

NUMERICAL METHODS & STATISTICS

Subject Code	: 12BBT11	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to statistics and study design

Introduction to statistics, data, variables, types of data, tabular, graphical and pictorial representation of data. Significance of statistics to biological problems, experimental studies; randomized controlled studies, historically controlled studies, cross over, factorial design, cluster design, randomized; complete, block, stratified design, biases, analysis and interpretation.

Descriptive statistics and Observational study design

Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, case-control studies, outcomes, odd ratio and relative risks.

Principles of statistical inference

Parameter estimation, hypothesis testing. Statistical inference on categorical variables; categorical data, binomial distribution, normal distribution, sample size estimation,

Comparison of means

Test statistics; t-test, F distribution, independent and dependent sample comparison, Wilcoxon Signed Rank Test, Wilcoxon-Mann-Whitney Test, ANOVA.

Correlation and simple linear regression

Introduction, Karl Pearson correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, regression model fit, inferences from the regression model, ANOVA tables for regression.

Multiple linear regression and linear models

Introduction, Multiple linear regression model, ANOVA table for multiple linear regression model, assessing model fit, polynomials and interactions. One-way and Two-way ANOVA tables, F-tests.

Design and analysis of experiments

Random block design, multiple sources of variation, correlated data and random effects regression, model fitting. Completely randomized design, stratified design.

Statistics in microarray, genome mapping and bioinformatics

Types of microarray, objectives of the study, experimental designs for micro array studies, microarray analysis, interpretation, validation and microarray informatics. Genome mapping, discrete sequence matching, programs for mapping sequences.

TEXT BOOKS:

1. John F. Monahan “Numerical Methods of Statistics (Cambridge Series in Statistical and Probabilistic Mathematics)” Cambridge University Press; 2 edition (April 18, 2011).
2. Joe D. Hoffman Numerical Methods for Engineers and Scientists, Second Edition, CRC Press; 2 edition (May 31, 2001)

REFERENCE BOOKS:

1. J.D. Lee, T.D. Lee Statistics and Numerical Methods in BASIC for Biologists, Van Nostrand Reinhold Company (July 1982)
2. Wolfgang Boehm (Author), Hartmut Prautzsch (Author)” Numerical Methods” A K Peters/CRC Press (March 15, 1993)
3. BIOS instant notes series of mathematics and statistics for life sciences, Garland sciences

BIOMOLECULES, MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Subject Code	: 12BBT12	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

DNA Structure; Replication; Repair & Recombination

Structure of DNA: A, B, Z and triplex DNA; Replication: Enzymes and accessory proteins, Initiation, elongation and termination in prokaryotes and eukaryotes; DNA damage and repair: Photoreactivation, Nucleotide excision repair, Mismatch repair, SOS repair; Recombination: Homologous and non-homologous, site specific recombination.

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription: Transcription unit, Promoters: Constitutive and Inducible, Operators, Regulatory elements, Initiation, Elongation, Termination (Rho-dependent and independent); Eukaryotic transcription and regulation: RNA polymerase I, II and III, Eukaryotic promoters and enhancers, General Transcription factors, TATA binding proteins (TBP) and TBP associated factors (TAF), Activators and repressors; Post Transcriptional Modifications: Processing of mRNA (splicing), 5'-Cap formation, 3'-end processing and polyadenylation, RNA editing; Nuclear export of mRNA; mRNA stability; Catalytic RNA.

Transcriptional regulation-Positive and negative gene regulation; Operon concept: lac, trp operons; Transcriptional control in lambda phage; Transcriptional and post-transcriptional gene silencing; RNA interference (Role of miRNA and siRNA in gene regulation) and Antisense RNA.

Translation & Transport

Translation machinery; Ribosomes; Composition and assembly; Universal genetic code; Degeneracy of codons; Termination codons; Isoaccepting tRNA; Wobble hypothesis; Mechanism of initiation, elongation and termination; Co- and post-translational modifications; Genetic code in mitochondria; Transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation.

Basics Concepts of Genetic engineering

Introduction to genetic engineering; Restriction Enzymes; Klenow enzyme; T4 DNA polymerase; DNA ligase; Cloning Vectors: Plasmids, Bacteriophages, M13 mp vectors, Phagemids, Lambda vectors, Cosmids, Artificial chromosome vectors (BACs, YACs), Shuttle vectors, Animal Virus derived vectors-SV-40, Expression vectors: pMal, pET, GST-tag vectors; Isolation and purification of plasmid and genomic DNA, and total RNA; Recombinant DNA technology: Cloning, screening of the recombinants, Protein purification; Isolation and purification of recombinant proteins. Native and SDS PAGE, His-tag; GST-tag; MBP-tag.

Techniques in Genetic engineering

Construction of genomic and cDNA libraries, Screening of the clones, PCR: Primer design, technique. Types of PCR: endpoint PCR, real time PCR, inverse PCR, cloning of PCR products, applications. Blotting techniques (Southern, Northern and Western) Radio labeled and non-radio

labeled probes, Primer extension, DNA foot printing, EMSA (Electrophoretic mobility shift assay), *In vitro* transcription and translation.

TEXT BOOKS:

1. Freifelder D. Molecular Biology, 2nd edn, Narosa, New Delhi. 1987.
2. Primrose S.B., Twyman R.M. and R.W. Old. Principles of gene manipulation – An introduction to genetic engineering. 6th edn. Blackwell Science. 2001.
3. Lewin B. Genes IX. Jones and Bartlett Publications. 2008.

