Master of Science (Biotechnology)
Syllabus

FIRST SEMESTER

BIO6101: CELL & MOLECULAR BIOLOGY [3 1 0 4]

Cell Structure: Comparison between plant and animal cells; Plasma membrane; Electrical properties of membrane, Modification of plasma membrane and intracellular junctions; Organization of plant cell wall. Cell Signaling: Communication between cells and their environment. Introduction to Cytoplasmic Organelles and Cytoskeleton: Protoplasm; Mitochondria; Chloroplast; ER; Golgi complex; Lysosome, Endosome, Ribosome; Centriole; Nucleus. Chromosomes, Chromatin and Nucleosome: Chromosome structure in bacteria and eukaryotes, Centromere, Telomere, Hetero- and euchromatin, Nucleosome model and radial-loop scaffold model. Overview of Cell Cycle: Stages of cell cycle, Cell cycle control, Mitotic and meiotic cell division; Distinction between mitosis in plant and animal. Cell Death: Apoptosis and Necrosis. Nucleic Acids Structure: DNA as genetic material, Watson-Crick model, A, B and Z forms of DNA; RNA types, Distinctions between RNA and DNA. The Central Dogma: Overview of synthesis of DNA, RNA and protein. The Genetic Code: Genetic code and its properties. Gene Cloning: Restriction endonuclease and cloning vector, Screening of cloned DNA.

References:

1. B. Alberts, A. Jahusan, J. Levis, M. Raff, K. Roberts and P. Walter. Molecular Biology of Cell, Garland Science, USA, 2002.
2. H. Lodish and D. Baltimore. Molecular Cell Biology, WH Freeman and Company, USA, 2012.
3. B. Lewin. Genes XII, Jones and Bartlett Publishers, USA, 2014.
4. G. Karp. Cell and Molecular Biology – Concepts and Experiments, John Wiley & Sons, Inc. USA, 2009.
5. T.A. Brown. Genomes, Garland Science, New York, 2006.

BIO6102: FUNDAMENTAL & APPLIED MICROBIOLOGY [3 1 0 4]

Applications of Microorganisms: Bacteria, Fungi, Protozoa, Algae, etc. Growth and Nutrition: Phases in bacterial growth, Growth Curve, Calculation of G-time, Physical and environmental requirements of growth, Microbial nutritional requirements, Types of culture media. Environmental Microbiology: Degradation of major macromolecules (lignin, cellulose, protein, starch etc.); Applications of Microbes in Bioremediation: Heavy metals, Textile, Pulp & paper, Leather industry; Microbial Ecology: Microbial ecotoxicology, Microbial community shift, Microbial interactions; Food & Dairy: Bakery, Brewery, Fermented food products, Yoghurt, Cheese; Concept of probiotics; Agricultural Microbiology: Plant microbe interactions, Plant growth promoting rhizobacteria, Biopesticides; Industrial Microbiology: Production of antibiotics, Vitamins, Enzymes, Organic acids; Applications in Energy: Production of biogas, Biohydrogen, Bioethanol, Microbial fuel cell; Control of Microorganisms: Physical, chemical and biological methods; Antimicrobial Compounds: Disinfectant, Antiseptic, Antibiotic; Mode of action of antibiotics; Drug resistance in bacteria. MRSA.

References:

1. L.M. Prescott, J.P. Harley and D.A. Klein. Microbiology. McGraw-Hill Science, USA, 2004.
2. M.J. Pelczar, E.C.S. Chan and N.R. Krieg. Microbiology: Concepts and Applications. McGraw-Hill Inc. USA, 1993.
3. J. Saxena, M. Baunthiyal and I. Ravi. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, India, 2012
4. R.W. Bauman. Microbiology with Diseases by Body System. Benjamin Cummings, USA, 2011.
5. J.G. Capuccino and N. Sherman. Microbiology-A Laboratory Manual. Benjamin Cummings, USA, 2004.
6. J.C. Pommerville. Alcamo's Fundamentals of Microbiology. Jones & Bartlett Publishers, USA, 2010.
7. J. Barnes and R. Brand. Microbiology Lab Manual, Kendall Hunt Pub Company, 1994
8. T.R. Johnson, C.L. Case. Laboratory Experiments in Microbiology Lab Manual, Benjamin Cummings, USA, 1997.
9. D. J. Brenner, N.R. Krieg and J. R. Staley. Bergey's Mannual of Systematic Bacteriology Vol. 1&2, Springer, USA, 2005.

