BHARATHIAR UNIVERSITY :: COIMBATORE – 641 046
M.Sc. BIOTECHNOLOGY (UNIVERSITY DEPT.)
(For the students admitted during the academic year 2011– 2012 batch & onwards)
SCHEME OF EXAMINATION

Semester	Paper	Subject	Hrs / week	University examination			Total Marks	Credits
				Dur/ Hrs.	INT.	EXT		
SEMESTER I								
11BIOBC01	Paper-I	Biochemistry	4	3	25	75	100	4
11BIOBC02	Paper - II	Cell and Molecular Biology	4	3	25	75	100	4
11BIOBC03	Paper - III	Microbiology	4	3	25	75	100	4
11BIOGE01	Elective 1	Genetics	4	3	25	75	100	4
	Supportive1		2	2	12	38	50	2
11BIOBCP1	Practical - I	Basic Biotechnology	6	6	25	75	100	4
SEMESTER II								
11BIOBC04	Paper – IV	Developmental Biology and Physiology	4	3	25	75	100	4
11BIOBC05	Paper – V	Recombinant DNA technology	4	3	25	75	100	4
11BIOBC06	Paper – VI	Immunology	4	3	25	75	100	4
11BIOGE02	Elective	Bioprocess Technology	4	3	25	75	100	4
	Supportive2		2	2	12	38	50	2
11BIOBCP2	Practical –II	Advanced Biotechnology	6	6	25	75	100	4
SEMESTER III								
11BIOBC07	Paper VII	Animal Biotechnology	4	3	25	75	100	4
11BIOBC08	Paper VIII	Plant Biotechnology	4	3	25	75	100	4
11BIOBC09	Paper IX	Environmental Biotechnology	4	3	25	75	100	4
11BIOGE03	Elective 3	Stem Cell Biology and Tissue Engineering	4	3	25	75	100	4
	Supportive3		2	2	12	38	50	2
11BIOBCP3	Practical III	Applied Biotechnology	6	6	25	75	100	4
SEMESTER IV								
11BIOBC10	Paper - X	Computational Biology	4	3	25	75	100	4
11BIOBC11	Paper - XI	Biosafety Bioethics & IPR	4	3	25	75	100	4
11BIOBC12	Paper - XII	System Biology	4	3	25	75	100	4
11BIOBC13	Paper - XIII	Pharmaceutical Biotechnology	4	3	25	75	100	4
	Project Work*			-	-	-	200	8
		Total					2250	90

***** The report is the bonafied work carried out by the candidate under the guidance of a faculty authenticated and countersigned by the HOD. This project work must be presented and defended by the candidate in the department attended by all faculties and reviewed by external examiner. Candidate who has presented the work as 'Not qualified as per CBCS' must resubmit the project again in the ensuing academic year.

Subject Title : Biochemistry
Course Number : 11BIOBC01 Number of Credits: 4 (Four)
Subject Description :
Preamble:

Scope: This paper presents the study of identification and quantitative determination of the substances, studies of their structure, determining how they are synthesized metabolized and degraded in organisms, and elucidating their role in the operation of the organism.

Objective: On the successful completion of the course the students will get an overall understanding of structure of atoms, molecules and chemical bonds, enzyme kinetics, bio polymers and metabolic reactions in a living system.

Goal: This paper in biochemistry has been designed to provide the student with a firm foundation in the biochemical aspects of cellular functions which forms a base for their future research.

UNIT I

Structure of atoms, molecules and chemical bonds; Classes of organic compounds and functional groups. Covalent and Noncovalent interactions - Van der Waals, Electrostatic, Hydrogen bonding and hydrophobic interactions; Respiration and photosynthesis. Chemical foundations of Biology- pH, pK, acids, bases and buffers, Henderson – Hasselbach equation, biological buffer solutions.

Energy metabolism (concept of free energy); Principles of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds; weak interactions; coupled reactions and oxidative phosphorylation; group transfer; biological energy transducers; bioenergetics.

UNIT II

Sugars - classification and reactions. Polysaccharides: classification, occurrence, isolation, purification, properties and biological reactions. Structural features of homoglycans, heteroglycans and complex carbohydrates. Methods for compositional analysis.

Proteins: Amino acids and peptides-classification, chemical reactions and physical properties. Peptide bond, Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramchandran map), conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure), Purification and criteria of homogeneity: protein folding-biophysical and cellular aspects.

Lipids: Classification, structure and functions. Triglycerides; Phospholipids; Steroids and terpenes. Glyco and lipoproteins - structure and function. Role of lipids in biomembranes.

Nucleic acids: Structure of double stranded DNA (B, A, C, D, T and Z DNA). The biological significance of double strandedness, sequence dependent variation in the shape of DNA. Physical properties of double stranded DNA, types of RNAs and their biological

significance. DNA bending, DNA supercoiling. Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis.

UNIT III

Enzyme kinetics (negative and positive cooperativity); Regulation of enzymatic activity; Enzyme catalysis in solution, kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Active sites; Enzymes and coenzymes: Coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes; Ribozyme, hammer head, hair pin and other ribozymes, strategies for designing ribozymes. Abzyme: structure and drug targets (enzymes and receptors); Drug development; Prodrug delivery using enzymes; Bioluminescence

UNITIV

Silk fibroin, coiled coils, collagen triple helix and hemoglobin. Denaturation and renaturation of proteins. Lysozyme- structure, enzymic activity, mechanism of lysozyme action.

Analytical techniques: separation techniques, small and macro biomolecules, Protein-Protein and protein-ligand interactions. Physical and chemical methods for immobilization of small and macro molecules.

UNIT V

Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconeogenesis; interconversion of hexoses and pentoses: Co-ordinated control of metabolism; Biosynthesis of purines and pyrimidines; Oxidation of fatty acids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Sterols.

References:

1. Biochemistry (3rd Edition) - Christopher K. Mathews, Kensal E. van Holde, Kevin G. Ahern, Pearson Education.
2. Principles of Biochemistry – Smith et al., McGraw – Hill International book Company, 8th Edition.
3. Principles of Biochemistry – Lehninger , Nelson, Cox, CBS publishers
4. Fundamentals of Biochemistry – Voet et al., John Wiley and Sons, Inc.
5. Biochemistry – Zubay , WCB publishers
6. Harper's Biochemistry – R.K.Murray, D.K.Granner, P.A.Mayes and V.W Rodwell, Prentice-Hall International.
7. Biochemistry (VIthEd.) – J.M Berg; J.L.Tymoczko and L.Stryer, W H Freeman and Company, NY.

Subject Title : Cell and Molecular Biology
Course Number : 11BIOBC02 Number of Credits: 4 (Four)

Subject Description :

Scope: This paper provides a thorough knowledge about structure and function of cells, cellular energetics, protein trafficking, bio molecules and cellular development.

Objective: Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function.

Goal: Students after completion of this paper will be exceptionally well prepared to pursue careers in cellular and sub cellular biological research, biomedical research, or medicine or allied health fields.

UNIT I

Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Model membranes, Glyco conjugates and proteins in membrane systems; Response to stress - active and passive, transport channels and pumps, Neurotransmission, neuromuscular junction. Extra cellular matrix – cell to cell and cell matrix adhesion – selectins, integrins, cadherins, gap junctions.

UNIT II

Mitochondria – structure, biogenesis; Chloroplast – structure, biogenesis; Molecular events of electron transport chain, ATP synthesis, photosynthesis and photorespiration. Structure of Endoplasmic reticulum, Golgi complex, lysosomes; protein synthesis and post translational modification; of proteins vesicular transport and import into cell organelles

UNIT III

Oxidative reactions in microbodies and nucleus. The nucleosome, the supranucleosomal structures. Nucleic acid structure: DNA and RNA; DNA replication; transcription and translation. Gene regulation: prokaryotic gene regulation- Operon concept; lac operon and tryptophan operon; Eukaryotic gene regulation: transcriptional and translational regulations.