REFERENCE BOOKS:

1. Alberts B. Johnson A. Lewis J. Raff M., Robert K. and P. Walter. Molecular Biology of the cell fifth edition, Garland Science. 2008.
2. Brown T.A. Gene Cloning and DNA Analysis – An Introduction, 5th edn. Blackwell Science. 2006.
3. Glick, B.R. and J.J. Pasternak. Molecular Biotechnology – Principles and applications of recombinant DNA. 3rd edn. ASM Press. 2003.
4. Voet D., Voet J.G. and C.W. Prott. Fundamentals of Biochemistry-Life at the molecular level. 2nd edn. John Wiley & Sons. 2006.
5. Watson, J.D., Baker, T.A., Bell S.P., Gann A., Levine M and R. Losick. Molecular Biology of the Gene. 5th edn. Pearson Education. 2004.
6. V.B. Rastogi, Fundamentals of molecular biology, revised and updated 2010, Ane books
7. BIOS instant notes series, molecular biology, 2011, Ane books

**MOLECULAR BIOLOGY AND GENETIC ENGINEERING
LABORATORY SYLLABUS**

Subject Code	: 12BBT16	IA Marks	: 25
No. of Practical Hrs./ Week	: 03	Exam Hrs	: 03
		Exam Marks	: 50

1. Isolation of plasmid DNA from *E.coli* cells.
2. Isolation of genomic DNA from (any two)
 - a. Bacteria
 - b. Fungi
 - c. Plants
 - d. Animal fibroblast cell
3. Isolation of total RNA from plants.
4. Restriction digestion of plasmid and Agarose gel electrophoresis.

5. Restriction digestion of Genomic DNA, Agarose gel electrophoresis and isolation of gene of interest.
6. Preparation of competent cells and Transformation.
7. Screening of recombinant clones.
8. Transformation of *Agrobacterium tumefaciens*.
9. Genetic transformation of tobacco.
10. Screening and selection of transformants.
11. Amplification of cloned gene.

PLANT AND ANIMAL BIOTECHNOLOGY

Subject Code	: 12BBT13	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Plant Tissue Culture Technology

Introduction to plant cell and tissue culture. Concept of totipotency. Plant culture media. Growth regulators and adjuvants. Methods of plant regeneration in vitro organogenesis and embryogenesis. Callus culture, Single cell and cell suspension culture. Micro propagation techniques Bioreactors for micropropagation. Somatic embryogenesis. Production of industrially important secondary metabolites from plants. Hairy root culture. Protoplast culture for the production of somatic hybrids and cybrids. Production of haploids through anther, microspore, Ovule culture role in Plant breeding. Cryopreservation of plant cell and tissues.

Genetic transformation in Plants.

Biological and direct method of transformation. Agrobacterium and plant interaction. *Agrobacterium* mediated gene transfer in plants, Plant vectors for genetic transformation, Organization of Ti plasmids. Design of Ti plasmid based vectors. Plant viruses as tool to deliver foreign genes. Physical methods of gene transfer – Electroporation, microinjection, particle bombardment, PEG and liposome mediated. Screening of transgenics by marker genes. Transgene silencing and stability. Transplastomic transformation - Chloroplast transformation.

Metabolic Engineering in Plants

Plant oil modifications by genetic engineering; Production of medium and longer chain fatty acids. Improvement of seed oil for health benefits (PUFA oil). Metabolic engineering of flavanoids, vitamin E, and carotenoid pathway (golden rice)

Marker Assisted Selection

Qualitative and Quantitative traits Marker assisted selection for genes for agronomic importance , ex. Disease resistance, insect resistance

Transgenic Plants as Biofactories

Biopharming in plants for the production of industrial enzymes, edible vaccines, plant antibodies, therapeutic proteins a Plant metabolic engineering for the production of biodegradable plastics (Polyhydroxybutyrate and Polyhydroxyvalerate), Biopharming of carbohydrate

Transgenic Plants for Crop Improvement

Manipulation of photosynthesis to increase crop yield. Engineering plant proteins, lipids and vitamins for improved nutrition. Post harvest protection of plants antisense technique to increase shelf life of fruits and flowers, Herbicide tolerance, Biotic and abiotic stress. Plant responses to abiotic stress. Transgenic strategies for drought, cold and saline tolerance. Transgenic technology for the development. Viral, bacterial a, fungal and insect resistance plants.

Embryo Cloning

Technology for embryo augmentation of reproductive efficiency. embryo culture. Embryo preservation. Micromanipulation and cloning-concept of nuclear transfer. Sem cells- embryo and adult sem cells.

Animal Cell Culture Technology

Culturing of cells, primary and secondary cell lines, Animal cell growth characteristics and kinetics; Scaling up of animal cell culture; Various types of bio-reactors used for animal cell cultures; Cell lines and their applications. Specialized techniques in animal cell culture- Amniocentesis, Oncofetal antigens, 3D culture, cell immobilization.

Genetic Transformation in Animals

Methodology for gene transfer in animal cells; mechanisms of transfection, vectors used in transfection. Methods of production of transgenic animals, recent advances in gene targeting technology. Characterization and screening of transgenic animals. Applications of genetically modified animals and molecular Biopharming. Stem cell research - Hematopoietic and embryonic stems cells. Gene Therapy- Prospects and problems; Knock out mice and mice model for human genetic disorder.

Hybridoma Technology and Healthcare

Production of Hybridomas- Antibodies, Immunotoxins, Vaccines, Toxoids, Interferons and Antiviral substances. Tumour immunology, Immune diagnosis and therapy with monoclonal antibodies.

Animal Breeding and Ethical Issues

Artificial insemination and storage; *In vitro* fertilization and embryo transfer micro manipulation of embryos, advantages of cell manipulation techniques. Hazards of artificial breeding. Ethical issues in animal biotechnological products and techniques.

TEXT BOOKS:

1. Animal cell biotechnology – R.E. Spier and J.B. Griffiths, Academic Press, 5th edition, 1988.
2. Culture of Animal cells A manual of basic techniques – R. Ian Freshney, John Wiley and Sons Publishers, 5th edition, 2005.
3. Animal Biotechnology – M.M Ranga, Student edition, 2nd edition, 2007.
4. Plant Biotechnology – A. Slatter, N. Scott and M fowler, Oxford university press, 2st ed. 2009.

