

I SEMESTER (THEORY)

BTH- 101: CELL BIOLOGY

Total Hours: 52

Unit 1

Basic Characteristics of the Cell:

Structure, organization and composition of prokaryotic and eukaryotic cell. Plasma membrane- structure and functions, membrane models. Components of Blood & their functions (Plasma, RBC, WBC, Platelets). Extracellular matrix (collagen, proteoglycans, fibronectin, lamins).

8 Hours

Unit 2

Cytoskeleton:

Nature of cytoskeleton, Actin filaments, actin binding proteins, Intermediate filaments, Microtubules, MAPs, Structure and functions of cilia and flagella.

8 Hours

Unit 3

Membrane Transport:

Transport across membrane- passive diffusion, osmosis, active transport, Ion Channels, A B C transporters, Na⁺ and K⁺ pump, Ca²⁺ ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic.

8 Hours

Unit 4

Cell Signalling:

Cell to cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight and gap junctions, Desmosomes, plasmodesmata. General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers.

8 Hours

Unit 5

Cell Cycle:

Molecular events of cell division and cell cycle, regulation of cell cycle events- Cyclins, Cyclin dependent kinases, inhibitors. Apoptosis, necrosis.

6 Hours

Unit 6

Specialized Cells (Muscle & Nerve cells):

Structure & functions of muscles (Straited, nonstraited and cardiac). Molecular basis of muscle contraction. Structure of neuron, neuroglia. Mechanism of nerve transmission- Resting and action potential, electrical and chemical transmission, Neurotransmitters and their receptors.

8 Hours

Unit 7

Antioxidant defence system and Senescence:

Free radicals- ROS, RNS. Effect of free radicals on Proteins, Lipids and Nucleic acids. Mechanism of antioxidant defence system- enzymatic and non-enzymatic. Senescence-theories and concepts of aging.

6 Hours

References:

1. Matthews, C.A. (2003). Cellular physiology of nerve and muscle. 4th Edn. Blackwell publishers.
2. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K., Watson, J.D. (1994). Molecular Biology of the Cell.
3. Cooper, G.M. (1997). The Cell: A molecular approach, ASM Press, USA.
4. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
5. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
6. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
7. Holy Ahern (1992). Introduction to Experimental Cell Biology, Wm. C. Brown Publishers.
8. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
9. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastysdaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.
10. Tobin and Morel (1997). Asking about "Cells" Saunders College Publisher.
11. Wolfe, S.L. (1991). Molecular and Cellular Biology, Wordsworth Pub.Co.
12. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.
13. Kanugo, M.S. (2002) Genes and aging. Cambridge University Press.

BTH- 102: MOLECULAR GENETICS

Total Hours: 52

Unit 1

Physical basis of Heredity:

Introduction, concepts and theories of Mendelian genetics, chromosome theory of inheritance, Nucleus, nucleolus and extra chromosomal inheritance. 6 Hours

Unit 2

Chromosomes and Genes:

Structure and organization of eukaryotic chromosomes: Super coiled loops, domains and scaffolds in eukaryotic chromosome. Difference between interphase chromatin and mitotic chromosomes. Heterochromatin, euchromatin and telomeres. Nucleosomes- Organization of DNA in the nucleosome, histone octamer. Split genes and overlapping genes, gene interaction. Human chromosomal aberrations, karyotype analysis- normal and abnormal karyotype.

10 Hours

Unit 3

Genetic Recombination:

Mechanism of recombination, Holliday, White house and Radding models, Enzymes involved in homologous and site specific recombination. Breakage and reunion of DNA at specific sites. Synapsis of homologous duplexes, role of RecA in recombination. Topological manipulation of DNA

Bacterial Recombination-Transformation, conjugation, transduction, plasmids and episomes- Application in genome mapping of E. coli. 10 Hours

Unit 4

Transposable Genetic Elements:

Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance. Transposable elements in human and their genetic and evolutionary significance.

8 Hours

Unit 5

Mutation:

Base pair and frame shift mutation, genetic suppression. Molecular basis of mutation – spontaneous and induced mutation and their role in evolution.

Detection of mutation – Ames's test, Mutation in – yeast, neurospora and chlamydomonas. Mutation studies in drosophila and human disorders by mitochondrial genome mutation.

10 Hours

Unit 6

Sex Determination and Dosage Compensation:

Sex determination in Drosophila and mammals. Secondary sex determination in mammals. Dosage compensation in Drosophila and mammals. 4 Hours

Unit 7

Population Genetics:

Gene pools, allele frequencies, Hardy Weinberg equation, non random breeding, genetic drift, gene flow, selection, speciation. Protein and DNA sequence polymorphism, molecular basis of evolution in Homosepians. 4 Hours

References:

1. David Freifelder. (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
2. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastysdairs and Darnell, J. (2004). Molecular cell biology. Scientific American Books Inc., NY.
3. Gardner/Simmons/Snustad. (2006). Principal of Genetics. 8th Edn. John Wiley & sons.
4. Klug, W.S., Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.
5. Dale, J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
6. Streips and Yasbin. (2001). Modern microbial Genetics. Niley Ltd.
7. John Ringo (2004). Fundamental Genetics. Cambridge University Press.

BTH-103: GENERAL MICROBIOLOGY

Total Hours: 52

Unit 1

Microbial classification:

Three domain system of classification, Phylogenetic Relationships, Code for bacterial nomenclature and taxonomy, Criteria for microbial classification-morphological, staining techniques, biochemical methods, serological techniques, phage typing, fatty acid profiles, Flow cytometry, DNA base composition, DNA fingerprinting, rRNA sequence, Nucleic acid hybridization, Numerical Taxonomy, Chemotaxonomy, Classification of bacteria according to Bergey's Manual of systematic Bacteriology, Dichotomous keys, Cladograms, dendrograms, universal phylogenetic tree.

12 Hours

Unit 2

Prokaryotic Microorganism- General properties, Structure, and Reproduction:

Domain Bacteria: Proteobacteria (Alpha, Beta, Gamma, Delta and Epsilon Proteobacteria), Cyanobacteria, Chlorobium, Firmicutes, Actinobacteria, Chlamydiae, Spirochaetes, Bacteroidetes, Fusobacteria. Domain Archea: Crenarchaeota, Euryarchaeota.

10 Hours

Unit 3

Eukaryotic Microorganisms- General characters, Structure and Reproduction:

Fungi (Saccharomyces), Algae (Spirulina), Protozoa (Plasmodium), Slime molds (Physarum)

8 Hours

Unit 4

Viruses, Virioids and Prions (Acellular entities)

General characters, Structure, Criteria for classification of Viruses, Viruses that affect humans, animals and plants, Isolation, cultivation and identification of Viruses (Growing in Bacteria, Living Animals, embryonated eggs, Cell Cultures). Viral Multiplication (Lytic and lysogenic life cycle), Virioids and Prions - General properties and diseases caused by virioids and prions.