BIO6103: BIO-ANALYTICAL TECHNIQUES [3 1 0 4]

Microscopy: Principles and applications of light microscopy, Phase contrast, Polarization, fluorescence, Confocal and electro n microscopy. Centrifugation: Principles of centrifugation. Concepts of RCF. Different types of instruments and rotors. Preparative, differential and density gradient centrifugation. Analytical ultracentrifugation, Determination of molecular weights and other applications. Electrophoresis: Different types of electrophoresis - agarose gel, pulse gel, SDS-PAGE and native gel, isoelectric focusing, 2-D gel electrophoresis, capillary electrophoresis. Chromatography: Principles and applications of partition, TLC, Affinity, Size exclusion, Ion exchange, Liquid-liquid chromatography, GC, HPLC, UPLC. Spectrophotometry: Beer and Lambert law, Types of detectors (UV-VIS). Techniques in structural analysis: UV, IR, Mass Spectrometry, NMR, LASER/Raman spectroscopy, XRD, X-ray Crystallography. ORD, CD and ESR. Radioactivity: Stable and radioactive isotopes. Concepts of half-life and decay. Principle of scintillation counting. GM counters. Applications of isotopes. Isotope dilution technique. Autoradiography. Radiation hazards.

References:

1. D. Frefilder. Physical Biochemistry, WH Freeman & Company, New York, 1983.
2. K. Wilson and J. Walker. Practical Biochemistry– Principles and Techniques, Cambridge University Press, 2005.
3. J. Jayaraman. Laboratory Manual in Biochemistry, New Age Publishers, New Delhi, 2011
4. A.J. Ninfa, D.P. Ballou and M.B. Parsons. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Wiley Interscience, 2009.
5. R. Boyer. Modern Experimental Biochemistry, Pearson Education, USA, 1986.
6. K. Wilson and K.H. Goulding. A biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, 1991.

7. M. Holtzhauer. Basic Methods for the Biochemical Lab, Springer, USA, 2006.
8. S.O. Farrell and L.E. Taylor. Experiments in Biochemistry: A Hands-on Approach, Cengage Learning, USA, 2005.

BIO6130: BIOTECHNOLOGY LAB. I [0 0 6 2]

Introduction of various laboratory instruments. Working principles of various available laboratory instruments: Laminar air flow cabinet, centrifuge, spectrophotometer, oven, incubator, BOD incubator, autoclave. Identification of different cells, Preparation of mitotic and meiotic chromosomes. Sectioning of plant tissues. Morphological study of microorganisms by differential staining techniques. Study of structure of cell organelles through electron micrographs. Isolation of genomic DNA from bacteria. Demonstration of fluorescence spectrophotometer. Synthesis of nanoparticles using biological route from plant extract and characterization of nanoparticles.

SECOND SEMESTER

BIO6201: ADVANCED BIOCHEMISTRY [3 1 0 4]

Principles of Biochemistry: Structure, composition and function of biomolecules and chemical bonds: Water, Carbohydrates, Lipids, Proteins, Nucleic acids and Vitamins. Stabilizing interactions, Van der Waals Forces, Electrostatic Effects, Hydrogen bonding, Hydrophobic interactions. Proteins biochemistry: Ramachandran plot, Secondary, Tertiary and Quaternary structure, Domains, Motif and folds, Protein Folding. Enzymology and Enzyme Kinetics: Principles of catalysis, Michaelis Menten equation, Enzyme inhibition and regulation of enzyme activity, feedback inhibition. Isozymes and Ribozymes. Bioenergetics and Metabolism: Carbohydrates, Lipids. Biological energy transducers, Oxidative phosphorylation. Biological Membranes and Bio signaling: Composition and dynamics of membranes. Molecular mechanism of signal transduction, Gated ion channels, GPCRs and second messengers.

References:

1. T.A. Brown. Gene Cloning and DNA analysis: An Introduction, Blackwell Publishing Professional, USA, 2006.
2. D. Nelson and M.M. Cox. Lehninger's Principles of Biochemistry, BI publications Pvt. Ltd. Chennai, India, 2008.
3. D. Voet and J.G. Voet. Principles of biochemistry, CBS Publishers & Distributors, New Delhi, 2008.
4. J.M. Berg, J.L. Tymoczko and L. Stryer. Biochemistry (5th Ed.), W.H. Freeman Publishers, 2005.

