 5th Ed.) Pg. 99-109, 245-250, 274-277, 533-538, 548-550; Molecular and Cell Biol.(Lodish 6th Ed.) Pg. 278-314.
DNA Damage-Repair: Introduction to Genetic Analysis (Griffiths et al.): Chapter 15; Review papers
Post-transcriptional gene control and Nuclear transport: Molecular Biology (Weaver) Chapters:14-16; Molecular Cell Biology : Chapter 8.

Paper II
MBCR4402

Part A: Cell Biology III (50 marks)

Unit I: Cell Signaling II: Receptor Tyrosine Kinases – RTK families, mechanism of activation, cell signaling, RTKs as nodes in complex signaling networks, receptor downregulation, RTK mutations in diseases, RTKs as important drug targets; **Cytoplasmic tyrosine kinases** - Src kinases; **Ser/Thr kinases** - Ras/MAPK pathways; **Lipid signaling** – phospholipase C and phosphatidylinositol 3'-kinase (PI3K) pathways; **Monomeric G proteins** – Rho/Rac/Cdc42 and cytoskeleton (very briefly);
Receptor Ser/Thr kinases – TGF-β signaling; **Cytokine receptors** - interferon response to virus infection; **Histidine kinase associated receptors** – bacterial chemotaxis; **Insulin Signaling** (seminar). [24 classes]
Unit II: Cell junction and Extracellular matrix (ECM) signaling: Gap junction signaling; mechanism of cell-cell adhesion (cadherin mediated-calcium-dependent and calcium-independent); cell surface molecules; regulation of signaling molecules by ECM proteins; glycoproteins of ECM; regulation of ECM component degradation; integrin signaling. [7 lectures]
Unit III: Apoptosis: purpose; events; caspases and types; Bcl-2 family and signaling pathways; other regulators and their interaction; plant PCD: significance, tissues responsible, mechanism and the different regulators; comparison between animal and plant apoptosis [7 lectures]
Unit IV: Cancer: Cancer cells and normal cells, cancer and apoptosis. (3 lectures)

Teachers involved:
Dr. U. Siddhanta (Unit I)
Dr. A. Roy Choudhury (Units II and III)
Dr. A. Banerji (Unit IV)

Recommended texts:
Unit I: 1) Molecular Biology of the Cell - Alberts, Johnson, Lewis, Raff, Roberts & Walter (4th) – Ch.15
2) Lehninger Principles of Biochemistry - Nelson & Cox (5th Ed) – Ch.12
3) Review article – Cell Signaling by Receptor Tyrosine Kinases. Lemmon M.A. and Schlessinger J. (2010) Cell, 141, 1117-1134
Unit II: Molecular Biology of the Cell - Alberts, Johnson, Lewis, Raff, Roberts & Walter (4th edition) – Chapter 19)
Unit III: The Cell – A Molecular Approach. G.M. Cooper, R.E. Hausman (5th ed.) (Chapter 17); 2-3 review articles will be provided on Plant PCD
Unit IV: 1) The Cell – A Molecular Approach. G.M. Cooper, R.E. Hausman (5th ed.) Chapters 17, 18

Part B: Eukaryotic Genetics I (50 marks)

Unit I: Mendel's laws and the Principles of Inheritance: Mendel's experiments, Mendel's laws (Segregation and Independent Assortment), monohybrid and dihybrid crosses, test crosses.

(3 lectures)

Unit II: Extension of Mendelian Genetic Principles and deviation from Mendelian segregation: Codominance, incomplete dominance, multiple allelic systems (ABO blood groups in humans, the complementation test), gene interactions, epistasis (recessive epistasis, dominant epistasis, duplicate recessive epistasis, duplicate dominant epistasis), lethality and lethal alleles.

(9 lectures)

Unit III: Post Mendelian Inheritance: penetrance and expressivity, environmental effects on gene expression (outline only), genomic imprinting (IGF2 allele, Prader-Willi and Angelman syndromes), dynamic mutations and anticipation, dysgenic effect of medicine.   (2 lectures)

Unit IV: Chromosomes: Chromosomes as physical basis of inheritance. Chromosomal aberrations – variations in chromosome structure (deletions, duplications, inversions, translocations) and variations in chromosome number (autopolyploidy, euploidy, aneuploidy, allopolyploidy).