10 Hours

Unit 5

Microbial Growth and Control

Physical parameters (Temperature, pH, Osmotic Pressure), Chemical parameters (Carbon, Nitrogen, Phosphorous, Sulphur, Trace elements, oxygen), Growth factors, Culture Media, Phases of Growth, Growth Measurements, Microbial growth control -Physical methods (Heat, Pasteurization, Filtration, Radiation, Dessication, Low Temperature, High Pressure, Osmotic Pressure) and Chemical Methods (Phenols, Halogens, Alcohols, quaternary ammonium compounds).

6 Hours

Unit 6

Microbiological methods:

Isolation and cultivation of microorganisms from Water, Soil, Air, Rhizosphere, Phyllosphere and Mycorrhiza, Biogeochemical cycle.

6 Hours

References:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NR Krieg 5th Edition, Pub: Tata Mcgrah-Hill Publishing Co Ltd.
2. Introductory Microbiology by Heritage Pub Heritage
3. General Microbiology by Stainer Pub; Ingraham and Wheeler (McMillan)
4. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc.N.Y.
5. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan Publishing Co.
6. Brock T.D. and Madigan M.T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eagle wood cliffs N.j.
7. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T (1994) Bergey's Manual of Systemic Bacteriology 9th Edn. William and Wilkins, Baltimore.
8. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers

BTH- 104 BIOCHEMISTRY

Total Hours: 52

Unit-1

Principles of Bioenergetics:

Introduction, Laws of thermodynamics, Gibbs free energy, Relationship of Standard free energy to enthalpy, entropy and equilibrium constant, High energy compounds, ATP as universal currency of free energy, Oxidation-Reduction Reactions, Electromotive force, Half reactions, Redox potentials, Relationship of standard redox potential and standard free energy change. Standard redox potentials of some biologically important Half reactions.

6 Hours

Unit-2

Oxidative phosphorylation:

Electron transport chain, Electron transfer reactions in mitochondria, Electron carriers, Ubiquinone, Cytochromes, Iron sulfur centers, Methods to determine sequence of electron carriers, Fractionation of Multi enzyme complexes I, II, III, IV of Mitochondria and their inhibitors, Oxidative phosphorylation, ATP synthesis, Chemiosmotic model, Proton gradient, Structure of ATP synthetase, Mechanism of ATP synthesis, Brown fat, Regulation of Oxidative phosphorylation.

8 Hours

Unit-3

Carbohydrates:

Classification, structure and Properties of mono, oligo and polysaccharides. Chirality and optical activity, stereoisomerism, cyclic structure of monosaccharide, (pyranoses and furanoses) , structures of glucose. absolute and relative configuration (D & L and R & S nomenclature). Derived sugars- Sugar acids (Aldonic, Aldaric and Saccharic acids), Amino sugars. Disaccharides-structures of Maltose, Lactose, Sucrose, Trehalose, Raffinose. Polysaccharides-structure and properties of homo and hetero polysaccharides. Storage polysaccharides. (Starch, Glycogen, cellulose, chitin) Glycosamino glycans and glycoproteins.

Carbohydrate metabolism: Glycogenolysis, Glycogenesis, Coordinated regulation of Glycogen metabolism. Glycolysis-Energetics and Regulation, Fermentation reactions (Lactic acid and alcoholic fermentation), Gluconeogenesis, Reciprocal regulation of Glycolysis and Gluconeogenesis, Citric acid cycle- Energetics and regulation, Glyoxylate cycle. Pentose phosphate pathway.

12 Hours

Unit-4

Amino acids and Proteins:

Classification, structure and properties of amino acids, reactions of amino acids, peptide bond. Classification of proteins- Structural organisations of proteins (primary, secondary, tertiary and quaternary), conformational analysis, Ramachandran's plot. Thermodynamic aspects of protein folding.

General aspects of amino acid metabolism: Transamination, Deamination, Decarboxylation, basic glutamine and glutamic acid pathways, urea cycle and its regulation, formation of uric acid.

10 Hours

Unit-5

Lipids:

Classification- Structure, properties, reactions and biological functions of lipids. Phospholipids, Sphingo and glyco lipids, Steroids-cholesterol-bile salts, steroid hormones.

Metabolism of Lipids: Beta oxidation of Fatty acids-activation, transport to mitochondria, Beta oxidation reactions. Oxidation of unsaturated fatty acids. Alpha and omega oxidation. Biosynthesis of saturated and unsaturated fatty acids and cholesterol. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

10 Hours

Unit-6

Nucleic acids:

Structure and properties- Bases, Nucleosides, Nucleotides, Polynucleotides.

Nucleic acid metabolism: Biosynthesis of purines and pyrimidines, Denovo and Salvage pathways, biodegradation of purines and pyrimidines.

6 Hours

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
3. Mathews, Van Holde and Ahern, Biochemistry by 3rd edition, Pub Pearson education
4. Stryer, L. Biochemistry 4th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, Wiley-Liss Inc. NY
8. Zubey, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
9. Edwards and Hassall. Biochemistry and Physiology of the cell 2nd Edn. McGraw Hill Co. UK. Ltd.

BTS-105 BIOSTATISTICS
(Soft core)

Total Hours: 26

Unit 1:

Introduction to Bio-statistics, basic concepts, data types. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations.

Frequency distribution, Arithmetic mean, mode, median and percentiles. Measures of variability: Range, mean deviation. standard deviation and co-efficient of variation.

Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness and kurtosis and their various measures, percentiles Simple linear correlation and regression analysis. Analysis of variance.

Population and sample: Random sample, use of table of random numbers, parameter and statistics, sampling distribution of sample means, Standard error; confidence intervals.

14 Hours

Unit 2:

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions and a few simple problems. Statistical Inference- Estimation, standard error, confidence interval for means and proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square and F distributions, interpretation of 'p' value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical programme.

12 Hours

References:

1. Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
8. Wiley and Sons, Inc. NY.

I SEMESTER (PRATICAL)
BTP-106: CELL BIOLOGY AND MOLECULAR GENETICS

Total Units: 16

1. Mounting of polytene chromosomes
2. Mounting of Barr bodies
3. Study of Karyotyping in onion, humans (normal and abnormal)
4. Study of mutation in E.coli by UV light
5. Demonstration of multiple allele by blood group in humans
6. Mounting of imaginal discs of drosophila
7. Study of Drossophila mutant type
8. Problems on (a) law of segregation (b) Independent assortment (c) Sex linked inheritance (d) population genetics
9. Study of mitosis by using onion root tips
10. Study of meiosis
11. Isolation of nucleus and determination of its purity
12. Isolation of mitochondria and determination of purity
13. Isolation of chloroplast by sucrose density gradient and determination of its purity
14. Determination of the rate of active transport of glucose across the intestinal membrane
15. Determination of muscle ATPase activity
16. Determination of acetylcholine esterase activity in the rat brain