UNIT IV

Mechanism of cell division: regulation of cell cycle; factors and genes regulating cell cycle. Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signaling. Biochemistry and molecular biology of Cancer, tumor suppressor and oncogenes.

UNIT V

Cellular signaling; cell differentiation; gametogenesis and fertilization; life cycle and molecular biology of some pathogens – AIDS virus, tuberculosis, malarial parasite, hepatitis virus, filarial parasite and kalazar parasite

Techniques (Self Study):

Radiolabelling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

References

1. Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
3. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. Introduction to Practical Molecular Biology, P.D.Dabre, John Wiley & Sons Ltd., New York, 1998.
5. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxfor, 1991.
6. Molecular Biology of the Gene (4th Edition), J.D.Watson, N.H.Hopkins, J.W.Roberts, J.A. Steitz and A.M.Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
7. Genes VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998

Subject Title : Microbiology
Course Number : 11BIOBC03 Number of Credits: 4 (Four)
Subject Description :

Scope: This paper provides the knowledge about different types of microorganisms and their identification techniques in modern biology and there by the usefulness of the techniques in research and commercial purposes.

Objectives: In order to make the students to understand the identification of microorganism based on the advanced microbiological methods and applications of microorganisms.

Goal: Students can gain the idea of how to identify the microorganisms based on the modern microbiological approach.

UNIT – I

Microbial Bio-diversity: Origin and evolution of microorganisms – concepts of species and hierarchical taxa, Bergy's system of classification: Bacteria, Fungi, Viruses; Biological nomenclature - Measurement of species richness and evenness: Simpson's diversity index – Multivariate analysis. Preservation and maintenance of microbes - Microbial Culture Collection centers – India and International organizations.

UNIT – II

Molecular Taxonomy: Molecular systematics: Polyphasic approach –16S rRNA gene sequencing, Phylogenetic grouping. Mol % G+C analysis, DNA-DNA hybridization, Fatty Acid Methyl Ester (FAME) analysis, peptidoglycan, Isoprenoid and quinines. Microbial Community analysis: DGGE, TGGE, SSCP, T-RFLP, FISH.

UNIT – III

Soil Microbiology: Soil Environment – Microbial Phylogeny and Diversity in Soil – Bacteria, Archae, Protozoa, Fungi and other Protista. Microorganisms Cycling Soil Nutrients and their Diversity. Microbial Interactions in Soil; Horizontal Gene Transfer and Microevolution in Soil. Soil Microbial Communities and Global climate change. Plant Associated Bacteria – Life Style and Molecular Interactions; Plant growth promoting bacteria; Biological pesticides for control of seed and soil borne plant pathogens. Biosensors to monitor Soil Health – soil suppressiveness to plant diseases – Biodegradation and bioremediation of organic pollutants in soil – Statistical analyses of microbiological and Environmental data.

UNIT – IV

Medical Microbiology:

Bacterial Diseases: Host parasite relationship, epidemiology, pathogenesis, prevention and treatment - Gram positive cocci; *Staphylococcus* and *Micrococcus*; *Streptococcus*; *Enterococcus*. Gram positive rods – *Coryneforms*, *Listeria*, *Mycobacterium* and *Nocardia*. Gram negative rods - *Klebseilla*, *Salmonella*, *Shigella*, *Neisseria*, *Haemophilus* and *Pseudomonas* and Anaerobic bacteria - *Clostridium*.

Viral Diseases: Classification of virus, epidemiology, pathogenesis, prevention and treatment - Small pox, common cold, Influenza, Measles, Mumps, Rubella, Arbovirus infections, Polio, Rabies, Hepatitis, AIDS, Herpes virus infections.

Fungal Diseases: Superficial mycosis, subcutaneous mycosis and systemic mycosis.

Protozoan Diseases: Protozoan infections, Nematode infections, and Trematode infections. **Mycoplasma and other infections:** Mycoplasma - Zoonotic and Nosocomial infections. Diagnosis of infectious diseases; Immunoassays, molecular detection and identification using variants of PCR.

UNIT –V

Metagenomics - culture independent studies: Exploring and exploiting the microbial Gene pool. Methods to detect and quantify bacteria in various ecological niches – Analysis of microbial communities in microhabitats using FISH – Functional characterization of microbial communities by mRNA analysis – Detection of active bacterial populations in soil.

REFERECES:

1. Microbiology by Lansing M. Prescott
2. Microbial Diversity - Form and Function in Prokaryotes By Oladele Ogunseitan
3. Molecular Microbial Ecology by Dr. A. Mark Osborn and Dr. Cindy J. Smith. Taylor and Francis Group.
4. Modern Soil Microbiology, Janet Dirk Van Elsas, Janet K. Jansson, Jack T. Trevors – CRC Press – ISBN 0-8247-2749-5.
5. Greenwood D (2007). Medical Microbiology. I.K. International.
6. Medical Microbiology, Vol. 1: Microbial Infection, Vol. 2: Practical Medical Microbiology, - Mackie and McCartney.
7. Diagnostic Microbiology, Authors- Baron, Peterson and Finegold.
8. Medical Microbiology by S. Rajan, MJP Publishers
9. Molecular identification, systematics, and population structure of prokaryotes By Erko Stackebrandt

Subject Title: Genetics (Elective –I)
Course Number: 11BIOGE01 Number of Credits: 4 (Four)
Subject Description:

Scope: This paper in genetics has been structured to give the student an in depth knowledge of the organization of the genome in prokaryotes and eukaryotes, the principles of genetic inheritance and other vital aspects such as Hardy Weinberg law, pedigree analysis and the genetic basis of disease inheritance.

Objective: The major objective of the paper is to envisage thorough knowledge in genetics and genome organizations in organisms.

Goal: After successful completion of the paper the students will get an overall view about genetic makeup of organisms and can take up a career in research.

UNIT I

Genome Organization in prokaryotes: genome of bacteria, bacteriophage and viruses, plasmids. The fine structure of a prokaryote gene; Genetics of bacteria: transformation, conjugation, transduction; the genetic map of *E.coli* genetic recombination. Genetics of viruses: Life cycle of virulent bacteriophages, temperate phages and prophage; genetic recombination in phages; mapping genes in phage lambda; The RNA phages, tumor viruses and cancer; viroids.

UNIT II

Genome Organization in Eukaryotes, variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B-chromosome. The fine structure of Eukaryote gene; complementation test, pseudo alleles, split genes, overlapping genes; transposons. Linkage and crossing over; The three point cross; double crossing over, cytological basis of crossing over; sex linkage; recombination in neurospora.

UNIT III

Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid, trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleotrophy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; extra chromosomal inheritance.

UNIT IV

Human Genetics: Introduction to Human Genetics. Human Chromosomes: Structure and organization of DNA; Normal human karyotype: Paris Nomenclature; Chromosomal aberration: Numerical: Aneuploidy, Polyploidy (eg: Turner, Down & Klinefelter Syndromes). Structural: Translocation, Duplication, Inversion, Ring Chromosome and Deletion (Eg: Cri-du-chat syndrome). Others: Mosaic, Chimera [Individual with two cell lines] Mendelian Traits: Straight

hair, Curly hair, Blue and Brown colour of the eyes, Rolling of the tongue, attached and free ear lobes and Hypertrichosis.