(8 lectures)

Unit V: Linkage: Single and double crossovers, calculation of map distances with two and three point test crosses, coincidence and interference.   (3 lectures)

Unit VI: Sex Determination and Sex Linkage: Systems of sex determination, sex determination in *Drosophila* and man. Autosomal and sex linked genes, X and Y linked traits, dosage compensation mechanism for X linked genes, sex influenced and sex limited traits.   (7 lectures)

Unit VII: Pedigree Analysis: analysis of dominant, recessive, autosomal, X linked and Y linked traits.   (3 lectures)

Teachers involved:
Dr. A. Banerji

Recommended texts:
1) iGenetics – A Molecular Approach. P.J. Russell (2nd ed.). Chapters 11 (Unit I), 12 (Unit IV, VI), 13 (Unit II, III), 15 (Unit V), 17 (Unit IV), 20 (Unit III)
2) An Introduction to Genetic Analysis. A.J.F. Griffiths, S.R. Wessler, R.C. Lewontin, S.B. Carroll (9th ed.). Chapters 2 (Units VI, VII), 3 (Units I, IV), 16 (Unit IV)
3) Genetics – M.W. Strickberger (3rd ed.). Chapters 6 (Unit I), 9 (Unit II), 16 (Unit V), 21, 22 (Unit IV)

Paper III
MBCR4403

Bioenergetics and Metabolism I (50 marks)

Unit I: Principles of Bioenergetics: [CB =12 lectures]
Biological energy transformations and thermodynamics and thermodynamics, Standard free energy change and equilibrium constant. Phosphoryl group transfer and ATP, ATP and other phosphorylated compounds and thioethers w.r.t their free energies of hydrolysis. Free energy of ATP hydrolysis in context of cellular metabolism. ATP energized biological processes, High energy

phosphate compounds as free energy sources in biological systems, Biological oxidation / reduction reactions.

Unit II: Carbohydrate metabolism: Overview of processes involved in carbohydrate metabolism and their regulation (glycolysis, TCA cycle, glycogenesis, glycogenolysis, gluconeogenesis, pentose phosphate pathway), Cori cycle, carbohydrate metabolic disorders. (12 lectures)

Unit III: Mechanism of aerobic respiration in mitochondria: Electron transport chain, oxidative phosphorylation, chemiosmotic coupling. (8 lectures)

Unit IV: Vitamins: Types, physiological effects and deficiency diseases. (4 lectures)

Teachers involved:
Dr. C. Barat (Unit I)
Dr. P. De (Unit II-IV)

Recommended texts:
Unit I: Bioenergetics: Principles of Bioenergetics (Nelson Cox) Pg. 489-519.
Unit II-IV:
(1) Biochemistry- J.M. Berg, J.L. Tymoczko, L. Stryer (7th Ed): Unit II (Ch 15-17, 20, 21), Unit III (Ch 18).
(2) Biochemistry-D. Voet and J.G.Voet (4th Ed) : Unit II (Ch 16-18, 21, 23), Unit III (Ch 22).
(3) Harper's Illustrated Biochemistry. R.K. Murray, D.K. Granner, V.W. Rodwell, (28th Ed): Unit II (Ch 17-21), Unit III (Ch-13), Unit IV (Ch 44).
(4) Lehninger Principles of Biochemistry. M.M. Cox, D.L. Nelson (5th Ed.): Unit II (Ch-14, 16), Unit III (Ch-19).
(5) The vitamins: fundamental aspects in nutrition and health- Gerald F. Combs (4th Ed): Unit IV (Ch 1-17).

MBCR4413
Annual viva voce II (50 marks)

Course material covered in Semesters I-IV.

Paper IV
MBCH4404

Chemistry IV (50 marks)

Unit I: Molecular Spectroscopy-II:
Infrared Spectroscopy- Modes of molecular vibrations; Vibration of a diatomic molecule; Application of Hooke's law; characteristic stretching frequencies of O-H, N-H, C-H, C-D, C=C, C=N, C=O functions; Factors affecting stretching frequencies (H-bonding, electronic factors, mass effects, bond multiplicity); Applications of infrared spectroscopy, Analysis and interpretation of IR data, FT-IR spectroscopy, Determination of secondary structure of proteins. (9 lectures)

Unit II: Chemical Bonding-II: Co-ordinate bonding and co-ordination compounds- Lewis acid base adducts; Double salts and complex salts; Warner theory of co-ordination; ligand and its classifications; Co-ordination number; Chelate complexes; Inner metallic complexes; IUPAC nomenclature (up to two metal centres); Chelate effect; Applications of co-ordination compounds (analytical application, industrial application, chelation therapy); Constitutional, geometrical and

optical isomerism in respect of co-ordination number 4 and 6; Determination of configurations of cis- and trans-isomers by chemical methods; Trans effect and its applications, Stablity constants of co-ordination complexes. (12 lectures)

Unit III: Fundamentals of Organic Reaction Mechanism: Bond cleavage and bond formation; Reaction intermediates- Structure, stability, formation and fates of carbon radicals, carbocations, carbanions; Types of reagents- electrophiles, nucleophiles; Classification of reactions.