REFERENCE BOOKS:

1. Introduction to plant tissue culture – M.K.Razdan. Oxford & IBH publishing Co., 1st edition. 2002.
2. Plant Biotechnology in Agriculture – Lindsey and M.G.K. Jones, Prentice Hall, New Jersey, 1990.
3. Molecular Approaches to Crop Improvement – Dennis Liwelly, 3^{ed} 1991.
4. Plant Molecular Biotechnology – S.Mahesh, New Age International, 1^{ed}, 2008.
5. Molecular biotechnology – Glick Pasternak, Asm Press, 4th, 2009.
6. Plant conservation biotechnology- Erica Benson, CRC Press (Ane Books)

7. Plant genome analysis- current topics in plant molecular biology, Peter Greshoff et. al., CRC Press (CBS)
8. Microbes and non-flowering plants, 2009, Mamatha Rao, Ane Books
9. Plant ecology, Verma, 2011 Ane Books
10. Plant tissue culture, SP Misra, 2009 Ane Books
11. Text book of plant physiology, V. Verma, 2011, Ane Books
12. Plant Biology, Alison M Smith, 2009, Garland science, (Ane Books)
13. Plant Biochemistry, Caroline Browsher, 2008, Garland science
14. BIOS Instant notes in Plant biology, 2nd edition, 2009, Ane Books

MICROBIAL BIOTECHNOLOGY

Subject Code	: 12BBT14	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to Microbial Biotechnology

Scope and techniques. Cultivation and growth of microorganism – Physical conditions for cultivation of microorganisms, reproduction and growth of microorganisms. Structure and function of components of the bacterial cell envelope. Protein secretion with a special emphasis on its various roles in pathogenesis.

Microbial Genetics and Strain Improvement

Transformation, conjugation and transduction. Development of industrial microorganisms – Mutation, mutant detection, mutant selection. Microbes and genetic engineering – Introduction to genetic engineering, producing genetically engineered microorganisms – *Escherichia coli* and *Saccharomyces cerevisiae*. Interaction between bacteria and bacteriophages. Microorganisms for insect and pathogen control – Bioinsecticides (Bt proteins, Chitinase).

Fermentation and Downstream Processing

Types of fermenter, process of fermentation, Microbial culture system – batch culture, fed batch culture, continuous culture, measurement and control of bioprocess parameters, scale-up. Downstream processing – Solids removal, primary separation, purification and isolation of products.

Microbial Production of Enzymes

Genetic and metabolic regulation of enzyme action and enzyme formation. Hydrolases (Glycosidases, cellulase, proteolytic enzymes), Recombinant DNA technology for enzyme production. Immobilization of enzymes and cells – methods of immobilization, applications.

Microbial Production of Organic Compounds

Solvents - Alcohol, Glycerol. Organic acids – Citric acid, acetic acid, L-ascorbic acid, lactic acid. Antibiotics – Penicillins (Penicillin), Cephalosporins (cephalosporin), Aminoglycosides (streptomycin), Tetracyclines (chlortetracycline), Macrolides (erythromycin A). Amino acids – L-glutamic acid, L-lysine, L-tryptophan. Vitamins – Vitamin B12, Riboflavin, Beta-carotene. Foods and beverages – Cheese, single cell protein (yeast), beer, wine. Polysaccharides (Xanthan) and polyhydroxyalkanoates (polyhydroxybutyrate).

Microbes in Energy & Environment

Alcohol and methane from biomass, photo-biological hydrogen production, Electricity from biofuel cells. Microbial mining and metal biotechnology – Bioleaching and biosorption. Bioremediation.

TEXT BOOKS

1. Microbial Biotechnology, Alexander N glazer, Hiroshi nikaido, 2nd Edition, Cambridge, (2008).
2. Industrial microbiology (2008), L.E. Casida Jr, New age International publisher.

REFERENCE BOOKS

1. Microbial biotechnology – Principles and applications (2004) Lee yuan Kun (edi), World Scientific publisher.
2. Microbiology; An application based approach (2010), Michael J Pelczar, Jr ECS Chan, Noel R Krieg, Mc Graw Hill publisher
3. Fermentation microbiology and biotechnology, Mansi, 2012 Taylor & Francis (Ane books)
4. Text book of microbiology, Kanika Sharma, (Ane books)
5. Microbiology clinical approach, Anthony Strelkauskas, 2010, Garland science
6. Living in microbial world, Bruce Hofkin, Garland science

ENZYME TECHNOLOGY

Subject Code	: 12BBT151	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction

Significance, potential applications and economic aspects of enzyme technology. Enzymes as biocatalysts advantages and disadvantages over chemical catalysts and characteristics.

Extraction and Purification of Enzymes

Methodology for extraction of enzymes Extraction of soluble enzymes and membrane-bound enzymes, nature of extraction medium and conditions of extraction. Purification of enzymes preliminary and secondary purification procedures, degree of purification and criteria of purity of enzymes. Determination of molecular mass of enzymes.

Production of Enzymes

Sources of enzymes, selection of organisms, cultivation technique solid substrate cultivation and submerged cultivation. Production of enzymes case studies- amylase, inerase and proteases. Engineering organisms for production of enzymes.

Enzymatic Techniques

Principles of enzymatic analysis. End-point and kinetic methods, immunoassays, spectrophotometric, electrochemical and radiochemical. Test strips methods, automation in enzymatic analysis fixed time, fixed and continuous concentration. Applications of enzymes in medicine and diagnostic kits; therapeutic enzymes.

Industrial Applications of Enzyme Technology

Textile industry, detergents, pulp and paper, leather, wood, animal feed, brewing, food and dairy industry - amylases, proteases, lipases, pectinases.

Immobilization of Enzymes

Introduction, immobilization techniques and carriers. Immobilization techniques for soluble and insoluble (bound) enzymes. Immobilization of cells and organelles. Activity and kinetics of immobilized enzymes. Mass transfer effects in immobilized enzymes. Analysis of pore and film diffusion.

Immobilized Enzyme Reactors

Types of bioreactors Batch stirred tank, plug-flow tubular, continuous stirred tank, fixed (packed) bed, fluidized bed and membrane.

Applications of Immobilized Enzymes

Enzyme sensors for clinical analysis, therapeutic medicine (intracorporeal and extracorporeal applications). Production of high-fructose corn syrup, L-aspartic acid, L- alanine and acrylamide. Environmental applications. Economic aspects of immobilized enzymes, microorganisms, mammalian cells and plant cells. Safety aspects.

Enzyme Biosensors

Applications of enzyme in analysis Design of enzyme electrodes and their applications in industry, healthcare and environment.

Enzyme Engineering

Glucose isomerase, subtilisin, redesigned lactate dehydrogenase. Synthetic enzymes- peroxidase. Catalytic antibodies.