BTP- 107: GENERAL MICROBIOLOGY AND BIOCHEMISTRY

Total Units: 16

1. Determination of pI of amino acid by titration method
2. Estimation of glucose by Hagerdon and Jensen method
3. Estimation of total sugar by Anthrone method
4. Estimation of amino acid by Ninhydrin method
5. Estimation of protein by Lowry's method
6. Estimation of inorganic phosphate by Fiske-Subbarow method
7. Determination of (a) Iodine number and (b) Acetyl number of a lipid
8. Separation of amino acids by paper chromatography and TLC
9. Microbes culture in broth and solid media, Colony characteristics and Counting of colony (serial dilution method)
10. Bacterial growth assessment by turbidometry
11. Staining techniques (a) Simple staining (b) Gram staining (c) Endospore staining (d) Capsule staining (e) AFB staining (f) negative staining
12. Biochemical tests (a) Indole test (b) Methyl red test (c) Voges Proskauer test (d) Citrate utilization test (e) Triple sugar iron agar test (f) Starch hydrolysis test (g) Gelatin hydrolysis test (h) Catalase test (i) Oxidase test
13. Soil Microbiology Isolation microflora of (a) rhizosphere (b) phylloplane (c) actinomycetes (d) Rhizobium from legume of root nodules (e) Sporocarp by sieve method (f) identification of Rhizobium and agrobacterium
14. Air Microbiology Isolation of air microflora (a) exposure plate method (b) rotorod sampler method.
15. Water Microbiology: Testing of quality of water (coliform test), H₂S strip method.
16. Estimation of lactate/ Citrate from bacterial culture media

II SEMESTER (THEORY)

BTH-201: BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

Total Hours: 52

Unit 1

Physical Techniques:

Principles and applications of Rayleigh scattering, viscometry. Absorption, adsorption, crystallization, x-ray crystallography spectrophotometry, fluorimetry, flame photometry, mass spectroscopy.

Distillation, liquid - liquid extraction

Centrifugation, differential, gradient, ultra centrifugation, salt fractionation and dialysis.

10 Hours

Unit 2

Chromatographic Techniques

Principles and applications of gel filtration- ion exchange chromatography-thin layer chromatography-affinity chromatography- gas chromatography, high performance liquid chromatography (HPLC).

8 Hours

Unit 3

Electrophoresis

Principles and applications of moving boundary electrophoresis, zone electrophoresis, gel electrophoresis-PAGE and SDS PAGE agarose gel electrophoresis, isoelectric focusing and 2D Gel electrophoresis. Pulsed field electrophoresis.

6 Hours

Unit 4

Enzyme catalysis

Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, activation energy, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Types of enzyme specificity, units of enzyme activity. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Enzyme single and multi substrate reactions. Ping-pong mechanism, sequential mechanism (ordered and random), enzyme models - host guest complexation chemistry.

8 Hours

Unit 5

Enzyme Kinetics and Mechanism of Enzyme catalysis

Chemical kinetics, rate of reaction, order of reaction, zero order and first order. Derivation of michaelis-menton equation, k_m value and its significance, lineweaver-burk plot. Velocity maximum. Mechanism of enzyme action, lock and key model, induced fit hypothesis, substrate strain theory (with lysozyme as a typical example). Mechanism of enzyme catalysis - Acid-Base catalysis, Covalent catalysis, metal ion catalysis and entropy effect. Enzyme inhibition-reversible and irreversible, competitive, uncompetitive, non competitive. Regulation of enzyme activity – Covalent modulation, Allosteric regulation, ligand interactions, scatchard plot, co-operative interactions, feedback regulation. Isozymes.

12 Hours

Unit 6

Coenzymes

Structure and mechanism of action of some important co-enzymes NAD⁺, FAD, FMN, TPP, pyridoxal phosphate, lipoic acid, CoASH and vitamin B12

8 Hours

References:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4th edition Pub WH Freeman Co.
2. Daniel, L, Purich, Melvin, I. Simon, John, N., Abelson. (2000). Contemporary enzyme kinetics and mechanism.
3. Plowman. (1972). Enzyme kinetics. McGraw hill.
4. Jack kite. (1995). Mechanisms in protein chemistry, Garland publishers.
5. Gerhartz, W. (1990). Enzymes in industry: Production and applications. VCH publishers, NY.
6. Chaplin, M.F., Bucke, C. (1990). Enzyme technology. Cambridge university press, Cambridge.
7. Belter, P.A., Cussier, E. (1985) Wiley Bio separations .
8. Asenjo, J. Dekker, M. (1993) Separation processes in biotechnology.
9. Upadhyay and Nath (2003). Biophysical chemistry, principles and techniques, Himalaya publishing house.

BTH-202: MOLECULAR BIOLOGY

Total Hours: 52

Unit 1

Structure and Properties of DNA and RNA:

Information flow in biological systems: Central dogma. Biochemical evidences for DNA as genetic material. Watson and Crick model of DNA, different forms of DNA (A, B, Z, C and D). Properties and types of DNA. UV absorption, Denaturation and renaturation, thermodynamics of melting of the double helix, kinetics of unwinding of the double helix, Interaction with small ions. Structure and functions of different types of RNA.

6 Hours

Unit 2

Replication:

Characteristics and functions of bacterial DNA polymerases, Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Nearest neighbor frequency analysis. Eukaryotic DNA polymerases and mechanism of replication. Telomere synthesis-telomerases. Replication of viral DNA, rolling circle model. Inhibitors of replication

8 Hours

Unit 3

Transcription:

Characteristics and function of bacterial RNA polymerases, mechanism of transcription and regulation. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription and regulation. Stringent response. Post transcriptional modifications of mRNA (5'CAP formation, poly adenylation, mechanism of splicing, Group I, II and III, splicosome assembly, splicing editing, Group IV splicing), stability. Processing of tRNA and rRNA. Inhibitors of transcription. Ribozyme technology: mechanism of action and applications.

8 Hours

Unit 4

Translation:

Genetic code, Wobble hypothesis. Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and posttranslational modifications of proteins. Control of translation in eukaryotes (Antisense RNA, Heme and interferon).

8 Hours

Unit 5

Regulation of Gene expression:

Gene regulation, Operon model-Inducible and repressible systems, lac, gal, trp, his and arabinose operon; Attenuation, positive and negative regulation, role of cAMP and CRP in the expression of lac genes, catabolite repression, regulation of eukaryotic gene expression,

transcriptional control, cis control elements, promoters, enhancers, transacting factors, homeobox in the control of developments in insects and vertebrates. DNA binding motifs of transcription factors, posttranscriptional control.

10 Hours

Unit 6

Protein localization and Targeting:

Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxysomes and membrane.

5 Hours

Unit 7

DNA damage and Repair:

DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- photo-reactivation, excision repair, post replication repair, mismatch repair and SOS repair.

5 Hours

Unit 8

Gene Silencing:

Definition, types –transcriptional and post transcriptional gene silencing, RNAi pathway (si RNA and mi RNA).

2 Hours

References:

1. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications, 1993.
2. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition Pub WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.
4. Mathews, Van Holde, Ahern, Biochemistry by 3rd edition, Pub Pearson education.
5. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
6. Cooper, G.M. (1997). The Cell: A molecular approach, ASM Press, USA.
7. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
8. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
9. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
10. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastysdaira, P., Darnell, J. (2004). Molecular Cell Biology, Scientific American Books Inc. NY.