BIO6202: PLANT BIOTECHNOLOGY [3 1 0 4]

Introduction: History and scope of plant biotechnology. Organogenesis: Direct and indirect methods of organogenesis. Embryo culture and embryo rescue. Protoplast isolation, culture and fusion; Selection of hybrid cells and regeneration of hybrid pla nts; Symmetric and asymmetric hybrids, cybrids. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Transfer and establishment of whole plants in soil. Plant Transformation Technology: Features of TI and RI plasmid, mechanisms of DNA transfer, Role of virulence genes, Use of TI and RI as vectors, binary vectors, use of 35S and other promoters, Use of reporter genes. Transformation for Productivity and Performance: Bt genes, non-Bt like protease inhibitors, Alpha amylase inhibitor. Abiotic stresses. Chloroplast Transformation: Metabolic engineering and industrial products. Plant as chemical and pharmaceutical factories. Biodiversity and Its Conservation: Plant germplasm collection and conservation including wild species, Cryopreservation.

References:

1. S.S. Bhojwani, and M.K. Razdan. Plant Tissue Culture: Theory and Practice, Elsevier Science Publishers, New York, USA, 2011.
2. H.S. Chawla: Biotechnology in Crop improvement, International Book Distributing Company, Lucknow, 1998.
3. P.K. Gupta: Elements of Biotechnology, Rastogi and Co, Meerut, 1996.
4. J. Hammond, P. McGarvey and V. Yusibov. Plant Biotechnology, Springer Verlag, USA 2000.
5. T.J., Fu, G. Singh and W.R. Curtis. Plant Cell and Tissue Culture for the Production of Food ingredients, Kluwer Academic/Plenum Press, USA, 1999.
6. R.J. Henry. Practical Application of Plant Molecular Biology, Garland Science, USA, 1997.

BIO6203: GENETIC ENGINEERING [3 1 0 4]

Genetic Engineering: Scope, Early discoveries and milestones, Introduction to gene cloning, Basic steps of genetic engineering; Tools of Genetic Engineering: Restriction endonucleases, DNA ligases, DNA polymerases, Reverse transcriptase, Polynucleotide kinases, Modification of enzymes, Sticky and blunt ends, End labelling and other processes used in rDNA technology. Safety measures and regulations for recombinant DNA work. Gene Cloning Vectors: Plasmids, Cosmids, Phage vectors, phagemids, Ti plasmid, Shuttle vectors, Artificial chromosomes (YAC, BAC), Expression and binary vectors. Nucleic acid amplification and its applications. Nucleic acid sequencing. cDNA synthesis and cloning. Genomics & Proteomics: Different approaches and basics. Gene regulation and Homologous Recombination: Site directed mutagenesis and protein engineering; Primer extension, SI mapping, Reporter assay. Different types of blotting techniques. Antisense RNA and ribozyme technology. RNAi technology. Molecular Mapping of Genome: Genetic and physical maps, Fluorescence in situ hybridization in genome analysis, RFLP, RAPD, AFLP analysis and their application in mapping of genome.

References:

1. A.J.F. Griffiths, W.M. Gelbart, R.C. Lewontin and J.H. Miller. Modern Genetic Analysis Integrating Genes and Genomes, WH Freeman and Company, New York, 2002.
2. J.D. Watson, A.A. Candy, R.M. Myers and J.A., Witkowski. Recombinant DNA (Genes and Genomes – A short Course), WH Freeman and Company, New York, 2006.

3. K.V. Chaitanya. Cell and Molecular Biology: A Lab Manual, Phi Publisher, India, 2013.
4. J. Saxena, M. Baunthiyal and I. Ravi. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. Scientific Publishers, India, 2012.
5. J.W. Dale and M. Von Schantz. From Genes to Genomes (Concepts and Applications of DNA Technology), John Wiley and Sons Ltd., USA, 2011.
6. S.B. Primrose and R.M., Twyman. Principles of Gene Manipulation and Genomics, Blackwell Publishing, 2006.
7. E.L. Winwacker. From Genes to Clones–Introduction to Gene Technology, Panima Publishing Corporation, 1997.
8. M.S. Clark. Plant Molecular Biology - A Laboratory Manual, Springer, USA, 2014.