TEXT BOOKS

1. Klaus Buchholz, Volker Kasche and Uwe Theo Bornscheuer. Biocatalysis and Enzyme Technology. 1st edn. Wiley-VCH, 2005.
2. Wolfgang Aehle. Enzymes in industry-production and applications. 3rd edn. Wiley-VCH, 2007.
3. Chaplin M.F. and C. Bucke. Enzyme Technology. CUP. Cambridge. 1990.
4. Price N. C. and L Stevens. Fundamentals of Enzymology 3rd edn. Oxford University Press. 2003.

REFERENCE BOOKS

1. Trevor Palmer. Enzyme – Biochemistry, Biotechnology, Clinical chemistry, affiliated East-West Press Pvt. Ltd. 2004.
2. Bommarius, A.S and R. Riebel. Biocatalysis. Wiley – VCH. 2004.
3. Octave Levenspiel. Chemical Reaction Engineering. 3rd edn., John Wiley and Sons. 1999.
4. Prescott & Dunns- Industrial microbiology. 4th edn. CBS Publ. 1987.
5. Industrial and environmental biotechnology, Ahmed , Taylor and Francis, (Ane books)
6. Protein engineering in industrial biotechnology, Alberghina, Taylor and Francis, (Ane books)
7. Industrial biotechnology A. S. Mathuriya, Ane books

ENVIRONMENTAL BIOTECHNOLOGY

Subject Code	: 12BBT152	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction

Concept and scope of environmental biotechnology. Elements of life and biodistribution of elements. Microbiology of air, water & soil, interactions among soil microorganisms. Role of environmental biotechnology in sustainable development.

Waste Water Biotechnology

Nature and components of Waste water, Eutrophication – causes detergents, effects and control. Waste water treatment – primary waste water treatment unit operations, secondary waste water treatment design and modeling of activated sludge process - aerobic and anaerobic, and tertiary waste water treatment - reverse osmosis and ultra filtration, microbial removal of phosphorous and nitrogen.

Wastewater composition and treatment strategies in food processing & pharmaceutical industries - sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries distilleries & pharmaceuticals.

Solid Waste Management

General composition of urban solid wastes, treatment aerobic treatment, anaerobic treatment, biogas generation, solid waste management through biotechnological processes involving - hazardous wastes, Biomedical wastes, Dairy wastes, Pulp industry wastes, Textile industry wastes, leather industry wastes and pharmaceutical industry wastes, petroleum wastes treatment. Integrated waste management, super critical water oxidation of wastes.

Energy and Environment

Renewable and non-renewable resources. Conventional fuels and their environmental impacts. Modern fuels and their environmental impacts. Biotechnological inputs in producing good quality natural fibers. Plant sources like *Jatropha*, *Pongamia* etc. Waste as an energy core, energy recovery systems for urban waste, technology evaluation, concept of gasification of wastes with molten salt to produce low-BTU gas; pipeline gas from solid wastes by syngas recycling process; conversion of feedlot wastes into pipeline gas; fuels and chemicals from crops, production of oil from wood waste, fuels from wood waste, methanol production from organic wastes. Gasohol, Dye-pigments, sensitized solar cells.

Xenobiotics

Characteristics of Xenobiotics, dose response relationship, effects of xenobiotics, Relationship of Bioaccumulation with Chemical Structures, Eco-physiology of Bioaccumulation - Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation. Degradation of Xenobiotics in the Environment. Biodegradable alternatives for xenobiotics. Biomonitoring of environment, Bioremediation using microbes, Phytoremediation.

Biobleaching & Biomining

Biometallurgy, Microbes in Biobleaching and Metal Recovery Microbial recovery of phosphate, microbial extraction of petroleum and microbial production of fuels.

Green Technology and Environmental Protection

Principles of green technology, enzyme based detergents, alternative pesticides, alternative fuels, bio polymers, techniques and directions in practicing green technology, super critical liquid carbon dioxide solvent, polylactic acid polymers, use of hydrogen peroxide as a benign bleaching agent in paper industry, enzymatic production of cotton textiles, biodegradable builders in detergents, replacement of wood preservatives and synthesis of specialty compounds.

Biodiversity Conservation

Significance of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.

Biotechnology & Climate Change

GHG & Carbon foot printing, Biotechnology- a sink for GHGs, reduction in GHG emission, alternatives for GHG, carbon credit & trading through BT.

Environmental Management in Biotech Industries

Environmental issues of biotech industries, environmental management & ISO 14000, Lean manufacturing - waste minimization, Green solvents & solvent recovery, Excellence modules – 5S, Kaizen, six sigma. Future Strategies to Reduce Pollution and Conserve a Natural & Healthy Environment

TEXT BOOKS

1. Foster C.F., John ware D.A., Environmental Biotechnology, Ellis Horwood Limited, 1987.
2. M. C. Newman, Ecotoxicology – *Fundamentals of Ecotoxicology*.
3. Hans-Joachim Jördening and Josef Winter, Environmental Biotechnology Concepts and Applications.
4. Larry Anderson and David A Tillman, Fuels from Waste , Academic Press, 1977.
5. S O Enfors & L Hagstrom, Bioprocess Technology- fundamentals and applications, RIT, Stockholm (1992).
6. Asim K Das, Environmental Chemistry with Green Chemistry, Books and allied (P) ltd, 2010.

REFERENCE BOOKS

1. M.Y. Young (Eds.), Pergamon Press. Comprehensive Biotechnology Vol. 1- 4
2. L.E. Casida, Industrial Microbiology Willey Eastern Ltd., 1989.
3. Prescott & Dunn, Industrial Microbiology CBS Publishers, 1987.
4. E.J. Dasilva, C Ratledge & A Sasson, Biotechnology, Economic & Social Aspects Cambridge Univ. Press, Cambridge.
5. Environmental science, V.K. Ahluwalia, Ane Books
6. Industrial and environmental biotechnology, Ahmed, Taylor and Francis (Ane Books)

FOOD BIOTECHNOLOGY

Subject Code	: 12BBT153	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Basic Constitutes of Food

Basic constituents of food, colloidal systems in food, molecular stability of colloidal systems, types of food starches, soluble fibers pectin's, mucilage & gums, protein rich foods, oils in foods.