BTH-203: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Total Hours: 52

Unit 1: Immune system and Immune Response: Innate and acquired immunity, structure and functions of immune cells- T cells, B cells, Macrophages, NK cells and dendritic cells, Eosinophils, Neutrophils, Mast cells. Organs of immune system- Primary and secondary lymphoid organs. Primary and secondary immune response, Clonal selection theory.

10 Hours

Unit 2: Antigens and Antibodies: Structure and properties of antigens –Iso and alloantigens-antigen specificity, Haptens and adjuvants- structure and properties. Immunoglobulins-Structure and properties, types and subtypes. Generation of immunological diversity. Complement system- component, properties and functions. Complement pathways and biological significance.

8 Hours

Unit 3: Major Histocompatibility Complex and Transplantation: Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation- Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy.

6 Hours

Unit 4: Hypersensitivity Reactions: Allergy, Hypersensitivity reactions- types (I, II, III, and IV), symptoms, immunodiagnosis.

Lymphokines and cytokines : Interleukins and Interferons- Production, biological functions and assay methods. Immunological tolerance.

8 Hours

Unit 5: Autoimmunity and Immunomodulation: Autoimmunity- Autoimmune diseases- Hashimoto's disease, Systemic lupus erythematosus, Multiple sclerosis, Myasthenia gravis and their treatment. Immunomodulation(immunosuppression & immunostimulation), Immunotherapy, lymphocyte migration, homing and trafficking, antigen-induced lymphocyte proliferation, Granulysin mediated anti-microbial activity of T cells.

8 Hours

Unit 6: Immunological Techniques: Agglutination, precipitation, immune- fluorescence, immunoelectrophoresis, immunoblotting, ELISA, RIA, Flow cytometry. Production and purification of antibodies, determination of antibody titre by RID and EID, production of hybridoma.

T- cell cloning: Mechanism of antigen recognition by T and B -lymphocytes, Importance of antigen and MHC class II molecules in T-cell cloning. Antigen specific and alloreactive T-cell cloning - immunologically relevant antigens and T cell subtypes. Applications in vaccine development.

8 Hours

Unit 7: Immunization: Vaccines- conventional, peptide vaccines, subunit, DNA vaccines. Toxoids, antisera, edible vaccines, plantibodies, ISCOMs, recombinant antibodies, Immune stimulatory complexes. Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

4 Hours

References:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ. NY.
3. Borrebacc, C.A.K. (1995). Antibody Engineering, 2nd eidtion. Oxford University Press.
4. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd.Oxfird.
5. Hyde, R.M. (1992). Immunology, 2nd edition, Williams and Wilkins, Baltimore.
6. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
7. Klaus D. Elgert (1996). Immunology. ELBS, Blackwell Scientific Publishers, London.
8. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers, London.
9. Richard A., Goldsby, Thomas, J., Kindt, Barbara, A., Osborne (2000). Kuby Immunology, 4th edition. W.H. Freeman and Company, NY.
10. Tizard I.R.(1995). Immunology, 4th edition, Saunder College Pub.
11. William E Paul (1989). Fundamentals in Immunology, Raven Press. NY.

BTH-204: ENVIRONMENTAL BIOTECHNOLOGY

Total Hours: 52

Unit 1

Environment and monitoring: Introduction, renewable and non-renewable sources of energy; Environmental pollution- water pollution, soil pollution and air pollution-sources. Xenobiotic compounds and their sources, Biomagnification, Bioindicators.

Biomonitoring: Biosensors and biochips.

8 Hours

Unit 2

Water Management and waste water treatment: Water as a scarce natural resource, water management including rain water harvesting. Waste water characteristics, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors. Reverse osmosis and ultra filtration. Treatment of industrial effluents.

12 Hours

Unit 3

Biomining and Biodiesel: Bioleaching of ores to retrieve scarce metals, Bio-mining; Biodiesel production from *Jatropha*, *Pongamia* and Castor.

4 Hours

Unit 4

Bioremediation: Concept and principles, Bioremediation using microbes, *In situ* and *ex situ* bioremediation, biosorption and bioaccumulation of heavy metals; Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastic). Bioremediation of soil and water contaminated with hydrocarbons and surfactants, biofilms.

8 Hours

Unit 5

Biowaste treatment: Microorganisms involved in the degradation of plant fibre, cell wall, lignin, fungal de-lignification and pulping of wood. Pitch problems in pulp and paper processes and solving by enzymes or fungi. Hemicellulases in pulp bleaching. Solving slime problem in the pulp and paper industry. Reduction of organochlorine compounds in bleach plant effluents.

Solid wastes: Sources and management, waste as a source of energy. Production of oils and fuels from solid waste, composting, vermiculture, Biogas production, methanol production from organic wastes, byproducts of sugar industries.

12 Hours

Unit 6

Global environmental problems: Global warming, ozone depletion, UV-B, green house effect and acid rain, their impact and management. Biodiversity and its conservation, status of biodiversity, hotspots, Red data book.

8 Hours

References:

1. Allsopp D and K.J Seal., Introduction to Biodeterioration-ELBS/Edward Arnold. 1999
2. Christon, J. Harst Manual of Environment Microbiology, ASM Press, Washington DC.1997.
3. Ericksson Ed., Biotechnology in the pulp and paper industry, Springer –Verleg.1997
4. Hurst CJ et al. eds., Environmental Microbiology, ASM Press, Washington, D.C. 1997
5. Larry Anderson and David A. Tilman., Fuels from waste, Academic Press. 1997.
6. Whitaker J R and S.Philip. Biocatalysis in agricultural Biotechnology, Washington ACS.1989
7. Jordening H J and Josef Winter Environmental biotechnology: concepts and applications (2nd Ed.) Wiley & Sons Publishers.UK.2005
8. Daniel Vallero., Environmental Biotechnology: A Biosystems Approach (1st Ed.) Academic press. New York.2010
9. Wang LK. Handbook of Environmental Engineering (1st Ed.) Springer Publishers.2010
10. Evans G G and Judy Furlong., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers. 2011
11. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering (1st Ed.) Springer Publishers
12. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

BTS-205 BIOINFORMATICS
(Soft core)

Total Hours: 26

Unit 1

Introduction to Computer: Computer softwares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS).

2 Hours

Unit 2

Computer Network and Programming Languages: Structure, architecture, Advantages, types (LAN, MAN & WAN), Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. C Programming and PERL- Algorithm and flowchart, Structure of C program, Header file, Global declaration, Main function, variable declarations, Control statement-conditional and unconditional - sub functions. Introduction to PERL, Application of Bioperl.

6 Hours

Unit 2

Databases: Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.

3 Hours

Unit 3

Biological Databases: Datamining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB). Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Sequence alignment - Global and Local alignment, scoring matrices. Restriction mapping - NEB CUTTER, Similarity searching (FASTA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs.

10 Hours

Unit 4

Protein Structure and Molecular Interaction: Introduction to protein structure - secondary structure prediction, tertiary structure prediction, protein modelling- principles of homology and comparative modelling. Threading, structure evaluation and validation and *ab initio* Modelling, Applications - Molecular docking - Autodoc .