UNIT V

Clinical genetics: Genetic Diseases and Inheritance Pattern: Autosomal inheritance – Dominant (Eg: Adult polycystic kidney, Achondroplasia & eurofibromatosis.); Autosomal inheritance – Recessive (Eg: Albinism, Sickle Cell Anemia, Phenyl Ketonuria); X-linked : Recessive (Eg: Duchenne muscular dystrophy – DMD); X-linked : Dominant (eg. **Xg** blood group); Y-linked inheritance (Holandric – eg. Testes determining factor); Multifactorial inheritance (Eg: Congenital malformations – Cleft lip & palate, Rheumatoid arthritis and Diabetes. Pedigree studies: Symbols used in pedigree analysis. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchenne Musculat Dystrophy (DMD). How normal genes work; Mechanism of disease. Diagnosis of disease: cytogenetics; Molecular cytogenetics, molelcular genetics ; cancer genetics. Prevention of disease: Prenatal diagnosis; Genetic counseling.

References

1. The science of Genetics by Alan G. Atherly, Jack. R, Girton, Jhon. F, Mc Donald. Sounders college publishers.
2. Genes VII by Benjamin Lewin
3. Hartl. D.L. A primer of population genetics. III edition, Sinauer associates inc. Sunderland, 2000
4. Molecular cell Biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
5. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
6. Human genetics, A.Gardner, R.T.Howell and T.Davies, Published by Vinod Vasishtha for Viva Books private limited, 2008. Publishe

Subject title : Developmental Biology and Physiology

Course number : 11BIOBCB04 Number of credits: 4 (Four)

Scope:

This paper encodes information on the physiology of various eukaryotic systems.

Objective:

To enable the students to know the actual path of physiological metabolism of different living system.

Goal:

The information gained will help the students to understand the various living system which will help in the future to develop the drugs.

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Unit I:

Basic concepts of development:

Production of gametes, cell surface molecules in sperm egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; Morphogenesis and organogenesis in animals (Drosophila, Amphibia and Chick). Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Embryogenesis in plants (Arabidopsis).

Unit II:

Plant system physiology:

Photosynthesis: Mechanism of photosynthesis; Plant hormones: biosynthesis, storage, breakdown and transport; physiological effects and mechanism of action. Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism. Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates, biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Unit III

Animal system physiology:

Digestion and Haematology:

Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscules, haemopoiesis, plasma function, blood volume, haemostasis. Comparative anatomy of heart structure, myogenic heart, ECG- its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

Unit IV

Respiration and Excretion:

Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.

Unit V:
Nervous system:

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of musle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; reproductive processes, neuroendocrine regulation. Thermoregulation.

Reference:

1. An introduction to embryology- Balinsky
2. Developmental biology- Gilbert
3. Chordate embryology- Verma, Agarwal and Tyagi
4. Plant physiology by Delwin and Withem
5. Plant physiology by Lincoin Taiz, Eduardo Zeiger Publishers, Sinauer

Subject Title : Recombinant DNA technology
Course Number : 11BIOBC05 Number of Credits: 4 (Four)
Subject Description :

Scope: This paper provides the student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms, Human Genome Project and gene therapy. Techniques employed are carved as self study.

Objective: The main objective of the paper is to expose students to application of rDNA technology to various fields of biotechnology.(medicine and research areas).

Goal: This paper will help the student to get a grasp on the latest advances in recombinant DNA technology, which is a powerful tool in modern Biotechnology

UNIT- I

Principles and methods in genetic engineering: Isolation and purification of Nucleic Acids - Agarose Gel Electrophoresis - Southern, Northern and South-Western blotting techniques - Principles and techniques of nucleic acid hybridization and cot curves - Polymerase Chain Reaction: Methods and advancements.

Enzymes in Molcular Biology: Nucleases, Restriction endonucleases, DNA Ligases, topoisomerases, gyrases, methylases, other modifying enzymes – Bacterial Transformation: Principles and methods.

UNIT-II

Vectors in Gene Cloning: Plasmids, Bacteriophages, Phagemids, Cosmids - Artificial Chromosomes: PAC, BAC, YAC. Cloning in Prokaryotes (*E.coli).* Cloning in Organisms other than *E.coli*: (Pseudomonas, *Bacillus subtilis*, Yeast and Fungi). cDNA sysnthesize and cloning:mRNA enrichment, Reverse transcription,DNA primers,Linkers,Adaptors. Library

construction and screening: Alternative strategies for gene cloning:cloning interaction genes. Two and three hybrid systems - Gene expression in Prokaryotes: merits and demerits – examples. How to study gene regulation? DNA transactions, primer extension, S1 Mapping, Rnase protection assay, Reporter assay.

UNIT-III

Expression strategies for heterologous genes.: vector engineering and codon optimization, host engineering, *in vitro* transcription and translation, expression in bacteria , yeast, insect, insect cells, mammalian cells, phage display.

UNIT-IV

A. Mapping of genome: Genetic and physical maps, physical mapping and map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence *in situ* hybridization for genome anlalysis, chromosome micro decection and micro cloning ,molecular markers in genome analysis; RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes ,application of RFLP in forensic, disease prognosis, genetic counseling.
B. Genome sequencing: Genomic libraries, YAC, BAC libraries, strategies for genome, packaging, transaction and recovery of clones, application of sequence information for defective gene identification.

UNIT-V

Gene Therapy: Strategies for gene delivery gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing,Si/micro RNA, antisense RNA, non coding RNAs regulation of genes. Gene therapy for inherited diseases, ADA, FH, Cystic Fibrosis, DMA, Neoplastic disorders, infectious diseases. Somatic Cell Gene therapy, Triple helix therapeutics, Antisense oligonucleotides, Ribozymes, Aptamers.DNA vaccines, Applications in medicine.Transgenic and gene knockout technologies: targeted gene replacement, chromosome engineering.

Techniques (Self Study):

Molecular biology and recombinant DNA methods: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, Epigenetic inheritance, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.

References:

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Pricinciples of Gene Manipulation. Blackwell Science Limited.
2. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W.Wu, D.Kim and L.J: Cseke, CRC Press, Florida, 1995.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA.
4. Bernard R. Glick,Jack J. Pasternak, Asm Press.
5. Methods in Enzymology Vol.152, guide to molecular cloning Techniques, S.L. Berger and A.R.Kimmel, Academic Press, Inc. San Diego, 1998
6. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
7. DNA Science, A First Course in Recombinant Technology, D.A.Mickloss and G.A.Freyar, Cold Spring Harbor Laboratory Press, New York, 1990.
8. Molecular Biotechnology (2nd Edition), S.B.Primrose, Blackwell Scientific Publishers, Oxford, 1994.
9. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
10. Route Maps in Gene Technology, M.R.Walker and R.Rapley, Blackwell Science Ltd., Oxford, 1997.
11. Genetic Engineering. An introduction to gene analysis and exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998
12. Human Molecular Genetics, Tom Strachan and Andrew P.Read, Bios Scientific Publishers, 1996.
13. LEWIN'S Gene X, J E. Krebs, E.S. Goldstein and S.T. Kilpatrick, Jones and bartlett Publishers, London.

Subject Title : Immunology

Course Number : 11BIOBC06 **Number of Credits: 4 (Four)**

Subject Description :

Scope: Understanding the immune system, antigen antibody reactions, applications of immunological techniques, humoral and cell mediated immunity, hypersensitivity reactions and hybridoma technology.

Objective: To expose the students with various immune systems of human body.

Goal: This course will provide the student insights into the various aspects of Immunology such as classical immunology, clinical immunology, Immunotherapy and diagnostic immunology.