Food Spoilage and Food Borne Disease

Microbial growth pattern, types of microorganisms associated with food mold, yeast and bacteria. Contaminants of food stuff, milk and meat during handling and processing. Mechanism of food spoilage. Biochemical changes caused by microorganism. Determination of various types of food products. Food borne intoxicants and mycotoxins

Food Preservation Technology

Food preservation by high and ultra high temperatures- canning, drying. Food dehydration Equipments for food dehydration fixed tray dehydration, cabinet drying, tunnel drying. Freeze dehydration, controlled atmosphere, storage, Food preservation by irradiation treatment. Preservation by freezing and refrigeration. Frozen foods. Thermal properties of frozen foods. Food freezing equipments Air blast freezers, plate freezers and immersion freezers. Preservation by Chemicals and Bacteriocins

Principles of Food Processing Technology

Specific objectives of food processing, impact of food processing on food constituents. Post harvest processing technology for plantation crops processing of coffee, tea, and cocoa. Processing of spices.

Food Additives and functional foods

Food additives; food flavours, pigments, amino acids, natural and artificial sweeteners. Aroma compounds in foods. Nutraceuticals as food additives.

Food Production Technology

Importance of food industry, , Production of single cell protein, Tailoring of milk proteins and milk fats, Production of fermented food products yoghurt, pro-biotic cheese, recombinant lactic acid bacteria in food industry, labeling of constituents Soya foods, organic foods, dietary foods, nutritional food supplements, Use of plant cell culture for the production of food additives (Vanillin, Capsaicin), microbial transformations, Food packaging, edible films, Marketing of food and promotional strategies.

Biotechnology for Improved Processing

Role of biotechnology in food industry, maintenance of nutritional quality, Enzymes in bakery and cereal products, utilization of hydrolases and lipases enzymes. Applications of immobilized enzymes in food industry, enzymes for enhanced flavor and aroma compounds, enzymes in fat and oil industries. Genetically modified plants for high nutritional food.

Food Quality Assurance and Control

Importance and functions of quality assurance and control Methods of quality, concept of rheology, assessment of food materials- fruits, vegetables, cereals, dairy products, meat and processed food products. Microbiological safety of food products, chemical safety of food products, contaminants by heavy metal, fungal toxins and pesticide residue. Food regulations, grades and standards, USFDA/ ISO 9000 Series. Food adulterations and safety, sensors and instrumental analysis in quality control food laws and standards.

TEXT BOOKS

1. James M, Jay. Food Biotechnology CBS Publishers 2nd edition, 2005.
2. Food Biotechnology by Kalidas shetty CRC Press. 2nd ed. 2005

REFERENCE BOOKS

1. T.Britze, R.K Robinson., Advanced Dairy Science and Technology. Wiley- Blackwell publish. 1st edition. 2008
2. H. Elmer, L James, Marath and Steele. Applied dairy microbiology, CRC press 2nd edition 2005.
3. Food chemistry, 3rd edition, Owen E. Fennema, CRC Press (Researchco books)
4. Fundamental of food production, KK Tulli, Ane books

DNA Chips and Microarray Data Analysis

Subject Code	: 12BBT154	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to Biochip and Microarray Construction: Basics of Biochips and Microarray Technology, Biochip technologies. Types of Biochips - DNA Microarrays, Oligonucleotide, cDNA and genomic microarrays, Integrated biochip system. Biochip versus gel-based methods. Limitations of biochip technology. Biochip construction - Mega10ne technology for fluid microarrays, Microarray labels, Microarray scanners, Microarray robotics. Microfluidics systems, Chips and Mass Spectrometry. Electrical detection methods for microarrays. Applications of Biochips - Tissue Chip, RNA Chip, Protein Chip Technology, Glycochips, Biochip assays, Combination of microarray and biosensor technology. Bioinformatics and microarrays,

Applications of Biochip Technology:

Molecular diagnostics, Pharmacogenomics, application of microarray technology in drug discovery and development, Use of DNA chip technology for drug safety, drug delivery, population genetics and epidemiology. Applications of Microarray technology in Forensics. DNA chip technology for water quality management, Application of micro arrays in the agro-industry; use of microarrays in Genetic disease monitoring.

Microarray Data analysis: Introduction, Image Acquisition and Analysis, Detection of differential gene expression. Pathway analysis tools. Data validation.

Genomic Signal Processing: Introduction, Mathematical models, and Modeling DNA Microarray data - Singular Value Decomposition algorithm. Online Analysis of Microarray Data Using Artificial Neural Networks – Introduction, Methods. Signal Processing and the Design of Microarray. Time-Series Experiments.

Predictive Models of Gene Regulation: Introduction, Regression Approach to Cis-Regulatory Element Analysis, Cooperativity. Spline Models of Cooperative Gene Regulation. Statistical Framework for Gene Expression Data Analysis – Materials and Methods. Analysis of Comparative Genomic Hybridization Data on cDNA Microarrays – Introduction, materials and methods. Interpreting Microarray Results With Gene Ontology and MeSH – Introduction, Materials and methods. Incorporation of Gene Ontology Annotations to Enhance Microarray Data Analysis – Materials and Methods.

DNA Computing: Introduction, Junctions, other shapes, Biochips and large-scale structures. Strand algebras for DNA computing – Introduction, Strand Algebras. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube, computing with DNA, Electrical analogies for biological circuits, Challenges, Future Trends.

DNA programming - Deoxyribozyme-Based Logic Gate design processes. Renewable, Time responsive DNA Logic Gates for scalable digital circuits. Design of Bimolecular device.

Commercial Aspects of Biochip Technology: Markets for biochip technologies, Commercial and Government support for biochip development, Business strategies, and Patent issues.

TEXT BOOKS:

1. **Biochips and Microarrays – Technology and Commercial Potential** Published by: Informa Global Pharmaceuticals and Health Care.
2. **Functional Protein Microarrays in Drug Discovery** By Paul F. Predki, CRC Press – Publisher
3. **DNA Computing: 15th International Meeting on DNA Computing, DNA 15, Fayetteville, AR, USA, June 8-11, 2009**, Springer, 2009.

REFERENCE BOOKS:

1. **DNA Arrays: Technology and Experimental Strategies** by Grigorenko, E.V (ed), CRC Press, 2002.
2. **Microarray Analysis** by Mark Schena; J. Wiley & Sons (ed. New York), 2002.