5 Hours

References:

1. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
2. Jan (2001). Nucleic acid research, Genome Database issue
3. Higgins & Taylor (2000). Bioinformatics, OUP.
4. Baxavanis (1998). Bioinformatics.
5. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
6. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh

II SEMESTER (PRACTICAL)
BTP-206: ENZYMOLOGY AND IMMUNOLOGY

Total Units: 16

1. Isolation and assay of alpha-amylase activity from saliva
2. Isolation and assay of urease from horse gram or kidney gram
3. Isolation and assay of acid phosphatase from sweet potato
4. Determination of K_m and V_{max}
5. Effect of pH and temperature on enzyme activity
6. Determination of specific activity of an enzyme
7. Molecular weight determination of a protein by gel electrophoresis
8. Immobilization of enzyme (Urease/Amylase)
9. Partial purification of IgG by ammonium sulphate fractionation and Dialysis
10. Purification of IgG by column chromatography
11. Serum separation and serological reactions (a) agglutination (b) precipitation
12. Enzyme linked immunosorbant assay
13. Isolation of lymphocytes from peripheral blood
14. Ouchterlony double diffusion
15. Single radial immunodiffusion
16. Rocket immunoelectrophoresis

BTP-207 MOLECULAR BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Total Units: 16

1. Estimation of DNA by diphenyl amine method
2. Estimation of RNA by orcinol method
3. Isolation of Genomic DNA and agarose gel electrophoresis
4. Isolation of Plasmid DNA and agarose gel electrophoresis
5. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency
6. Study of conjugation in E.coli
7. Study of transduction in E.coli
8. Searching bibliographic databases for relevant information. Sequence retrieval from nucleic acid and protein databases
9. Determination of total dissolved solids, BOD and COD of water sample
10. Estimation of Chromium in Industrial effluent by colorimetry
11. Estimation of Calcium in water sample by titration method
12. Isolation of bacteriophages from sewage
13. Sludge analysis (a) Organic matter, (b) Nitrogen (c) Phosphorous (d) Potassium
14. Biodegradation of industrial aromatic compounds
15. Determination of Phosphate and nitrate from sewage samples
16. Microbial analysis of water-MPN

III SEMESTER (THEORY)

BTH- 301: PLANT AND AGRICULTURAL BIOTECHNOLOGY

Total Hours 52

Unit 1

Plant tissue culture: Scope and Importance of plant tissue culture- Media composition and types, hormones and growth regulators, explants for organogenesis, somaclonal variation and cell line selection, production of haploid plants and homozygous cell lines. Micro propagation, somatic embryogenesis, protoplast culture and somatic hybridization. Selection and maintenance of cell lines, cryopreservation, germplasm collection and conservation, plant tissue culture certification.

8 Hours

Unit 2

Plant transformation techniques: Mechanism of DNA transfer – *Agro bacterium* mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods-particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors-pBluescript IIKs, pBin19, pGreen vectors, Transgene stability and gene silencing.

10 Hours

Unit 3

Metabolic engineering of plants: Plant cell culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids; mechanism and manipulation of shikimate pathway.

Production of Industrial enzymes, biodegradable plastics, therapeutic proteins, edible vaccines and antibiotics using transgenic technology.

10 Hours

Unit 4

Plant Development: Plant growth regulators, auxin, gibberlins, cytokinins, abscisic acid, acetylene. Biological nitrogen fixation, importance and mechanism.

Biofertilizers-types, production, VAM, Rhizobium, Azotobacter, Mycorrhiza, Actinorhiza Vermicomposting technology. Biopesticides.

6 Hours

Unit 5

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal. Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops. Golden rice and transgenic sweet potato.

Strategies for engineering stress tolerance. transgenic plants; Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food; labeling of GM plants and products. Importance of integrated pest management and terminator gene technology. Environmental impact of herbicide resistance crops and super weeds

10 Hours

Unit 6

Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons). Post-harvest protection of cereals, millets and pulses.

8 Hours

References:

1. Chrispeels M.J. et al. Plants, Genes and Agriculture-Jones and Bartlett Publishers, Boston.1994.
2. Gamborg O.L. and Philips G.C.Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.1998
3. Hammound J, P McGravey & Yusibov.V. Plant Biotechnology, Springer verlag.2000
4. Heldt. Plant Biochemistry and Molecular Biology. Oxford and IBH Publishing Co. Pvt.Ltd. Delhi. 1997
5. Lydiane Kyte and John Kleyn. Plants from test tubes. An introduction to Micropropagation (3rd Ed.). Timber Press, Portland. 1996
6. Murray D.R. Advanced methods in plant breeding and biotechnology.Panima Publishing Corporation.1996
7. Nickoloff J.A.Methods in molecular biology, Plant cell electroporation and electrofusion protocols-Humana press incorp, USA. 1995.
8. Sawahel W.A. Plant genetic transformation technology. Daya Publishing House, Delhi.1997
9. Gistou, P and Klu, H.Hand book of Plant Biotechnology (Vol. I & II).John Publication.2004
10. Slatu A et al.The genetic manipulation of plant. Oxford University Press.2003
11. Kirakosyan A and Kaufman P.B.Recent Advances in Plant Biotechnology (1st Ed.).Springer Publishers.2009
12. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiely Publishers.2006

BTH-302: ANIMAL BIOTECHNOLOGY

Total Hours: 52

Unit 1

Animal Cell Culture: Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, types of culture media, composition, preparation and metabolic functions. Role of CO₂, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media.

Culture and maintenance of primary and established cell lines. Biology of cultured cells-culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.

15 Hours

Unit 2

Stem cells and Tissue Engineering: Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences.

Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues.

7 Hours

Unit 3

Transgenic Animals and Animal cloning: Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases.

Animal cloning: methods of cloning and their importance with reference to domestic animals. IVF- technology for live stock and humans.

10 Hours

Unit 4

Applications of Animal Biotechnology: Improvement of biomass, disease resistant, recombinant vaccines for poultry, live stock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.

8 Hours

Unit 5

Bioethics: Bioethics in Biodiversity, ethics of resource management, impact of patenting on biodiversity rich developing countries. Ethical issues associated with consumptions of genetically modified foods. Ethical implication of human genome project, international ethical and legal issues connected with human genome diversity research. Genetic studies of ethnic races.

Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation.

6 Hours

Unit 6

Biosafety: The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science, GM crops,. Experimental protocol approvals, levels of containment. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). Use of genetically modified organisms (crippling organisms) and their release to environment.

6 Hours

References:

1. Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.
2. Watson J.D. et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings. 2007.
3. Berger S. L. and A.R. Kimmel. Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego. 1996
4. Glick, B.R. and Pasternak J.J. Molecular Biotechnology. ASM Press, Washington DC. 2003.
5. Jenni, P., Mather and David Barnes, Methods in Cell Biology (Vol 57) Academic Press. 2001
6. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001
7. Watson J.D et al. Molecular Biology of the Gene (6th Ed), The Benjamin Cummings Pub. Co. Inc. USA. 2008
8. Shantharam, D., Jane F Montgomery. Biotechnology, Biosafety & Biodiversity: Scientific & Ethical issues for Sustainable development. 1999
9. Jan Freshney. R. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.) Wiley & Sons. 2010
10. John Davis., Animal Cell Culture: Essential Methods (1st Ed.) Wiley-Blackwell and Sons publisher. 2011
11. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003

BTH-303 GENETIC ENGINEERING

Total Hours: 52

UNIT 1

Introduction to Genetic Engineering: Scope and importance of Genetic Engineering

2 HOURS

UNIT 2

Tools of Genetic Engineering: Enzymes; Non-specific endo & exo nucleases, DNase, RNase. Restriction modification; restriction endonucleases- types, nomenclature, recognition sequences and mechanism of action. Methylation, RNA modification. Role of Kinases, phosphatases, polynucleotide phosphorylase, polynucleotide kinases. Ligases - types and mechanism of action.