UNIT I

The Immune System: Innate Immune response and its role in protection. Adaptive Immune response, the humoral and cellular component of the Immune response, Overlap

between Innate and adaptive immunity. Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Bone marrow, Spleen, lymph nodes, MALT. Haemopoiesis and differentiation, lymphocyte trafficking.

UNIT II

The antigens seen by the Immune System: Antigenicity and Immunogenicity. The epitopes seen by B Cells and T Cells. Antibody Molecule: Structure of antibody molecules; Function of antibody molecules; Antibody-Antigen interactions; Immunization protocol; The various immunotechniques for detection and quantification of antigens/antibodies: RID, ODD, immunoelectrophoresis, rocket immunoelectrophoresis, RIA, ELISA, western blot, floweytometry and immunofluorescence microscopy including *in situ* localization techniques such as FISH and GISH. Generation of antibody diversity. Antibody engineering: Hybridoma secreting monoclonal antibodies-Recombinant antibody molecules. Catalytic Antibodies.

UNIT III

Major Histocompatibility Complex: MHC molecules and organization of their genes; Structure and function of MHC gene products. Antigen Presentation: Antigen processing; Role of MHC and non-MHC molecules in antigen presentation. Structure of TCR and its interaction With MHC-I and MHC-II peptide Complex - T cell selection. Organization of TCR gene segments and their rearrangement. Activation of T-cells; Activation T_H and T_C cells; Generation of T memory cells; Apoptosis in T cells. B-Cell maturation: Activation of B Cells; Regulation of B-Cell mediated effector functions.

UNIT IV

Cytokines: structure of Cytokines; function of Cytokines. The Complement System. Cell mediated effector responses. Immune suppression and immune tolerance. Transplantation immunology- MLR, HLA Typing, Bone marrow transplantation, Organ transplants.

UNIT V

Hypersensitivity reactions, Autoimmune disorders, Immunity to Infectious agents - Bacteria, Viruses, Malaria, Anthrax and Helminthes. Tumor immunology, Tumor antigens, immune response to tumors, cancer immunotherapy Vaccine technology and recombinant vaccines.

References

1. J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork..
2. C.V.Rao. 2002, An Introduction to Immunology, Narosa Publishing House, Chennai.
3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
4. I.R.Tizard, 1995, Immunology: An Introduction , 4th edition , Saunders College Publishers, New York.
5. I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
6. A. Bul and K.Abbas, 1994, Cellular and Molecular immunology

Subject Title : Bioprocess Technology (Elective –II)
Course Number : 11BIOGE02 Number of Credits: 4 (Four)
Subject Description :
Core course : Bioprocess engineering / Bioprocess technology

Scope: This paper provides the thorough knowledge about types of microorganisms and their applications and there by producing various products of industrial and commercial uses.

Objective: In order make the students to understand the applications and uses of microorganisms.

Goal: Students will get the idea of fermentation technology and to produce economically important products and help to find out new methods and applications of microorganisms.

Unit I

Fundamentals of Bioprocess engineering: Introduction to bioprocess engineering.
Media design and usage in fermentation: Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors.

Microbial Growth: Isolation, Preservation and Maintenance of Industrial Microorganisms.

Inoculum development: Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes; aseptic inoculation of the fermentor.
Proteins as enzymes, Immobilized enzymes: methods, Industrial enzymes.

UNIT- II

Sterilization methods: Moist heat; dry heat, flame, filter, gas (ethylene oxide), HTST (high temperature/short time) treatments – continuous sterilizers and pasteurizers - Sterility, asepsis– medium sterilization, batch sterilization, contiuous sterilization, filter sterilization.

Microbial growth kinetics: Factors affecting microbial growth. Fermentation kinetics: Quantitative description of cellular process, Mass balances for bioreactors, Kinetic modeling, Population models.

Production Kinetics: Design for single and multiple reactions - size comparisons of single reactor for single reactions, multiple reactor systems for single reaction, reactions in parallel, in series, and series-parallel reactions of first order. Heterogeneous reactions, kinetics and mechanism of heterogeneous, non catalytic, and catalytic reactions.

UNIT –III

Bioreactors: Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; solid state and submerged; aerobic and anaerobic fermentation; mixed microbial populations; immobilization of cells and co-immobilization; immobilized cell reactors; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.,).

Design of Bioreactors: Construction material; Basic components – Agitator, aerator, Valves and steam traps,seals, stirrer glands; measurement and control of parameters (online and off line sensors) – temperature, flow rate, pressure, pH, DO, gas analysis, control pathways, computer in controlling; Air-lift, stirred tank, tower, fluidized bed, packed bed, pulsed, photo bioreactors.

UNIT -IV

Downstream Processing: Biomass removal: separation of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration; Disintegration of microorganism: Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Extraction(solvent, aqueous two phase, super critical), Drying – spray driers, drum driers and freeze driers.

UNIT –V

Microbial products in pharmaceutical, food and agriculture industry: Production, harvest, recovery and uses – enzymes, Antibiotics (penicillins, tetracycline, streptomycin), vitamins (B_2, B_{12}), Aminoacids (lysine, glutamic acid, arginine, threonine), Organic solvents (acetone, butanol, ethanol, glycerol); Organic acids (acetic acid, citric acid, lactic acid). Use of microbes in mineral beneficiation and oil recovery.

Production, harvest, recovery and uses – Baker's yeast, milk products, edible mushrooms. Single Cell Protein (algae/fungi).

Biofertilizer (Rhizobium, Azospirillum, Azolla, Phosphobacteria), Biopesticides (Bacillus thruingiensis, NPV, Pseudomonas)

Reference:

1. Principles of fermentation technology by P.F. Stanbury and A.Whitaker, Pergamon press. Second edition. 2005.
2. Fermentation microbiology and Biotechnology. Second edition, edited by El-.Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman. Taylor and Francis, 2007.
3. Introduction to Biochemical engineering by D.G.Rao, McGraw-Hill publications, I edition, 2007.
4. Industrial Microbiology by Prescott and Dunns 4th edition edited by Gerald Reed, Chapman & Hall publications 2007.
5. Industrial microbiology by L. E. Cassida Jr.

Subject Title : Animal Biotechnology

Course Number : 11BIOBC07 **Number of Credits: 4 (Four)**

Subject Description :

Scope: The study of animal cells has helped us gain an insight not only in the structure and function of cells and tissues but also in different physiological, biochemical and immunological processes. Biotechnologists explore and develop new technologies using molecular biology, embryo manipulation and cell and tissue culture. Research on gene regulation and early embryo development has resulted in novel techniques to manipulate and explore the genomes of domestic animals for ways to increase healthier food production as well as to develop biomedical applications.

Objective: The major objective is to provide a world-class training experience for these students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology**.**

Goal: This paper will help students interested in careers as laboratory, research or animal care technicians in the fields of veterinary and human health or biotechnology.

UNIT I

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, and applications. Culture Environment, Cell Adhesion, Cell Proliferation and Cell differentiation. Essential Equipments required for animal tissue culture, Aseptic Technique, Objectives, Elements, Sterile Handling, Risk Assessment and General Safety. Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media.

UNIT II

Primary Culture: Isolation of Tissue, Steps involved in primary cell culture, Cell Lines, Nomenclature, Subculture and Propagation, Immortalization of cell lines, Cell line designations, Routine maintenance. Characterization of Cell Line: Need for characterization, Morphology, Chromosome Analysis, DNA, RNA and Protein Content, Enzyme Activity and Antigenic Markers. Transformation of animal cell, Immortalization, Aberrant Growth Control, Tumorogenicity, Cell counting, Cell Proliferation, Plating Efficiency, Labeling Index, Generation Time of established cell line.