MAS6205: RESEARCH METHODOLOGY AND TECHNICAL WRITING [2 1 0 3]

Foundations of Research: Meaning, objectives, motivation, utility, empiricism, deductive and inductive theory, characteristics of scientific method , understanding the language of research; Research Process: Problem identification & formulation, research question, investigation question, measurement issues, hypothesis, qualities of a good hypothesis, types of hypothesis; Research Design: Concept and importance in research, features of a good research design, exploratory research design, descriptive research designs, experimental research design; Types of Data: Classification of data, uses, advantages, disadvantages, sources; Measurement: Concept of measurement, problems in measurement in research, validity and reliability, levels of measurement; Statistical Techniques and Tools: Introduction of statistics, functions, limitations, graphical representation, measures of central tendency, measure of dispersion, skewness, kurtosis, correlation, regression, tests of significance based on t, F, Chi-square, Z and ANOVA test; Paper Writing: Layout of a research paper, Scopus/Web of Science journals, impact factor of journals, when and where to publish, ethical issues related to publishing, plagiarism and self-plagiarism. Introduction to LATEX and MATLAB.

References:

1. C.R. Kothari, Research Methodology Methods & Techniques, New Age International Publishers, Reprint 2008.
2. Ranjit Singh, Research Methodology, Saga Publication, 4th Edition, 2014.
3. J. Anderson and M. Poole, Thesis and Assignment Writing, Wiley India 4th Edition, 2011.
4. Mukul Gupta and Deepa Gupta, Research Methodology, PHI Learning Private Ltd., New Delhi, 2011.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 1999.

THIRD SEMESTER

BIO7101: ADVANCED GENETICS [2 1 0 3]

Basic Principles of Mendelian Inheritance: Dominance, Segregation and Independent assortment. Intergenic and Intragenic inheritance - Incomplete dominance, Co-dominance, Duplicate genes. Linkage Analysis: Coupling and repulsion phases, Crossing over and recombination. Chromosomal mapping. Epistasis: Recessive, Dominant epistasis. Cytoplasmic inheritance. Multiple alleles, Lethal genes, Complementary genes, Supplementary genes. Sex determination and Sex-linked inheritance, Sex determination in humans, *Drosophila* and other animals. Sex linked, limited and influenced genes. Dosage sensitive genes and dosage compensation. Human Genetics: Pedigree analysis. Gene Concept: Fine structure of gene and gene concept, Extra-chromosomal Inheritance: Chloroplast and mitochondrial inheritance. Mutations: Spontaneous and induced mutations, Somatic vs germinal mutation. Chromosomal Aberrations: Main type of changes – deletions, duplications, inversions, translocations.

Change in Chromosome Number: Trisomy and polyploidy. Aneuploids – nullisomics, monosomics, and trisomics, somatic aneuploids. Changes in chromosome structure, Properties of chromosomes for detection of structural changes. Evolutionary Genetics: Genetic diversity (genome size, ploidy level, chromosome number) in microbes, Role of nuclear genetic markers (ribosomal DNA genes), Mitochondrial genetic markers in evolutionary studies. Gene sequence analysis is phylogenetics analysis. Medical Genetics: Genes associated with important diseases, Cancer Genetics.

References:

1. P.K Gupta. Cytology, Genetics and Evolution. Rastogi publications, Meerut, India, 2008.
2. J.F. Anthony, J.A. Miller, DT Suzuki, R.C. Richard, W.M Gilbert. An Introduction to Genetic Analysis. W.H. Freeman publication, USA, 1998.
3. A.G. Atherly, J.R. Girton and J.F. Mcdonald. The Science of Genetics. Saundern College publication, USA, 1999
4. B. Lewin. Genes XII, Jones and Bartlett Publishers, USA, 2014.

BIO7102: BIOPROCESS ENGINEERING [3 1 0 4]

Introduction: Development of bioprocess method as interdisciplinary approach. Engineering Calculations for Bioprocess Introduction: Development of bioprocess method as interdisciplinary approach. Engineering Calculations for Bioprocess Technology: Presentation and analysis of bioprocess data, Evaluation of mathematical models. Thermodynamics of Biomass: Assumptions and law of conservation of biomass for bioprocess, Procedure for material balance calculation: Mass balance calculation for microbial growth dynamics: Monod equation, Yield coefficients, specific growth rate. Residence Time Distribut ion (RTD): Batch Reactor, Plug Flow, Completely Mixed Flow Reactor. ideal chemostat and turbidostat model. Mechanical design of bioreactors: Aeration and Agitation, Oxygen supply, mass transfer coefficient (KL). Sterilization: Batch sterilization, Continuous sterilization. Material balances for recycle, Purge and bypass streams. General Energy balance equations and enthalpy calculation, Procedure for energy balance equations. Recovery Processes: Filtration, Centrifugation, Coagulation and flocculation, Liquid – liquid extraction, Chromatographic methods. Traditional Industrial Processes: Ethanol production, Lactic acid production, Acetone-butanol production, Citric acid production, Production of baker's yeast. Advance Industrial Process: Production of recombination insulin