UPSTREAM PROCESSING LAB

Subject Code	: 12BBT17	IA Marks	: 25
No. of Practical Hrs./ Week	: 03	Exam Hrs	: 03
		Exam Marks	: 50

1. Isolation of industrial important bacteria, yeast and fungi from
 - a. Soil
 - b. Water
 - c. Air
2. Microbial products formation (any two)
 - a. Production of Alcohol from fermentable sugars using Yeast.
 - b. Production of Citric acid from *Aspergillus Niger*.
 - c. Production of Vinegar from Alcohol.
 - d. Production of Lactic acid using Lactobacillus bacteria.
3. Cultivation of algae (*Spirulina*).
4. Production of enzyme (Amylase) from fungal source.
5. Hairy root culture for production of secondary metabolites.
6.
 - a) Invitro induction of Callus & multiple shoot from explants.
 - b) Anther culture for the production of haploid plants.
 - c) Protoplast isolation using plant material.
 - d) Establishment of suspension callus cultures (Horticulture/medicinal plant).
7. Animal cell culture by trypsinization.
8. Primary culture technique from chick embryo fibroblast.
9. MTT cell proliferation (cell viability assay) using human cell lines.

SEMINAR

Subject Code : 12BBT18 **IA Marks** : 25
Field work/Assignment Hrs./Week : 03

Seminar Mechanism

1. A list of contemporary topics will be offered by the faculty members of the department.
2. Student can opt for a topic of their own choice and indicate their option to the department at the beginning of the semester.
3. Students have to do a literature survey of the selected topic from journals and web resources.
4. A draft copy of the report should be submitted one week before the presentation, to the seminar coordinator.
5. Students have to give a presentation in power point for about 30 minutes followed by the Q/A session.
6. The Evaluation will be done by committee constituted by the department.
7. The final copy of the report should be submitted after incorporating any modifications suggested by the evaluation committee.

Guidelines for Evaluation

The following are the weightages given for the various stages of the seminar:

- | | |
|---|-----------------|
| 1. Selection of the topic. | 05 Marks. (20%) |
| 2. Literature survey. | 05 Marks. (20%) |
| 3. Understanding and presentation of the given topic. | 05 Marks. (20%) |
| 4. Reporting and Documentation. | 10 Marks. (40%) |

GENOMICS, PROTEOMICS AND MICROARRAY

Subject Code	: 12BBT21	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction

Genomics and Proteomics. Structure, organization and features of Prokaryotic & Eukaryotic Genomes. Vectors, Genome mapping. Polymorphisms
Molecular markers – RFLP, AFLP, RAPD, SCAR, SNP, ISSR, and Protein markers - Allozymes and Isozymes, Telomerase, FISH - DNA amplification markers and Cancer biomarkers. Genome sequences databases and Genome annotation, Gene discovery. Gene Ontology. Haplotyping and Diplotyping.

Genome Sequencing

Early sequencing efforts. DNA sequencing methods - Maxam-Gilbert Method, Sanger Dideoxy method, Fluorescence method, shot-gun approach and ultra-high-throughput DNA Sequencing using Microarray technology. Genome sequencing projects on *E.coli*. Arabidopsis and rice; Human-genome project and the genetic map. Recent developments and next generation sequencing. Raw genome sequence data, expressed sequenced tags (ESTs), Gene variation and associated diseases, diagnostic genes and drug targets. Genotyping - DNA Chips, diagnostic assays, diagnostic services. Comparative genomics and Functional Genomics. Studies with model systems such as Yeast, *Drosophila*, *C. elegans*, Arabidopsis. SAGE.

Functional Genomics

C-Values of eukaryotic genomes. Organization of microbial, plant and animal genomes, repetitive and coding sequences. Identification and tagging of markers for important traits, T-DNA & transposon tagging. Cloning of genes by map-based cloning, Construction & Screening of cDNAs libraries, differential display via RT-PCR. Micro-array in functional genomics.

Genome annotation

Extrinsic, Intrinsic (Signals and Content), Conservative information used in gene prediction. Frameworks for Information integration – Exon chaining, Generative models, Hidden Markov Models, Discriminative learning and Combiners. Evaluation of Gene prediction methods – Basic tools, Systematic evaluation and Community experiments (GASP, EGASP and NGASP).

Proteomics

Scope, Experimental methods for studying proteomics, methods of protein isolation, purification and quantification. Methods for large scale synthesis of proteins. Applications of peptides in biology. Analysis of proteins - high throughput screening, engineering novel proteins, Mass-Spectroscopy based protein expression and post-translational modification analysis. Bioinformatics analysis - clustering methods, proteome functional information.

Functional annotation of Proteins

Introduction, Protein sequence databases, UniProt, UniProtKB – Sequence curation, Sequence annotation, Functional annotation, annotation of protein structure, post-translational modification,

protein-protein interactions and pathways, annotation of human sequences and diseases in UniProt and UniProtKB. Protein family classification for functional annotation – Protein signature methods and Databases, InterPro, InterProScan for sequence classification and functional annotation. Annotation from Genes and Protein to Genome and Proteome.

Microarray

Basics of Biochips and Microarray Technology, Historical Development, Biochip technologies.

Applications Of Biochip Technology

Molecular diagnostics, Pharmacogenomics, application of microarray technology in drug discovery and development, Gene expression studies, Use of DNA chip technology for drug safety, Use of microchips for drug delivery, Use of biochips in healthcare, Use of microarrays in population genetics and epidemiology, Use of microarrays in forensics, DNA chip technology for water quality management, Application of micro arrays in the agro-industry; use of microarrays in Genetic disease monitoring; Point of Care (P.O.C) applications, Limitations of biochip technology.

Commercial Aspects of Biochip Technology

Markets for biochip technologies, Commercial support for the development of biochips, Government support for biochip development, Business strategies, and Patent issues.

DNA Computing

Introduction, Junctions, other shapes, Biochips and large-scale structures, Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube, computing with DNA, Electrical analogies for biological circuits, Challenges, Future Trends.