UNIT III

Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells. Cytotoxicity: measurement of cell death; Apoptosis and its determination; Cytotoxicity assays. Application of animal cell culture ; Vaccine production; Tissue engineering; Engineered cell culture as source of valuable products and therapeutic protein production.

UNIT IV

Transgenic Animals: Production Methodology-Embryonic Stem Cell method, Microinjection method, Retroviral vector method; Applications of transgenic animals-in therapeutic protein production; live stock improvement; Transgenic animals as disease models. Gene Therapy: Ex-vivo gene therapy, In vivo gene therapy, Germline gene therapy and Somatic gene therapy ; Vectors in gene therapy: Viral gene delivery system- Retrovirus vector system, Adenovirus vector system, Adeno-Associated virus vector system, Herpex simplex virus vector system; Non-viral gene delivery system; Prodrug activation therapy; Nucleic acid therapeutic agents. Gene targeting, silencing and knockout technologies.

UNIT V

In Vitro Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. Stem cell culture, embryonic stem cell and their applications. Ethical issues in animal biotechnology.

References

1. Animal cell culture; A practical approach, 4th Edition, by Freshney. R.I. John Wiley publication.
2. Methods in cell biology; Volume 57, Animal cell culture methods, Ed. Jennie P.Mather, David Barnes, Academic press.
3. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford university press.
4. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
5. Principles of genetic manipulation; Ed. Old and Primrose, 6th Edition. Blackwell science publication.

Subject Title : Plant Biotechnology
Course Number : 11BIOBC08 Number of Credits: 4 (Four)

Subject Description

Scope: Students will learn about genome organization in plants, basic techniques in tissue culture and its applications, Genetic transformation in plants, metabolic engineering, production of pharmaceuticals and industrial products.

Objective: To equip students to fully aware of the applications of plant biotechnology.

Goal: This paper has been designed to give the students comprehensive training in the plant biotechnology and its application for increasing agricultural production, environment improvement, human, nutrition and health. Help students to get a career in both industry/R&D.

UNIT – I

Genome organization in Plants: Nucleus, Chloroplast and Mitochondria, Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites,

SCAR (Sequence Characterized Amplified Regions), SSCP (Single Strand Conformational Polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.

UNIT – II

Plant Cell and Tissue Culture: Tissue culture media (composition and preparation), Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; transfer and establishment of whole plants in soil; green house technology. Embryo culture and embryo rescue. Artificial seeds. Protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants. Cryopreservation and DNA banking for germplasm conservation.

UNIT – III

Plant Genetic Transformation methods: Features of Ti and Ri plasmids and its use as vectors, binary vectors, viral vectors, 35S and other promoters, use of reporter genes and marker genes, Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages. Transgene stability and gene silencing.

UNIT – IV

Application of Plant Genetic Transformation: Herbicide resistance: phosphoinothricin, glyphosate, sufonyl urea and atrazine. Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors, alpha amylase inhibitor. Disease resistance: chitinase, 1,3-beta glucanase, RIP, antifungal proteins, thionins, PR proteins; Virus resistance: coat protein mediated, nucleocapsid gene. Nematode resistance. Abiotic stress: Drought, cold and salt. Post-harvest losses: long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase, RNAi and Reverse genetics.

UNIT – V

Metabolic Engineering and Biopharmaceuticals: Plant secondary metabolites, control mechanisms and manipulation of phenylproponoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology, Plant host-insect interactions- *nif* and *nod* genes.

References

1. An introduction to genetic engineering in plants, Mantel, Mathews and Mickee, 1985. Blackwell Scientific Publishers. London.
2. *In Vitro* culture of higher plants by R.L.M. Pierik, 1987. Martinus Nijhoff Publisher, Dordrecht.
3. Plant cell culture. A practical approach. Second edition. Edited by R.A. Dixon and R.A. Gonzales.1994.Oxford University Press. Oxford.
4. Plant Molecular Biology by Donald Grierson and S.V. Convey.1984. Blackie and Son Limited. New York
5. Plant Biotechnology by Mantell, S.H and Smith, H. 1983. Cambridge University press, UK

6. Plants, genes and agriculture by M.J. Chrispeels and D.F. Sadava.2000.The American Scientific Publishers, USA.
7. Practical Application of Plant Molecular Biology by R.J. Henry.1997. Chapmans and Hall.
8. Plant Biotechnology by J.Hammond, P. Mc Garvey and V. Yusibov 2000 Springer Verlag, UK
9. Plant Biotechnology and Transgenic Plants, Edited by Kirsi-Marja Oksman-Caldentey and Wolfgang H. Barz. 2002, Marcel Dekker, Inc. New York.
10. Plant Biotechnology (The genetic manipulation of plants) by Adrian Slater, Nigel W. Scott and Mark R. Fowler, 2003, Oxford University press, UK.
11. Molecular Plant Biology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, Oxford University press, UK.

Subject Title : Environmental Biotechnology
Course Number : 11BIOBC09 Number of Credits: 4 (Four)
Subject Description

Scope: To understand the energy sources, environmental pollution and remediation using biotechnology and its control.

Objective: Students will get an idea about the hazards to our environment, solutions to protect and for sustainable development.

Goal: This course is important in the era of industrialization leading to environmental hazards and hence will help students to take up a career in tackling industrial pollution and also who is willing to take up the research in areas like development of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes such as green manufacturing technologies and sustainable development.

UNIT - I

Bio-Fuels and Bio-Energy: Biofuels and sources, Advantages, Genetic improvement through metabolic engineering; Commercial success of Biofuels, Future energy needs and direction of research.

UNIT – II

Environmental pollution: Types of pollution, methods for the measurement of pollution, air pollution and its control, Global environmental problems: ozone depletion, green house effect and acid rain, principles of conservation and application of biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling, bioindicators and biosensors for detection of pollution. Solid waste: Sources and management (composting, vermiculture and methane production).

UNIT – III

Water Pollution and control: Need for water management, measurement and sources, water pollution. Waste water treatment: waste water collection, physico-chemical properties of waste water, physical, chemical and biological treatment processes. activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion, anaerobic filters, up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

UNIT – IV

Xenobiotics: Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. biopesticides; bioremediation and Phytoremediation.

UNIT – V

Environmental Impact Assessment and Environmental Acts: Ecoplanning and sustainable development: Indian standards IS: 2490, IS:3360, IS:3307, IS:2296, ISO: 14000 series, MINAS for industries and Ecomarks, Public liability insurance act, ElA guidelines and assessment methods, Agenda 21 and Carbon credit.

References

1. Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England.
2. Environmental biotechnology by S.N. Jogdand. Himalaya Publishing House. Bombay.
3. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi
4. Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi.
5. Introduction to Biodeterioration by D. Allsopp and k.J. Seal, ELBS/Edward Arnold.
6. Environmental Science (5th Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill. 1999.
7. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
8. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press.
9. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and JosefWinter. Winter-VCH. 2005
10. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
11. Environmental Biotechnology: Principles and Applications. Bruce Rittmann and Perry McCarty, Mc Graw Hill

Subject Title : Stem cell biology and Tissue Engineering

Course Number: 11BIOGE03 Number of credits: 4

Subject Decsription:

Scope: The course is to offer the student state of the art education of stem cells and how the pluripotent and multipotent cells can be used to treat the neurodegenerative disorders, cardiovascular disorders and diabetes. This course will also review the current scenario of tissue engineering applications in bioartificial organs development and transplantation.