References:

1. K.N. Mukhopadhaya. Advanced Process Biotechnology, Anshan Publications, New Delhi, 2006.
2. M.L. Shuler and F. Kargi. Bioprocess Engineering, Prentice Hall, New Delhi, 2006.
3. P. Doran. Bioprocess Engineering Calculation, Blackwell Scientific Publications, New Delhi, 2010.
4. P. F. Stanbury, J. Stephen Hall and A. Whitaker. Principles of Fermentation Technology, Science & Technology Books, New Delhi, 2010.
5. W. Harvey, Blanch, Douglas and S. Clark, Biochemical Engineering, Marcel Dekker, Inc., USA, 2011.

BIO7103: STRUCTURAL BIOLOGY & BIOINFORMATICS [2 1 0 3]

Techniques for Structure Determination: Circular dichroism, Electron microscopy, X-ray diffraction and nuclear magnetic resonance. Proteins: Definition and examples of primary, secondary, tertiary and quaternary structures of proteins. Nucleic Acid: Structure of Nucleosides, nucleotides and oligonucleotides, variation in DNA structure polymorphism. DNA-protein Interaction: Motifs, Histones. 3D conformational analysis of the structure of DNA. Introduction to Bioinformatics: Database concept, Database management system, Database browsing and data retrieval, Sequence Database and Genome Database: GenBank, EMBL, DDBJ, Swissprot, TrEMBL. Structural Databases: PDB, SCOP, CATH. Sequence Comparison and Alignment: Introduction to BLAST, FASTA, dynamic programming, Pairwise and multiple sequence alignment. Phylogenetic Studies: Tree-splits and metrics on trees, Tree interpretation. Homolog Modelling and protein structure prediction. Role of bioinformatics in drug discovery and development, Target discovery.

References:

1. L. Stryer, Biochemistry, WH Freeman and Co., 1999.
2. Cantor and Schimmel, Biophyscial chemistry Part I & III, WH Freeman & Company, 1980.
3. S. Neidle, Nucleic acid structure, VCH Publishing, Weinheim, 1987.
4. N. Gautham, Bioinformatics: Databases and Algorithms, Narosa Publications, 2006.
5. P.E. Bourne., Structural Bioinformatics, H. Wiley-Liss, Weissig, 2003.
6. Jean M. Claverie & C. Notredame, Bioinformatics for dummies, H. Wiley-Liss, 2007.

MAS7117: STATISTICS FOR BIOLOGIST [2 1 0 3]

Types and Architecture of Studies: Planning of experiments in lab and fields, design of experiment, case control, cross sectional, longitudinal studies, clinical trials; Data Collection: Census of human population and animal population, simple random sampling, stratified random sampling, cluster sampling, systematic sampling, two stage sampling, purposive sampling, snowball sampling; Regression Models: Simple linear regression, matrix approach to multiple regression, tests of regression coefficient, interval estimation; Analysis of Variance: Analysis of Variance for one- way, two -way with one/m observations per cell for fixed, mixed and random effects models, Tukey's test for non-additivity; Design of Experiment: Basic principles of experimental design, general block design and its information matrix, criteria of connectedness, balance and orthogonality, analysis of completely randomized, randomized blocks and Latin-square design; Survival Analysis: Censoring, hazard function, survival function, estimation of the survival function, Nelson-Aalen methods, Kaplan-Meier's method, methods for comparisons of two or more survival curves, proportional risk, Cox regression, non-parametric and parametric methods for analysis of survival data.

References:

1. M. Pandey, Biostatistics: Basic and Advanced, MV learning, 2015.
2. I. A. Khan, A. Khanum, S. Khan, Fundamentals of Biostatistics, 5th Edition, Hyderabad, 2018.
3. D. C. Montgomery, Design and Analysis of Experiments, John Wiley, 2008.
4. R. A. Johnson and D. W. Wichern, Applied Multivariate Statistical Analysis, Prentice Hall of India, 2001.
5. E.T. Lee and J.W. Wang, Statistical Methods for Survival Data Analysis, 2nd Edition, John Wiley and Sons, 2003.