Vectors: General characteristics of vectors, Brief account of naturally occurring plasmids. Promoter, MCS, Ori, and marker genes-lac Z. Construction of pBR 322, pBR325, pUC 18 and 19 vectors and expression vectors. E.coli promoters, lac promoter, trp promoter, lambda pL promoter, hybrid tac promoter, ribosome binding site, codon selection. M 13 derived vectors, Lambda based vectors, cosmids, phagemids, minichromosomes, BAC's, YAC's,

Shuttle vectors, Ti plasmids, vectors for animals-SV40 and Bovine papilloma virus.

14 Hours

UNIT 3

Gene Cloning Strategies and Construction of Gene Libraries: Cloning from mRNA: Isolation and purification of RNA, synthesis of cDNA, Isolation of plasmids, cloning cDNA in plasmid vectors, cloning cDNA in bacteriophage vectors. cDNA library.

Cloning of genomic DNA: Isolation and purification of DNA, preparation of DNA fragments and cloning. Construction of genomic libraries (Using λ gt 10 and 11 vector). *In vitro* packaging of λ phage and amplification of libraries.

Advanced cloning strategies-synthesis and cloning of cDNA, PCR amplified DNA, use of adaptors and linkers, homopolymer tailing in cDNA cloning, expression of cloned DNA molecules,

Selection, screening and analysis of recombinants: Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, screening methods for cloned libraries, PCR screening protocols, immunological screening, restriction mapping of cloned gene, blotting techniques, sequencing methods. Purification strategies of expressed His- tagged proteins.

14 Hours

UNIT 4

Transformation Techniques: Purification of vector DNA, restriction digestion, end modification, cloning of foreign genes, (from mRNA, genomic DNA, synthetic DNA) transformation screening, selection, expression and preservation. Transformation and transfection techniques, preparation of competent cells of bacteria, chemical methods-calcium phosphate precipitation method, liposome mediated method, physical methods-Electroporation, gene gun method. Method of DNA transfer to yeast, mammalian and plant cells, transformation and transfection efficiency.

8 Hours

UNIT 5

Labelling and Detection Techniques: Labeling of DNA, RNA and Proteins by radioactive isotopes, non-radioactive labeling, in vivo labeling, autoradiography and autofluorography. DNA sequencing by enzymatic and chemical methods, Agarose gel electrophoresis, PAGE, PFGE. Methods of nucleic acid hybridization; Southern, Northern and Western Blotting techniques.

8 Hours

UNIT 6

Chemical Synthesis of Genes and PCR: Phosphodiester, phosphotriester and Phosphite ester methods, principles and strategies. Oligonucleotide synthesis and application, synthesis of complete gene.

PCR, methodology, essential features of PCR, primers, Taq polymerases, reverse transcriptase-PCR, types of PCR-Nested, inverse, RAPD-PCR, RT-PCR (real time PCR), Applications of PCR.

6 Hours

References:

1. Nicholl D.S.T. Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK. 2008
2. Old R.W., Primrose S.B. Principles of gene manipulation - An introduction to genetic engineering (5th Ed.), Blackwell Scientific Publications, UK. 1996.
3. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, 1994.
4. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
5. Benjamin Lewis, Genes VIII (3rd Ed.) Oxford University & Cell Press, NY. 2004
6. Robert Williamson. Genetic Engineering (1st Ed.) Academic Press. 1981. USA
7. Rodriguez. R.L (Author), Denhardt D.T. Vectors: A Survey of Molecular Cloning Vectors and Their Uses (1st Ed.) Butterworth-Heinemann publisher. UK. 1987
8. Ansubel F.M., Brent R., Kingston R.E., Moore D.D. et al. Short protocols in molecular biology (4th Ed), Wiley publishers. India. 1999.
9. Sambrook J et al. Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA. (1989, 2000)
10. Terence A Brown. Genomes, (2nd Ed.) BioScientific Publishers. UK. 2002
11. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin Modern Genetic Analysis (1st Ed.) W. H. Freeman Publishers. NY. 1999
12. S. B. Primrose, Richard M. Twyman. Principles of gene manipulation and genomics (7th Ed.) John Wiley & Sons publishers. 2006

OPEN ELECTIVE
BTO-304: APPLIED BIOTECHNOLOGY

Total Hours: 52

Unit-1

Bioprocess Engineering

Introduction: Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation processes- Industrially important products: Ethanol, citric acid, penicillin, riboflavin, amylase, protease, biodegradable plastic: Fermented foods

8 Hours

Unit -2

Plant and Agricultural Biotechnology

Plant tissue culture, micropropagation, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, production of enzymes, biodegradable plastics, therapeutic proteins, edible vaccines.

8 Hours

Unit-3

Animal Biotechnology

Animal cell culture, stem cells and tissue engineering, transgenic animals, IVF technology for livestock improvement, biofarming, pharmaceutical products, plasminogen activator, blood clotting factors, interleukins, vaccines.

8 Hours

Unit-4

Medical Biotechnology

Microbial diseases of humans: AIDS, Hepatitis B, Rabies, Typhoid, STDs, Tb, plague, malaria, amoebiosis, tumors, treatment of cancer, diabetes, anemia, gene therapy

8 Hours

Unit-5

Environmental Biotechnology

Pollution : Air, water, soil , Bio-indicators, waste water management, treatment, bioremediation, biodegradation, biowaste treatment, global warming, ozone depletion, acid rain

8 Hours

Unit-6

Nanobiotechnology

Introduction, types, DNA, protein based applications, nanobiosensors, drug and gene delivery, risk potential of nanomolecules

6 Hours

Unit-7

IPR, patenting of biotech products, examples: turmeric, basmathi rice, neem, Bioethics, ethical issues related to consumption of GM crops, ethical implication of Human Genome Project

6 Hours

References:

1. Kuby, J. (2003). Immunology 5th Edition. WH. Freeman and Company, NY.
2. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers, London.
3. Gistou, P and Klu, H. Hand book of Plant Biotechnology (Vol. I & II). John Publication. 2004
4. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers. 2006
5. Ballin C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon press, New York. 1989.
6. Watson J.D. et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings. 2007.
7. Ratlege, C. and B. Kristiansen, Basic Biotechnology. Cambridge Univ. Press, London. 2001
8. David S L. Genetics to Gene Therapy – the molecular pathology of human disease (1st Ed.) BIOS scientific publishers, 1994.
9. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
10. Santaniello V, Evenson RE, Zilberman D and Carlson GA, Agriculture and Interlectual property rights: Economic, Institutional and Implementation Issues in Biotechnology, University Press. 2003
11. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008
12. Niemeyer C.M. and Mirkin C.A, Introduction to Nanobiotechnology, Wiley VCH publishers 2003