Objectives: The course will provide students with knowledge of wide ranging topics related to stem cells, regenerative biology and tissue engineering.

Goal: The course goal is to introduce students to updated fundamental knowledge, technological advancements and potential applications of stem cells and tissue engineering.

Unit-I

Introduction to Stem Cells – Definition, Classification, characteristics, Differentiation and dedifferentiation, Stem cell niche, stem cell Vs cells; Basic culture procedures – Isolation, culture methods, identification, stem cell markers, feeder layer; Instrumentations in stem cell biology.

Unit-II

Different kinds of stem cells – Adult Stem cells, Embryonic stem cells, Embryonic Germ cells, Heamtopoietic stem cell, Neural stem cells, muscle and cardiac stem cells, Umbilical cord blood stem cells, cancer stem cells, Mesenchymal stem cells, Induced pluripotent Stem cells.

Unit-III

Therapeutic applications – stem cells and neurodegenerative disorders, stem cells and diabetes, stem cells and cardiac disorders, regeneration of epidermis, Success stories of stem cell therapy. Stem cell banking around the world. Current status of Stem cell research. World federal fundings for stem cell research; Public view and ethical approaches on stem cells.

Unit – IV

Principles of Tissue Engineering – History and scope, Basics of Tissue Engineering, Tissue Engineering triangle, Cell-ECM interaction, wound healing mechanism, Tissue Engineering Bioreactors, Models of Tissue Engineering, Biomaterials in Tissue Engineering.

Unit – V

Bioartificial organs – source of cells, choosing the right scaffold material, mode of transplantation. Epidermal Tissue engineering, Bladder reconstruction, Skin equivalents, Liver reconstruction, Bone regeneration through tissue engineering, Tissue Engineering and future perspectives.

Self study: Confocal Microscopy, Fluorescence microscopy, FACS.

Reference

1. Stem cells: Scientific progress and future research directions – NIH report. Available @ www.stemcells.nih.gov/index ; www.stembook.org.
2. Essentials of Stem cell Biology – Robert Lanza, John Gearhart, Brigid Hogan.
3. Stem cell now – Christopher Thomas Scott.
4. Principles of Tissue Engineering – Robert Lanza.
5. Tissue Engineering – B.Palsson, J.A.Hubbell.

Subject Title : COMPUTATIONAL BIOLOGY
Course Number : 11BIOBC10 Number of Credits: 4 (Four)
Subject Description :

Scope: To provide molecular biologists the modern molecular databases and tools including literature, sequence, structure and expression databases.

Objective: To provide information an understanding of the major computational problems in the field of molecular biology.

Goal: To gain knowledge on molecular databases, comparative genomics, pattern search, classification of sequence and structure, alignment of sequences, rapid similarity searching, phylogenies, automated pattern learning, representing and searching protein structure, gene expression profiling, clustering expressed genes, discovering transcription factor binding sites,discovering common functions of co-expressed genes, metabolic pathways, signal transduction pathways.

Contents:

Unit – I

Biological Data bases : Gen Bank: Sequence data / types; – Protein data bases-ESTs-STSs – GSSs - HTGS; NCBI – PubMed – Entrez – BLAST – OMIM; Types of accession numbers - Locus link, Uniigene, Entrez, EBI and Expasy.

Unit - II

Sequence Alignment: Alignment algorithms - Global and Local - Significance; BLAST search steps - BLAST algorithm - BLAST search strategies; Advanced BLAST - Alignment tools.

Unit - III

Gene Expression analysis tools: The mRNA- cDNA - Libraries ; Microarrrays: Experimental design-Probe- Hybridization-Image analysis-Data analysis- Biological confirmation - Microarray Databases.

Unit - IV

Proteomic analysis tools: Protein domains and motifs - Bioinformatic tools for high throughput protein analysis- protein structure- homology and functional genomics-

Unit V

Molecular Phylogeny and Genome analysis: Molecular evolution-Phylogenetic analysis - Role of bioinformatics in taxonomy - Genome sequencing project - Genome annotation –Bioinformatics perspective on human diseases.

Techniques (Self Study):

Computational methods: Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.

References:

1. Bioinformatics and Functional Genomics by Pevsner, J**.** A John Wiley & Sons, Inc., USA**.**
2. Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley- Dream Tech India Pvt. Ltd.
3. Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reilly publications.
4. Introduction to bioinformatics by T.K. Attwood and D.J. Parry –Smith, Pearson Education Asia.
5. Bioinformatics by David.W.Mount, CBS publishers and distributers.
6. Instant notes in bioinformatics by D.R. Westhead, J.H.Parish and R.M.Twyman.
7. Biostatistical analysis. Zar.J.H
8. Peuzner, P.A., Computational molecular Biology, An algorithmic approach.

Subject Title: Biosafety, Bioethics and IPR

Course Number: 1BIOBC11 **Number of Credit Hours: 4(Four)**

Subject Description:

Scope: This course has been designed to provide the student insights into these invaluable areas of biotechnology, which play a crucial role in determining its future use and applications.
Objective: Students get an idea about the advantages and disadvantages of biotechnological applications, ethical implications, and intellectual property rights.
Goal: To study the diversity of plants and animal life in a particular habitat, ethical issues and potential of biotechnology for the benefit of man kind.

UNIT I

Introduction to biodiversity – levels of biodiversity –values of biodiversity – loss of biodiversity – Species concept – Classification and systematics: biological nomenclature – biological classification; Biodiversity conservation: *in situ* and *ex situ* - Magnitude and

distribution of biodiversity - wild life biology – conservation strategies – measures of biodiversity – biodiversity in India and global level – biodiversity hot spots.

UNIT II

Introduction to ethics/bioethics – Framework for ethical decision making; biotechnology and ethics – biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

UNIT III

Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT IV

Introduction to biosafety – biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containments.

UNIT V

Introduction to intellectual property and intellectual property rights – types: patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

References:

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press,2002Glimpses of Biodiversity – B.Bltosetti
2. Ehics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
3. http://books.cambridge.org/0521384737.htm
4. http://online.sfsu.edu/%7Erone/GEessays/gedanger.htm
5. http://www.actahort.org/members/showpdf?booknrarnr=447_125
6. http://www.cordis.lu/elsa/src/about.htm
7. http://www.biomedcentral.com/content/pdf/1472-6939-2-2.pdf
8. http://lifesciences.cornell.edu/vision/accelerating_focus05.php
9. http://thompson.com/libraries/fooddrug/
10. http://assets.cambridge.org/0521792495/sample/0521792495WS.PDF
11. http://europa.eu.int/eurlex/pri/en/oj/dat/1998/I_213/I_21319980730en00130021.pdf
12. http://www.clubofamsterdam.com/content.asp?contentid=281
13. Biosafety issues related to transgenic crops,DBT guidelines, Biotech Consortium India Limited, New Delhi.

Subject Title : Systems Biology
Course Number : 11BIOBC12 Number of Credits: 4 (Four)
Subject description

Scope: Biology is fast becoming an interdisciplinary science. There is accumulation of large amount of information in different areas of biology - on genome sequences of many organisms, genetic and biochemical interaction networks, cell interactions during development, and organism response to environmental stimuli, along with molecular understanding of diseases. This has led to the emerging need for a holistic description of the working of biological systems at different scales.

Objectives: Gain an appreciation for the field of systems biology. Understand and learn the technical details of several current experiments or technologies used in the field of systems biology. Understand some of the larger questions and issues with systems biology and large-scale data collection and analysis.

Goal: This paper has been designed to give the students comprehensive training in the emerging exciting upcoming area of Systems Biology, which will help students to get a career in both industry/R&D.