BIO7130: BIOTECHNOLOGY LAB. V [0 0 6 2]

Preparation of temporary mount. Microscopic analysis of mitosis in onion roots via chromosome staining. Mendelian genetics: Monohybrid and dihybrid crosses, Punnett square exercises, Mendelian inheritance in pea plants or simulated genetic crosses Calculate phenotypic ratios and Analyze deviations from expected results using Chi-square tests, Crosses involving traits with non-Mendelian inheritance: Predict outcomes using probability rules. Genetic Recombination and Linkage: Construct genetic maps and calculate recombination frequencies; Population Genetics: Hardy-Weinberg equilibrium, Calculate allele and genotype frequencies; Pedigree analysis of some human inherited traits. Introduction to Bioengineering Overview of bioengineering principles and laboratory practices. Safety procedures and sterilization techniques. Calculations Material Balance: Calculation of the input and output streams in a fermentation process, including substrates, products, and by-products. Cell Disruption by Sonication Disrupt microbial cells to release intracellular contents to understand Protein extraction, enzyme production, and nucleic acid isolation. Growth Curve in Batch Culture: Monitor and analyze microbial growth in a batch culture system. Precipitation of Protein by Salting Out Method Purify proteins from a mixture by altering solubility through salting out. Extraction of Protein by Aqueous Two-Phase Extraction Separate proteins using aqueous two-phase systems. Microbial Growth and Product Formation Kinetics Analyze kinetics using models such as Monod equation for growth and yield coefficients for product formation. Effect of Temperature, pH, and Substrate Concentration on Microbial Growth Curve.

BIO7131: BIOTECHNOLOGY LAB. VI [0 0 6 2]

Retrieval of nucleotide and protein sequence from data bank. Learning Genbank and PDB file format. Analysis of protein data bank file (PDB) for useful information. Protein sequence alignment using BLAST. To find ORF'S in an organism's nucleotide sequence by exploring the ORF finder tool. Performing multiple sequence alignment using CLUSTALW tool, program for function, operation

overloading program for multiple constructors in a class program for multiple handling program for error handling. To perform Ramachandran analysis of protein structure conformation. Study of absorbance spectra of different nucleotides. Analysis of molecular mass of a protein using size exclusion chromatography. To determine the homology model of a protein sequences using known template. To determine the secondary structural content of protein using CD spectroscopy.

DISCIPLINE SPECIFIC ELECTIVES

DSE – I

BIO7140: ANIMAL BIOTECHNOLOGY [3 1 0 4]

Culture of mammalian cells, tissues and organs, Primary culture, Secondary culture, Continuous cell lines, Adherent Cell Culture and Suspension cultures, Somatic cell cloning. cell culture contaminants, Application of Animal Cell Culture, Cytotoxicity as say Principles of cryopreservation, Animal Models: Animal models for human disease, Development of mouse models for cancer research, Advantages and limitations of mouse models, Immunocompetent mice, Immunodeficient mice, Xenograft model, Orthotopic model, Generation of the Cre/Lox mouse model, sphere assay, Future of Animal Biotechnology. Guidelines for Animal Based Research: Ethical, Legal issues. Role of animal cell culture in developing animal models.

References:

1. R.I. Freshney. Culture of Animal Cells (3rd Edition), Wiley-Liss, 2010.
2. P. Ramadass and R. S. Meera. Textbook of Animal Biotechnology, Akshara Printers, New Delhi, 1997.
3. Ashish S. Verma and Anchal Singh. Textbook of Animal Biotechnology
4. S. Mathur. Animal Cell and Tissue Culture, Agrobios, India, New Delhi, 2009.
5. R. Baserga. Cell Growth and Division: A Practical Approach, IRL Press, 1989.
6. Toni Lindl and Rosemarie Steubing. Atlas of Living Cell Cultures, Wiley VCH, 2013.