TEXT BOOKS

4. Bioinformatics, Genomics, and Proteomics By Ann Batiza, Ann Finney Batiza, Published by Chelsea House Publishers, 2005.
5. Biochips and Microarrays – Technology and Commercial Potential Published by Informa Global Pharmaceuticals and Health Care.
6. Functional Protein Microarrays in Drug Discovery By Paul F. Predki, CRC Press – Publisher.
7. Discovering genomics, proteomics and bioinformatics By A. Malcolm Campbell, Laurie J. Heyer, Published by Pearson/Benjamin Cummings, 2006.

REFERENCE BOOKS

1. Grigorenko, E.V DNA Arrays Technology and Experimental Strategies CRC Press. (2002). (ed),
2. Mark Schena Microarray Analysis J. Wiley & Sons (ed. New York). (2002);
3. Werner Kalow, Urs A. Meyer, Rachel F. Tyndale Pharmacogenomics, CRC Press.
4. Sándor Suhai Genomics and Proteomics Springer – Publisher
5. Proteomics, S.R. Pennington, Taylor and Francis (Ane Books)

BIOPROCESS CONTROL AND INSTRUMENTATION

Subject Code	: 12BBT22	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to Process Control

Automatic process control principles and Block diagram representation, open loop and closed loop system.

Controllers

Introduction to Controllers, Classification of controller based on type of action continuous and discontinuous, two position and floating controllers (discontinuous), Proportional, Proportional-Integral (PI), Proportional-Derivative (PD) & Proportional-Integral-Derivative (PID) controllers. Final Control Element I/P Convert-pneumatic, electric and hydraulic actuators. Control valve-characteristics of control valve. Types of valve Globe, Butterfly, Diaphragm and Ball.

Process Monitoring

Online & offline measurement of process variables. Measurement and control of pH, dissolved oxygen and carbon dioxide, temperature, pressure, foam, liquid level, gas flow rate, agitator speed and power consumption, turbidity. Offline measurement of biomass, carbohydrate, protein, phosphate and lipid concentrations, enzyme activity and broth rheology.

Data Acquisition Techniques

Computer Interfaces and peripheral devices; Fermentation software. Data smoothing and interpolation; State and parameter estimation; Direct regulatory control; cascade control of metabolism. Current practices of instrumentation and data acquisition in bioprocess industry.

Stability criteria

Routh Hurwitz method, Root locus method, Frequency response Bode and Niquist plots, design of control system, controller tuning Zigler-Nichols and Cohen-Coon tuning methods. Theory and Problems on above topics.

TEXT BOOKS

1. Bailey J.E. and Ollis D.F. Biochemical Engineering Fundamentals 2nd Edition, McGraw- Hill Book CO., Singapore, 1986.
2. Ghose T.K. Process Computations in Biotechnology, Tata McGraw Hill Publ.Co. New. Delhi. 1994.
3. Fischer A. Advances in Biochemical Engineering, Vol. 13, Springer Verlag, Germany. 1973.
4. Coughanowr Donald R. and S.E. Leblanc. Process Systems Analysis and Control, 3rd ed, McGraw-Hill, New York, 2009.

REFERENCE BOOKS

1. McNeil and Harvey, Fermentation - A Practical Approach, IRL Press, U.K. 1990.
2. Scragg, Bioreactors in Biotechnology - A Practical Approach, Ellis Horwood Ltd., U.K. 1991.

ADVANCED DOWNSTREAM PROCESSING

Subject Code	: 12BBT23	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction

Role and importance of downstream processing in Biotechnology. Economics of downstream processing, cost cutting strategies, characteristics of biological mixtures, process design criteria for various bioproducts.

Primary Separation and Recovery Process

Cell disruption method for intracellular products chemical, mechanical and enzymatic methods. Principles, operation, design and scale up of sedimentation, flocculation, centrifugal settling and filtration.

Enrichment Operations I

Precipitation and Extraction

Precipitation methods by isoelectric precipitation, salt fractionation, polymer and organic solvent. Extraction Concepts, modeling and design aspects. Principles and applications of aqueous two-phase, reverse micellar and super critical extraction.

Enrichment Operations II

Membrane Based Separations: Theory and applications of Ultrafiltration and microfiltration, design and configuration of membrane based separations, Structure and characteristics of membranes. Principles, working and applications of reverse osmosis, dialysis, liquid membranes and Membrane reactors.

Purification Techniques

Principle and practice of the Chromatography techniques Gel permeation, Ion exchange, Reverse phase, Hydrophobic and Affinity chromatography. Recent advances in purification techniques of bioproducts membrane chromatography and electrochromatography. In-situ product removal and process integration. Case studies Ethanol, Antibodies and mammalian proteins.

TEXT BOOKS

1. P.A. Belter, E. Cussler and W.S. Hu, Bioseparation- Downstream Processing for Biotechnology, 1st ed., Wiley Interscience, 1988.
2. B.Sivasankar, Bioseparations Principles and Techniques, 1st ed., Prentice Hall of India, New Delhi, 2006.
3. Protein purification. R.K. Scopes, IRL press, 1993.

REFERENCE BOOKS

1. R.G. Harrison, P. Todd, S.R. Rudge and D.P. Petrides, Bioseparations Science and Engineering, 1st ed., Oxford University Press, 2004.
2. Raja Ghosh, Principles of Bioseparations Engineering, 1st ed. World Scientific Pub, 2006.
3. M.R. Ladisch, Bioseparations Engineering Principles, Practice and Economics, 1st ed., Wiley, 2001.
4. J.E Bailey, D.F Ollis, Biochemical Engineering Fundamentals, 2nd ed., Mc graw Hill, 1986

APPLIED BIOINFORMATICS

Subject Code	: 12BBT24	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Biological Databases

Introduction – Biomolecules: Proteins, Nucleic Acids, DNA, RNA. Molecular Genetics, Chromosomes, Genome, Genes and Genetic code, Central dogma of Molecular biology, Sequencing Techniques. Nucleotide Sequence, Protein Sequence and Structure databases. Primary and Secondary databases. Primary databases - GenBank, EMBL, DDBJ, SWISSPROT and TrEMBL. Secondary databases – PROSITE, PRINTS, Pfam, BLOCKS, BioGRID and InterPro. Structure databases – PDB, SCOP, CATH, EuroCarbDB, PubChem Compound, DrugBank, ChemSpider and Cambridge Structural Database.