III SEMESTER (PRACTICAL)

BTP- 305: PLANT, AGRICULTURAL AND ANIMAL BIOTECHNOLOGY

Total Units: 16

1. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
2. Callus culture: Initiation and regeneration.
3. Anther culture for the production of haploids.
4. Isolation, culture and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants
7. Suspension culture and production, separation and estimation of secondary metabolites β -carotene from carrot and anthocyanin from beetroot
8. Study of VAM, isolation of spores, arbuscles and vesicles from roots
9. VAM culture
10. Organic pharming and Mushroom Cultivation
11. Study and culture of biocontrol agents (*Trichoderma viridae*, *Trichoderma harzianum*, *Aspergillus awamori*)
12. Animal cell culture: Preparation of (serum and non serum supplemented) media, cell culture, assessment of viability and counting using trypan blue exclusion method
13. Primary culture of fibroblast cells/liver cells/testis-leydig cells
14. Determination of GST enzyme activity in cytotoxicity induced cells
15. Estimation of lipid peroxides (Malondialdehyde) in cytotoxicity induced cells
16. MTT assay for cell viability and growth

BTP- 306: GENETIC ENGINEERING AND BIOINFORMATICS

Total Units: 16

1. Electrophoresis of restriction digested plasmid DNA, Restriction mapping and determination of molecular weight of digested DNA fragment
2. Ligation of DNA and analysis by electrophoresis
3. DNA amplification by PCR and RAPD
4. Preparation of competent cells and transformation by CaCl_2 method and Selection of Transformed colony by X-Gal method
5. Determination of molecular weight of proteins by SDS PAGE and analysis by Western blotting
6. Analysis of DNA by Southern blotting
7. Labelling of proteins by dinitrofluorobenzene and analysis
8. Isolation of total RNA and analysis by formaldehyde gel electrophoresis
9. Restriction mapping, Sequence (FASTA and BLAST) searches.
10. Pair wise comparison of sequences, multiple alignments of sequences.
11. Evolutionary studies / Phylogenetic analysis.
12. Identification of genes in Genomes and Primer Design
13. Protein databank retrieval and visualization Ros mol
14. Ramachandran plot-secondary structure prediction of proteins.
15. Introduction to Auto doc
16. Calculation of SD, Variance and plotting the graph by using MS Excel

IV SEMESTER (THEORY)

BTH-401: BIOPROCESS ENGINEERING

Total Hours: 52

Unit 1

Introduction: Scope and importance of bioprocess engineering technology, development and strain improvement of industrially important microorganisms.

3 Hours

Unit 2

Bioreactors: Typical structure of advanced Bioreactor and their working mechanism; Design features; Heat transfer and Mass transfer; Specialised bioreactors- design and their functions; Airlift bioreactor, Tubular bioreactors, Membrane bioreactors, Tower bioreactors, Fluidized bed reactor, Packed bed reactors and Photo bioreactors.

10 Hours

Unit 3

Fermentation media and Fermentation Process: Natural and synthetic media; Strategies for media formulation, sources of carbon, nitrogen, vitamins and minerals. Role of buffers, precursors, inhibitors, inducers and antifoam agents.

Types of fermentation processes-submerged fermentation, surface or solid state fermentation, batch fermentation, continuous fermentation, kinetics of fermentation process, bioprocess control, monitoring of variables-temperature, agitation, pH and pressure.

8 Hours

Unit 4

Downstream processing: cell disruption, precipitation methods, solid-liquid separation, liquid-liquid extraction, filtration, centrifugation, chromatography, drying devices (Lyophilization and spray dry technology), crystallization, biosensors-construction and applications,

Food processing: food preservation, and spoilage. Sterilization and pasteurization, canning and packing of foods.

8 Hours

Unit 5

Immobilization and Biotransformation; Methods of immobilization, adsorption, cross-linking, ionic bonding, entrapment, encapsulation; Advantages and industrial applications of Immobilization of enzymes and whole cells.

Biotransformation of antibiotics, steroids and their applications.

5 Hours

Unit 6

Production of Industrially important products: Alcohol: Ethanol, glycerol, butanol; Acetone; Organic acids: citric, acetic, and gluconic acid; Amino acids: lysine, glutamic acid; Antibiotics: penicillin, streptomycin, tetracycline; Vitamins: riboflavin, Enzymes: amylase, protease, biodegradable plastic: polyhydroxyalkanoates (butyrate, propionate.); Recombinant protein- Insulin, hepatitis-B vaccine. Fermented foods-sausages, olives, bread, idly and acidophilus milk.

10 Hours

Unit 7

Intellectual Property Rights (IPRs) and Entrepreneurship: IPRs– implications for India, WTO, WIPO, GATT, TRIPS. Patenting and the procedures involved in the application for patents and granting of a patent, compulsory licenses, patent search, Patent Cooperation Treaty (PCT), examples of patents in biotechnology, legal implications, traditional knowledge commercial exploitation, protection.

Entrepreneurship – Potential entrepreneurship activities in biotechnology, product development, marketing, research and training units. Industrial licensing, venture capital, Biotechnology Industries in India and the potential job opportunities.

8 Hours

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.).Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

BTH-402 MEDICAL BIOTECHNOLOGY

Total Hours: 52

Unit 1

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by

Viruses (AIDS, Hepatitis- B, Rabies, HSV-1)
Bacteria (Typhoid, STD, TB, Plague)
Fungi(Aspergillosis, Histoplasmosis, Cryptococcosis)
Protozoa(Malariaia, Amoebiasis)

8 Hours

Unit 2

Cancer Biology: Tumors, types of tumors, pre-disposing factors, cellular changes involved in tumor formation, genes associated with cancer (oncogenes, tumor suppressive genes etc.), methods of tumor detection, tumor markers, treatment of cancer-chemo therapy, radio therapy, immunotherapy and gene therapy.

6 Hours

Unit 3

Human Diseases: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von’Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell anemia, Beta Thalesimia and Diabetes

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ -glutamyl trans-peptidase

8 Hours

Unit 4

Nanobiotechnology: introduction, types and synthesis of nanomaterials, protein-based nano structures, DNA-based nano structures, Applications of nanomaterials, nanobiosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

6 Hours

Unit-5

Molecular therapeutics: Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half life, drugs accumulation, basic concepts of toxic effect. Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells. Recombinant therapy; Erythropoitin; Insulin analogs and its role in diabetes. Streptokinase and urokinase in thrombosis.

10 Hours

Unit 6

Drug discovery: Introduction, conventional drug design approaches, irrational Vs rational, Lipinski's rule of five, ADME, Calculation of LD 50 and ED 50. Acute,

subacute and chronic toxicity studies. Irwin profile test, Drug development process (Preclinical , clinical and toxicological studies). Novel Drug Development approaches - QSAR (quantitative structure activity relationship), Highthroughput screening.