UNIT-I

Systems Biology: Definition; Hypothesis driven research in systems biology: Wet experiments – Dry experiments: predictions and simulations. Molecular databases: Accessibility, compatibility, comprehensive database, portability, quality and navigability. Reductionist approach and Integrative approach

UNIT-II

Genes and Genomes: Interpreting expression data using Gene Ontology; Evolution of modularity and transcriptional networks, Riboswitches, metabolite sensing and translational control- Microarrays – types and applications. Comparative genomics of non-coding sequence

UNIT-III

Pathway bioinformatics: Protein – carbohydrate metabolism – Biochemical cycles – Interconnection of pathways – metabolic regulation – Translating biochemical networks into linear algebra – KEGG: theory and practice.

UNIT-IV

OMICS Concepts: Genomics, Proteomics, Metabolomics, transcriptomics, intactomics, Phenomics, localizomics; gene networks - Integration of Networks. Combination of omics approaches: data integration, modeling and synthetic biology

UNIT-V

Computer Tools for Systems Biology: SimTK ; Gaggle; Systems Biology Workbench; Systems Biology Markup Language; The CellML language; The little b Modeling Language; Copasi (Version 4 of Gepasi); E-Cell System; StochSim; Virtual Cell; JigCell (John Tyson Lab);

Python Simulator for Cellular Systems; Ingenuity Pathways Analysis; BIOREL; SAVI Signaling Analysis and Visualization; JSim; BioNetGen; SBML-PET.

References:

1. Kitano H. Systems Biology: A Brief Overview. Science, 2002, 295: 1662-1664.
2. Ideker T. et al. A new approach to decoding life: Systems Biology. Annu. Rev. Genomics Hum. Genet., 2001, 2: 343-372.
3. Ideker T. et al. Integrated Genomic and Proteomic Analyses of a Systematically Perturbed Metabolic Network. Science, 2001, 292: 929-934
4. Ge H. et al. Integrating 'omic' information: a bridge between genomics and systems biology. Trends in Genetics, 2003, 19, 10: 551-560.
5. Chong L et al., Whole-istic Biology, Science, Vol 295, no. 1, March 2002, p. 1661.
6. Catherine Brooksbank*, Graham Cameron and Janet Thornton. (2005).The European Bioinformatics Institute's data resources: towards systems biology. Nuc. AC Res. 33:D46-D53.

Subject Title : Pharmaceutical Biotechnology
Course Number : 11BIOBC13 Number of Credits:4 (Four)
Subject Description :
Scope
This paper encodes information on drug designing, drug discovery and drug metabolism.

Objective
To enable the students to know the actual path of metabolism of drugs and drug discovery.

Goal
The information gained will help the students to formulate novel drugs.

UNIT I

Prokaryotic and Eukaryotic Cells in Biotech Production: Actinomycetes in Biotech Production, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in Biotech Production, Transgenic Plants as Functional Foods or Neutraceuticals Transgenic Plants and Plant Cell Culture as Bioreactors of Secondary Metabolites, Transgenic Plants as Bioreactors of Recombinant Protein.

UNIT II

Drug Modifications Pharmacodynamics of protein therapeutics; Chemical modification of proteins/ therapeutics; Immuno suppressor in antibody therapy; Pharmaco Genomics.**,**Molecular modification of lead compounds; Assay systems and models (e.g., Knock-out Mice). Antisense technology as cell based therapeutics.

UNIT III

Pharmaceuticals production in Plants**: :Drugs derived from plants, , Antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic – Convallatoxin, Acetyldigoxin, Adoniside, Antiinflammatory – Aescin, Bromelain, Choleretic – Curcumin**, **Biopharmaceuticals Expressed in Plants Alternative Expression Systems, Three Promising Examples: Tobacco (Rhizosecretion, Transfection) and Moss (Glycosylation)**

UNIT IV

DNA Vaccines and antibody drug: DNA Vaccine Construction and Immunology DNA Vaccine Expression Plasmids Delivery of DNA Vaccines. Peptide vaccine, Gene Pharming, Cytokines as biopharmaceuticals, Rituximab, therapeutic enzymes.

UNIT V

Biogeneric Drugs Recombinant Therapeutic Proteins Erythropoietin (EPO), Colony-stimulating Factors (CSFs), Human Growth Hormone (hGH), Insulins, Hepatitis B Vaccine, Factor VIII (FVIII), Interferons (IFN) **.**Therapeutic hormone- insulin production through recombinant DNA technology.

REFERENCE

1. Oliver Kayser, Rainer H. Müller, Wiley Publishers, 2005. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications

2. Heinrich Klefenz, 2002, Industrial Pharmaceutical Biotechnology, WILEY-VCH Publication, Germany.

3. Daan Crommelin, Robert D Sindelar, 2002, Pharmaceutical Biotechnology, Tailor and Francis Publications, Newyork.

4. Jay P Rho, Stan G Louie, 2003, Hand book of Pharmaceutical Biotechnology, Pharmaceutical products press, Newyork.

5. Lachman L Lieberman, HA, Kanig, J, 1986, Theory and practice of industrial pharmacy, 3rd edition, Varghese publishing & Co, New Delhi.

6. 2000, Remington's Pharamaceutial sciences, 18th edtion, Mack publishing & Co., Easton,PA.

Practicals - I : Basic Biotechnology

Subject code: 11BIOBCP1 Number of Credits:4 (Four)

Students are advised to collect the practical protocols well in advance from the respective facult

Enzyme Biotechnology Laboratory - Dr. R. Boopathy

1. Determination of protein by Lowry method.
2. Determination of specific activity of the enzyme.
3. Determining the type of inhibitors for an enzyme.
4. Visualization of enzyme activity in Native PAGE.

Animal cell culture and Molecular Genetics Laboratory – Dr. V. Vijayapadma

5. Separation of peripheral mononuclear cells from the blood.
6. Culturing Lymphocytes from Peripheral blood samples.
7. Determination of Lipid peroxidation.
8. Assessing genotoxicity by COMET assay.

Molecular Toxicology Laboratory - Dr. P. Ekambaram

9. Hematology: RBC and WBC total counts, WBC differential count.
10. Mitotic index.
11. Micrometry.
12. Mounting of polytene chromosome from Chironomous larvae.

Plant Genetic Engineering Laboratory – Dr. R. Sathiskumar

12. Introduction to plant tissue culture-induction of callus and suspension cultures.
13. Isolation and purify the protoplasts and check its viability.
14. Induction of somatic embryogenesis and analysis of different stages.
15. Extract the genomic DNA from plants by CTAB method and resolve in the Agarose Gel.

Plant Biotechnology Laboratory – Dr. S. Girija

16. Isolation of genomic DNA from medicinal plant by SDS method (Peterson *et al*., 1993).
17. Staining of live plant cells.
18. Isolation of *Ri* plasmid from *Agrobacterium rhizogenes.*
19. Quantification of flavanoid content in fruit sample.

Molecular Microbiology Laboratory – Dr. S.R. Prabagaran

20. Isolation of Microorganisms from various environments (food, effluent, soil/sea, Glaciers).
21. Cultivation of Bacteria, Actinomycetes, Fungi and Archaea.
22. Staining techniques and microscopy.
23. Biochemical observations of Bacteria (Antibiotics/Enzymes).

Practicals – II : Advanced Biotechnology

Subject code: 11BIOBCP2 Number of Credits:4 (Four)

Enzyme Biotechnology Laboratory – Dr. R. Boopathy

1. Identification of BChE gene using PCR.
2. Construction of BChE cDNA by reverse transcriptase.
3. Purification of BChE by DEAE cellulose column.
4. Determination of molecular weight of the protein by SDS PAGE.