BIO7141: ENZYME TECHNOLOGY [3 1 0 4]

Enzyme Classification: Definition, Nomenclature and classification of enzymes, Isozymes, Characteristic Features of Enzymes: Enzyme cofactors, Catalytic power, Catalytic strategies and substrate specificity, Lock and key model, Induced fit hypotheses, Active site - structure, substrate binding, Role of catalytic amino acid residues, Catalytic mechanisms of enzymes with representative examples. Enzyme Kinetics and Regulation: Types of enzyme inhibition, Regulation of enzymes, Kinetics of enzyme-catalyzed reactions, Effect of pH and temperature on enzyme activity, Enzyme pathways and regulatory networks. Industrial Enzymes: Design and application of enzymes for industrial applications; Isolation and purification of industrially important enzymes. Recombinant Enzymes: Protein engineering strategies to improve enzyme stability, Specificity and activity. Enzyme Immobilization: Types, advantages, drawbacks and applications. Artificial enzymes. Enzymes in Clinical Diagnosis: Primary and secondary serum enzymes, Considerations for reliable serum enzyme assays, Intracellular distribution of diagnostic enzymes, Enzyme markers of xenobiotic toxicity - pharmacogenomics related to polymorphism of drug metabolizing enzymes, Keggs Pathway.

References:

1. A.C. Bowden. Fundamentals of Enzyme Kinetics Portland Press, 2004.
2. N. Price, L. Stevens. Fundamentals of Enzymology, Oxford University Press, 1999.
3. J. L. Reymond. Selection and Fingerprinting, Wiley VCH, 2005.
4. M. Chaplin, C. Bucke. Enzyme Technology, Cambridge University Press, 1990.
5. Methods in Enzymology, Volume 1, 1955.
6. D. Voet, J. Voet. Biochemistry, Wiley, 2010.

BIO7142: IMMUNOTECHNOLOGY [3 1 0 4]

Immune System: Recognition of self and non-self, Humoral Immunity: Immunoglobulins, Basic structure, classes and subclasses, structural and functional relationships, Nature of antigen, Antigen-antibody reaction. Cellular Immunity: Lymphocytes, Cytokines, Interferons, Interleukins, Complement System: Complement components, Their structure and functions and mechanisms of complement activation by classical, Alternative and lectin pathway. Major Histocompatibility System: Structure and functions of major histocompatibility Complex (MHC) and Human leukocyte antigen (HLA) system, Recognition of antigens by T and B-cells, Antigen processing, Role of MHC molecules in antigen presentation and co stimulatory signals. Hypersensitivity: Types, features and mechanisms of immediate and delayed hypersensitivity reactions, Immunity to microbes, Immunity to tumors, AIDS and immune deficiencies. Diagnostic Immunology: Methods for immunoglobulin determination quantitative and qualitative antigen and antibody reactions, Agglutination-precipitation, Immunofluorescence, Immune blotting and assessment of human allergic diseases

References:

1. T.J. Kindt, B.A. Osborne and R.A. Goldsby. *Kuby Immunology*, W.H. Freeman, USA, 2007
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt. *Roitt's Essential Immunology,* Wiley-Blackwell, USA, 2011.
3. W.E. Paul. *Fundamental immunology.* Raven Press, USA, 1993.
4. K.D. Elgert. *Immunology: Understanding the immune system*. Wiley-Blackwell, USA, 2009.
5. Nigam and A. Ayyangari. Lab Manual in Biochemistry, Immunology and Biotechnology, McGraw-Hill Education (India), 2008.

DSE – II

BIO7143: DEVELOPMENTAL BIOLOGY [3 1 0 4]

Basic Concepts of Development: Potency, Commitment, Specification, Induction, Competence, Determination and differentiation; Morphogenetic gradients, Cell fate and cell lineages, Stem cells, Genomic equivalence and the cytoplasmic determinants, Imprinting, Mutants and transgenics in analysis of development. Gametogenesis, Fertilization and Early Development: Production of gametes, Cell surface molecules in sperm-egg recognition in animals, Embryo sac development and double fertilization in plants, Zygote formation, Cleavage, Blastula formation, Embryonic fields, gastrulation and formation of germ layers in animals, Embryogenesis, Establishment of symmetry in plants, Seed formation and germination. Morphogenesis and Organogenesis in Animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, Amphibia and chick, Organogenesis in vertebrates, Differentiation of neurons, Post embryonic development-larval formation, Metamorphosis, Environmental regulation of normal development, Sex determination. Morphogenesis and organogenesis in plants. Cell-cell Communication: Induction and competence, Paracrine factors, Cell surface receptors and their signal transduction pathways, Programmed cell death pathways, Cross talk between the pathways, Juxtacrine signaling, Aging and senescence.