6 Hours

Unit 7

Clinical Research: Past, Present and future

Importance, Mile stones of regulations. FDA, US, Indian clinical research, global scenario of clinical research, Regulatory agency.

Designing clinical trials- History, principles, scheme for conducting clinical trials, planning defining, objectives, variables, study populations, testable hypothesis, prediction of errors and bioselection of appropriate study design, Execution steps.

Ethical Issues in clinical research- Introduction, codes, declaration and guidelines, Informed consent, special issues, Roles and responsibilities of IRBS, issues with ethics review.

ICH-GCP- History of ICH, Objectives, ICH structure, Guidelines, Future of ICH.

8 Hours

References:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. S N Jogdand Medical Biotechnology 2nd Edition Himalaya publishers 2008
3. Keith Wilson & John Walker, Practical Biochemistry- 5th edition, Cambridge University Press, UK 2000
4. Bartram G. Katzung, Basic & Clinical Pharmacology, 9th Edition, Mc Graw Hill Publications 2004
5. Devlin TM, Text book of biochemistry with Clinical Correlations 5th edition 2002
6. Richard B Silverman, Organic Chemistry of Drug design and Drug action Elsevier Science, Academic Press
7. Warren Levinson, Ernest Jawetz, Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications 2003
8. Jawetz, Melnuk and Adelgerg, Medical Microbiology, Appleton & Lange pub 1971.

BTH-403 GENOMICS AND PROTEOMICS

Total Hours: 52

UNIT 1

Introduction: Concept of genomics, structural genomics, Functional Genomics, Transcriptomics, RNAmics proteomics, and metabolomics.

4 Hours

UNIT 2

Genomics: Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Genome sequencing projects of *E.coli.*, yeast, and human genome project.

Genome sequence data bases, expressed sequenced tags (ESTs), Gene variation and Single Nucleotide Polymorphisms (SNPs), disease association, diagnostic genes and drug targets, genotyping - DNA Chips, diagnostic assays, Genome sequence analysis. Principle, salient features & drawbacks of methods of gene prediction / gene modeling: GRAIL, GENEMARK, GLIMMER. Promoter prediction methods.

10 hours

UNIT 3

Genome Analysis, Genome Organization and Structure: C-Values of genomes, Repetitive and coding sequences, Genetic and physical maps, Methods of physical mapping. Molecular markers, Hybridization based markers restriction fragment length polymorphism (RFLP's), random amplification of polymorphic DNA (RAPD's) and amplified fragment length polymorphisms (AFLP). Multiple arbitrary amplicon profiling using short oligonucleotide primers, SCAR, micro satellites and other markers, length polymorphisms in simple sequences repeats (SSR and ISSR).

Approaches to mapping, fluorescence *in-situ* hybridization (FISH) - DNA amplification markers; Telomerase as molecular markers, T-DNA tagging, Transposon tagging, General structural features of Viral and Bacterial genomes. Organization of *E.coli* genome, Arabidopsis genome, Rice genome, Human genome, Unusual structure of Y chromosome, Chloroplast and Mitochondrial genomes. Commercializing the genomics, polymorphisms.

15 Hours

Unit 4

Functional and Comparative Genomics: Transcriptomes-transcripts of a tissue, use of Northern blot, subtractive and additive library, Rnase protection assay, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, Microarray techniques, sequence analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS), Expression profiling in human diseases.

Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria.

5 Hours

UNIT 5

Proteomics: Expression analysis and characterization of proteins-separation of proteins-2D PAGE (2DGE), multiplexed analysis, multidimensional liquid chromatography, high throughput screening by Mass spectrometry, MALDI-TOF, peptide fingerprinting, protein micro array-antibody arrays, antigen arrays, general protein arrays, biochips.

Analysis of protein structures-Sequence analysis by Tandem Mass Spectrometry, structure prediction, X-ray, NMR and CD and Bio-informatic approaches.

Protein-protein interactions-genetic, comparative genomic, biochemical approaches. Large scale analysis of protein intractions-yeast two hybrid interaction screens, post-translational modification analysis, proteomics databases & analysis.

10 Hours

UNIT 6

Metabolomics: Concepts, Levels of metabolite analysis, metabolomics in humans, sample selection and handling, over view of different methods used for analysis of metabolites. Metabolic regulation network at genome level, Basic concept of metabolic engineering.

8 Hours

References:

1. Peter M Gresshoff .Plant Genome Analysis (1st Ed.), CRC Press.UK.1994
2. John R S Finchman. Genetic Analysis – Principles, Scope and Objectives (1st Ed.). Blackwell Science. Singapore.1994.
3. Smith D.W. Biocomputing Informatics and the Genome Projects (1st Ed.) Academic Press.USA.1993.
4. Benjamin Lewis. Genes VIII (7th Ed.). Oxford University & Cell Press.UK.1999
5. Benjamin Lewis. Genes IX (9th Ed.). Jones and Bartlett publishres.USA. 2007
6. Principles of Gene manipulation and Genomics, SB Primrose and RM. Twyman, 7th Ed.). Blackwell publishers.UK.2007
7. Dubitzky W et al. Fundamentals of data mining in genomics and proteomics (1st Ed.) Springer publishres.USA.2007
8. Liebler D C. Introduction to Proteomics-Tools for the New Biology (2nd Ed.).John R. Humana Press Totowa. NJ.,2002
9. Terence A B.Genomes (2nd Ed.).Bios Scientific Publishers.UK.2002
10. Griffiths AJF.An Introduction to Genetic Analysis (7th Ed.). W. H. Freeman publisher.NY.2000
11. Michel Blot. Prokaryotic Genomics (1st Ed.) Springer publishers.2002
12. Josip Lovric Introducing Proteomics: From concepts to sample separation, mass spectrometry and data analysis. Wiley-Blackwell publishers.UK.2011
13. Richard Twyman, Principles of Proteomics (1st Ed.).Wiley-Blackwell publishers.UK.2004

IV SEMESTER (PRACTICAL)

BTP- 404: BIOPROCESS ENGINEERING AND MEDICAL BIOTECHNOLOGY

Total Units: 16

1. Study of fermentor- Demonstration.
2. Production and isolation of antibiotics (Pencillin and Streptomycin)
3. Production and analysis of Single cell protein (Spirulina and yeast)
4. Production of yoghurt and estimation of lactic acid at different time intervals
5. Production of wine – estimation of percentage of alcohol, total acidity & volatile acidity in wine.
6. Production and assay of α -amylase from *Aspergillus niger*
7. Purification and assay of α amylase by simple precipitation using sodium sulphate, poly amines and organic solvents and immobilization
8. Blood urea analysis by diacetyl monoxyme method
9. Analysis of acid and alkaline phosphatase from serum samples
10. Estimation of serum cholesterol
11. Assay of SGOT enzyme activity
12. Assay of SGPT enzyme activity
13. Blood sugar analysis by Folin -Wu method
14. Estimation of Creatine and Creatinine from urine samples
15. Study of cancer cell and visit to cancer research Institute
16. Visit to industries/Biotech park-report to be submitted along with the record