Animal cell culture and Molecular Genetics Laboratory – Dr. V. Vijayapadma

5. Determination of antigen concentration by Radial immunodiffusion.
6. Determining antigen specificity by Double immunodiffusion.
7. Determination of antigen concentration by Rocket immunoelectrophoresis.
8. Passive heamagglutination assay for detection of soluble antigen.

Molecular Toxicology Laboratory – Dr. P. Ekambaram

9. Isolation of DNA from animal cells.
10. Estimation of Iron in water samples.
11. Estimation of chromium in water samples.
12. Drug administration methods.

Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar

13. Particle gene gun mediated genetic transformation of GUS gene in tobacco.
14. Analysis of GUS gene in transgenic plants by histochemical staining
15. Identification of WT/ Transgenic plant by PCR.
16. Perform the restriction digestion for the given DNA sequence and comment.

Plant Biotechnology Laboratory – Dr. S. Girija

17. Micropropagation, callus induction and regeneration using different explants of Plants.
18. *Agrobacterium rhizogenes* for hairy root culture.
19. Qualitative analysis of transgenic using phenolics content.
20. Estimation of Plumbagin (anticancer compound) in callus culture.

Molecular Microbiology Laboratory – Dr. S. R. Prabagaran

21. Mini prep of plasmid DNA and elution of DNA from gel.
22. Isolation of RNA from bacteria.
23. Competent cell and Electrocompetent cell preparation.
24. Transformation and Electroporation.

Practicals – III : Applied Biotechnology

Subject code: 11BIOBCP3 Number of Credits:4 (Four)

Enzyme Biotechnology Laboratory – Dr. R. Boopathy

1. Prediction and validation of protein structure (AChE using modellar)
2. Prediction of binding mode of receptor ligand (AChE/Tacrine/Gallanthamine)
3. Determination of interactive residues on ligand receptor complexes (chimera/SPV/PyMol).
4. Sequence analysis of nucleic acid (BLAST, MSV), motif analysis and domain identification for protein.

Animal cell culture and Molecular Genetics Laboratory – Dr. V. Vijayapadma

5. Checking the cell viability by MTT assay
6. Determination of cytotoxicity by Nitric oxide assay
7. Determination of cytotoxicity by measuring lactate dehydrogenase activity
8. Determination of Apoptosis through DNA fragmentation analysis

Molecular Toxicology Laboratory - Dr. P. Ekambaram

9. Preparation of primary cells from chick embryo.
10. Cell counting and cell viability.
11. Trypsinization of monolayer and subculturing
12. Sex chromatin identification from Buccal smear

Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar

13. Screening of rice germplasm for aroma using PCR-RFLP analysis
14. Transient gene expression in tobacco by infiltration of *Agrobacterium* culture
15. Determination of protein expression (transgene) by western blotting
16. Pair wise and multiple sequence alignment of nucleic acids and proteins

Plant Biotechnology Laboratory - Dr. S. Girija

17. Determination of Free radical scavenging activity by DPPH assay
18. Determination of secondary metabolite (Eugenol) using TLC and confirmation by HPLC
19. Determination of Iron chelating activity of medicinal plant extract
20. ISSR marker analysis for medicinal plant identification.

Molecular Microbiology Laboratory - Dr. S.R. Prabagaran

21. Metagenomic DNA isolation from problem soils
22. Estimation of mol% G+C content of DNA (Tm)
23. Detection of FAMEs through GAS chromatography
24. Southern blotting/dot blotting

Course: Supportive I –Tools in Biotechnology
Subject Code: 11BIOGS01 Number of Credits:2 (Two)

UNIT-I:

Gene and Genomes
Prokaryotic and Eukaryotic Genomes - Structure of Gene - DNA as the genetic material; Extra chromosomal DNA: Plasmid, mitochondrial DNA and chloroplast DNA.

UNIT-II:

Cloning Vectors
Vectors: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, CaCl2 method.

UNIT-III:

Tools for Gene Manipulation
Enzymes: Gel Electrophoresis: AGE and PAGE; Restriction Enzymes, Ligases, Modifying Enzymes - Markers for Selection: selectable and scorable - Examples.

UNIT-IV:

Selection Strategy and Screening for Transformants
Selection of rDNA Clones: Blue-White Selection, Colony Hybridization, PCR, Molecular analysis: Western blotting, Southern Blotting and Northern Blotting.

UNIT-V:

Application of Cloning
Over expression of Biomolecules (Insulin) - Gene therapy – GMO – DNA Finger printing Application and Biosafety issues

References
1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Principles of Gene Manipulation. Blackwell Science Limited.
2. Molecular Biotechnology. S.B Primrose, Blackwell Scientific Publishers, Oxford, 1994.
3. Principles of Gene Manipulation. T.A.Brown
4. DNA Science – A first course in rDNA technology, D.A. Mickloss nd G.A.Freyar, Cold Spring Harbor laboratory Press, New York, 1990.
5. Molecular Cloning. Maniatis, Fritsch and Sambrook.a

Course: Supportive II- Medical Biotechnology

Subject Code: 11BIOGS02 Number of Credits:2 (Two)

Unit I

Introduction to Biotechnology and medicine:
Medicine field of 21st century, Role of Biotechnology in medicine, rDNA technology, Vaccines, MoABS.

Unit II

Molecular Diagnostics:
Importans of diagnosis-PCR based diagnosis for infections diseases (HIV, Hepatitis, Typoid, Filariasis) ,Cancer and genetic disorders

Unit III

Cell and gene mediated therapy:
Introdcution to stem cells-History ofstem cell research-Classification of stem cells –Stem cell banking-applications of stem cells-importance of stemcells- regulations of stem cell research -Gene theraoy;outline and methods.

Unit IV
Assisted reproductive techniques:
Introdcution-causes of infertility-methods;IVF-Intra uterine insemination-cryopreservaton of germcells.

Unit V
Tissue Engineering
Introduction-Bioartificial organs-Historical backgrogund-liver-kidney-skin-pancreas-Urinary bladder-bone-Challenges and advantages.

Ref: Medical Biotechnology-P.C.Trivedi(2008)

Course: Supportive III - PLANT MOLECULAR FARMING
Subject Code: 11BIOGS03 Number of Credits: 2 (Two)

Unit I
Production technologies

Efficient and reliable production of pharmaceuticals in alfalfa; Foreign protein expression using plant cell suspension and cultures; Novel sprouting technology for recombinal protein production monocot expression systems for molecular farming the field evaluation of transgenic crops engineered to produce recombinant proteins; plant viral vectors: history and new developments

Unit II
Pharmaceuticals

Production of pharmaceutical proteins in plants and plant cell suspension cultures; chloroplast derived antibodies, biopharmaceuticals and edible vaccines; plant-derived vaccines: progress and constraints; production of secretory IgA in transgenic plants

Unit II
Field trial

Production of spider silk proteins in transgenic tobacco and potato ;Gene farming in pea under field conditions

Unit-IV
Production

Host plants, systems ad expression strategies for molecular farming; Downstream processing of plant-derived recombinant therapeutic proteins; Glycosylation of plant-made pharmaceuticals

Unit-V
Product issues

Biosafety aspects of molecular farming in plants; A top-down view of molecular farming from the pharmaceutical industry: requirements and expectations; The role of science and discourse in the application of the precautionary approach

Reference:

1. Molecular farming:Plant made pharmaceuticals and technical proteins (2004) Eds.Rainer Fischer and Stefan schillberg , Wiley publishers,USA