Nucleophilic Substitution Reactions: Nucleophilic substitution reactions of alkyl halide (S_N1, S_N2, S_Ni); Effect of substrate structure, solvent, leaving group, nucleophiles; Substitution involving NGP.

Elimination Reactions: E1, E2, E1cB mechanism, Reactivity, Substitution vs. elimination.

Electrophilic and Nucleophilic Aromatic Substitution Reactions: Mechanisms, Reactivity, π-complexes and σ-complexes, Orientation effect of groups. (15 lectures)

Teachers involved:
Dr. S. Saha
Recommended texts:
1. Fundamentals of Molecular Spectroscopy. Banwell and McCash (4th Edition), Chapter 3.
2. Spectroscopy of Organic Compounds. P. S. Kalsi (6th Edition), Chapter 3.
3. Organic Spectroscopy. William Kemp (3rd Edition), Chapter 2.
4. General and Inorganic Chemistry (Part-II)-R. P. Sarkar (1st Edition), Chapter 26.
5. Concise Inorganic Chemistry. J. D. Lee (5th Edition), Chapter 7.
6. Advanced General Organic Chemistry- A Modern Approach (Part-I). Sachin Kr. Ghosh (3rd Edition), Chapter 11, 12, 15, 17.
7. A Guide Book to Mechanism in Organic Chemistry. Peter Sykes (5th Edition), Chapter 4, 6, 9.

MBCH4454

Chemistry Practical II (50 marks)

Qualitative analysis of Single Solid Organic Compound:
(i) Detection of special elements (N, Cl, Br, I and S).
(ii) Solubility and classification.
(iii) Detection of the following functional groups by systematic chemical tests:
Aromatic amino ($-NH_2$), aromatic nitro ($-NO_2$), Aimdo ($-CONH_2$), Anilido ($-CONHAr$), Phenolic $-OH$, Carboxylic acid ($-COOH$), Carbonyl ($>C=O$).
(iv) Determination of melting point of the given compound (demonstration).

Teacher involved:
Dr. S. Saha
Prof. S. Roy
Recommended texts:
Manual of Practical Chemistry- R. C. Bhattacharyya

Paper V
MBBM4405

Paper V

MBBM4405

Mathematics IV (50 marks)

Special Techniques and Bio-modelling: (12L)
Special Techniques : Scaling, Spirals, Non-linear scales, Semi-logarithmic scales, Double logarithmic scales, triangular chart, nomography, polar graphs.
Bio-modelling: (4L)
 Cell-growth model, birth and death model, Radio-active tracer model, Dilution model, Restricted growth model, Nerve-excitation model, Infection spread model, Ecology model, Drug excretion model. (8L)

Numerical Methods: (36L)
 Approximation, Error, Relative and Percentage Error, Interpolation, E and Δ operators.
(4L)
 Newton's forward and backward interpolation, Lagrange's interpolation. (6L)
 Numerical differentiation (4L)
 Numerical integration - Trapezoidal and Simpson's one-third rules. (8L)
 Extraction of roots – bisection method and Newton-Raphson method. (8L)
 Numerical Solution of Differential Equations – Runge-Kutta Equations (6L)

Teacher involved:
Ms. S. Ray

Recommended text:
1.A Text Book of Numerical Analysis by D.C. Sanyal and K. Das (For Numerical Methods)
2.Mathematical Techniques for Biology and Medicine by William Simon (For Special Techniques)
3.Introduction to Mathematics for Life Scientists by Edward Batschelet (For Bio-Modelling)

MBCO4405
Computer II (Theory - 25 marks)
Data Base Management System: Basic concept. File Management systems. Advantages of DBMS, ANSI/SPARC Architecture, Physical, Conceptual and External Models, ER Diagram, Data Models: Relational, Hierarchical, Network
File Organisation: Sequential, Indexed Sequential, Random, Inverted
Query Languages, Relational Algebra, Relational Calculus, Functional Dependencies, Normal forms: INF, 2NF, 3NF and BCNF; Structured Query Languages, Elementary Concepts of Security, Integrity. Case
Studies: Any commercial RDBMS Package. Pattern Matching
Teachers involved:
Prof. Kaushik Goswami

Recommended texts:
No. of lectures and recommended texts: to be provided by Department of Computer Science, St. Xavier's College (Autonomous), Kolkata.

MBCO4455

Computer II (Practical - 25 marks)

Programming through Visual Basic: Visual Basic Programming elements, Working with Forms, ActiveX Controls, Graphics With Visual Basic, Multiple Document Interface, Error Handling, Windows API and DLLs, Object Oriented Programming with Visual Basic, Data Base Programming with Visual Basic

Teachers involved:

Prof. Kaushik Goswami

Recommended texts:

No. of lectures and recommended texts: to be provided by Department of Computer Science, St. Xavier's College (Autonomous), Kolkata.