References:

1. T. Subramoniam. Developmental Biology, Alpha Science Int. Limited, UK, 2003.
2. S.F. Gilbert. Developmental Biology, Sinauer Associates, USA, 2013.
3. K.V. Sastry and V. Shukal. Developmental Biology, Rastogi Publication, Meerut, 2013.
4. C. Tickle and L. Wolpert. Principles of Development, Oxford University Press, UK, 2012.
5. V. Raghavan. Developmental Biology of Flowering Plants, Springer, India, 2012.
6. T.A. Steeves and I.M. Sussex. Patterns in Plant Development, Cambridge University Press, UK, 1996.
7. Y. Shi. Animal Metamorphosis, Academic Press Inc, USA, 2013.
8. B.B. Buchanan, R.L. Jones. W. Gruissem. Biochemistry and Molecular Biology of Plants. IK Books, USA, 2007.
9. E.C. Pua and M. R. Davey. Plant Developmental Biology – Biotechnological Perspectives, Springer, USA, 2010.
10. M. Timmermans. Plant Development, Academic Press Inc, USA, 2010.

BIO7144: PHYSIOLOGY [3 1 0 4]

Photosynthesis: Light harvesting complexes; Mechanisms of electron transport; Photoprotective mechanisms; CO_2 fixation-C_3, C_4 and CAM pathways. Respiration and Photorespiration: Citric acid cycle; Plant mitochondrial electron transport and ATP synthesis. Nitrogen Metabolism: Nitrate and ammonium assimilation; Amino acid biosynthesis. Plant Hormones: Biosynthesis, storage, breakdown and transport; Physiological effects and mechanisms of action. Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, Cryptochromes and phototropins; Stomatal movement; Role of abscisic acid, Photoperiodism and circadian rhythms. Solute Transport and Photoassimilate Translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, transpiration; mechanisms of loading and unloading of photoassimilates. Secondary Metabolites: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology. Blood and Circulation: Blood corpuscles, Hemopoiesis and formed elements, Plasma function, Hemostasis. Cardiovascular System: Comparative anatomy of heart structure, Myogenic heart, Specialized tissue, Cardiac cycle, Blood pressure. Respiratory System: Transport and exchange of gases. Nervous System: Central and peripheral nervous system, Neural control of muscle tone and posture. Sense Organs: Vision, hearing and tactile response. Excretory System: Kidney, Urine formation, Waste elimination, Micturition, Regulation of water balance, Electrolyte balance. Thermoregulation. Digestive System: Digestion, Absorption, Anergy balance, BMR. Endocrinology and Reproduction: Endocrine glands, Basic mechanism of hormone action, Hormones and diseases; reproductive processes.

References:

1. W.G. Hopkins and N.P.A. Huner. An Introduction to Plant Physiology. John Willey & Sons, USA, 2008.
2. L. Taiz and E. Zeiger. Plant Physiology, Sinauer Associate, USA, 2010.
3. S.N. Pandy, B.K. Sinha. Plant Physiology, Vikas Publishing House, New Delhi, 2009.
4. S. Nielsen. Animal Physiology, Cambridge University Press, UK, 2013.
5. R.W. Hill, G.A. Wyse and R. Anderson. Animal Physiology, Sinauer Associates, USA, 2012.
6. F.B. Salibury and C. Ross. Plant Physiology, CBS Publication, New Delhi, 2006.
7. P. Stewart and S. Globig. Plant Physiology, Apple Academic Press, USA, 2012.
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Introduction to environmental biotechnology. Bioremediation: Aerobic and anaerobic processes for waste treatment. Biodegradation of hydrocarbons and pesticides. Industrial wastewater sources and treatment strategies. Molecular techniques in bioremediation. Air Pollution: Bio techniques for the control of air pollution, Removal of chlorinated hydrocarbons from air, biological control of air pollution. Metal Pollution: Treatment of heavy metal containing wastes, Microbial transformation of heavy metals. Bioleaching and Biomining. Microbiology of degradation of xenobiotic. Bio assessment of Environmental Quality, Biotechnology in Biodiversity conservation. Slurry bioremediation, Bioremediation of contaminated ground water and phytoremediation of soil metals. Biofertilizers, Biopesticides, Integrated pest management and composting. Plant derived fuels, Biogas, Landfill gas, Bioethanol, Biohydrogen. GEMs in environment.

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