Specialized Databases

Microarray - ArrayExpress, Gene Expression Omnibus, GPX, maxd and Stanford Microarray Database (SMD). Metabolic Pathway - BioCyc, KEGG PATHWAY, MANET and Reactome. Genome databases – NCBI Genome, HUGO, KEGG, TIGR, MGD, JGI, MaizeGDB, EcoCyc, and Ensemble and Viral genome database. Disease centered databases – Human Genome project, OMIM, Oncogenomic databases, Drug2Gene, HGMD, TDR Targets and p53. Sequence retrieval and Hidden Markov Models, HMMs based algorithms for biological data mining.

Molecular Modelling and *Insilico* Drug Design

Introduction to molecular modelling, Protein modelling using High Throughput methods – Modelling of targets and receptors. *Insilico* drug design – types, Virtual Library design, vHTS and Scaffold Hopping, pharmacophore mapping, Lead Optimization. Predictive Science (Biological Activity, ADMET). Structural Mining Protein Ligand work analysis. Study of drug-interactions and Docking.

Working with Discovery Studio (Molecular Modelling)

2D and 3D molecular descriptors, Quantum mechanics / molecular, mechanics. SAR analysis, 2D and 3D QSAR. Bayesian statistics, neural networks, recursive partitioning, GFA, etc. Library analysis and Library design. Conformation generation and Analysis. Pharmacophore generation (Catalyst), Scaffold hopping, 3D database screening, Virtual screening and compound ranking/scoring. Predictive ADME and toxicology (TOPKAT®).

Structure-based and structure-guided design, Receptor-ligand interactions analysis, Fragment-based design, *de novo* design (LUDI). Simulations, molecular mechanics/dynamics (CHARMm). Explicit/implicit solvation models, Transmembrane protein modeling, Homology modeling, Antibody modeling, Electrostatics calculations, protein ionization and pK prediction, Protein modeling (MODELER®) and analysis, protein engineering. Protein-protein docking and refinement, Sequence analysis, sequence alignment, phylogenetic analysis, X-Ray (CNX), structure refinement and analysis.

Systems biology

Introduction to systems biology, applications, basic notations for computational model, model scope and statements, system states, variables, parameters and constants, model behavior and model classification. Biochemical systems modeling – Kinetic modeling of enzymatic reactions, structural analysis of biochemical systems, Kinetic models of Biochemical systems. Tools and data formats for modeling. Modelling special biochemical systems Modelling of Metabolic pathway, signalling pathway, Cell cycle and Spatial models.

TEXT BOOKS

1. Setubal Joao and meidanis Joao, Introduction to Computational Molecular Biology, Publisher PWS Publishing; 1st edition (January 16, 1997).
2. Warren Ewens and Gregory R. Grant, "Stastical Methods in Bioinformatics an Introduction, Springer, 2nd ed. 2005.
3. An Introduction to Systems Biology Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical & Computational Biology) by Uri Alon (Jul 7, 2006)

REFERENCE BOOKS

1. R. Durbin, S. Eddy, A. Krogh and G. Mitchison, Biological Sequence Analysis, Cambridge. Cambridge University Press (1998)
2. Paul M. Selzer, Richard J. Marhöfer, Andreas Rohwer, Applied bioinformatics an introduction, Berlin Springer 2008.
3. Building bioinformatics solutions, Bessant, Ane books

NANOBIOTECHNOLOGY

Subject Code	: 12BBT251	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction

A brief history of the Super Small, Definition of nanotechnology, Nanobiotechnology; Discussions on nanofabrication, Bottom-Up versus Top-Down; Nanolithography, Fabrication in Hard materials: Silicon and glass materials for nanofabrication, Fabrication in Soft materials: Hydrogels / PDMS / others polymers and base materials for nanofabricated devices.

Nanomaterials and Their Characterization

Structure and Properties of Fullereness, Buckyballs, Nanotubes, Carriers, Dendrimers, Nanowires, Membranes, Matrices, Nanoshells, Quantum Dot, Nanocrystals, hybrid biological/inorganic devices. Characterization using Atomic force microscopy, Scanning and tunneling microscopy.

Bionanomaterials

Functions and application of DNA based nanostructures-DNA microarray. In-vitro laboratory tests on the interaction of nanoparticles with cells. Assessment of the toxic effects of nanoparticles based on in-vitro laboratory tests.

Nanodiagnostics

Diagnostics and Sensors, Rapid Ex-Vivo Diagnostics, Nanosensors as Diagnostics and Nanotherapeutics. Identification of pathogenic organism by magnetic nanoparticles based techniques. Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices.

Drug Discovery and Drug Delivery

Drug Discovery using Nanocrystals, Drug Discovery using Resonance Light Scattering (RUS) Technology. Benefits of Nano-imaging Agents, Nanosensors in Drug Discovery, Drug Delivery using Nanobiosensors, Drug Delivery Applications, Bioavailability, Sustained and targeted release, Nanorobots, Benefits of Nano-Drug Delivery. Drug Delivery, Health Risks and Challenges, Targeting Drug Delivery Revenues. Use of microneedles and nanoparticles for local highly controlled drug delivery.

Microfluidics

Laminar flow, Hagen-Poiseuille eqn, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps, Approaches toward combining living cells, Microfluidics and 'the body' on a chip, Chemotaxis, cell mobility, Case studies in Microfluidics Devices.

BioMEMS

Introduction and Overview of Micro electronic fabrication. Biosignal Transduction mechanisms: Electromagnetic Transducers, Mechanical Transducers, Chemical Transducers, Optical Transducers – Sensing and Actuating mechanisms. Case Studies in Biomagnetic Sensors, Applications of optical and chemical transducers and Recent Developments in BioMEM.

TEXT BOOKS:

1. J Rosenthal Sandra and W Wright David; Nanobiotechnology Protocols. Humana Press, 1st edition; 2005.
2. Richard Booker and Earl Boyse., Nanotechnology. Wiley dreamtech edition 2005.

REFERENCE BOOKS:

1. Chapman & Hall. Nanotechnology – Basic Science & Emerging Technologies. CRC 2002
2. Gregory Timp., Nanotechnology. Spring 1st edition; 1998.
3. Bio-nano Technology, Sharon, Ane books, 2012
4. Nanotechnology and tissue engineering, The scaffold, Laurencin, Taylor and Francis, (Ane books)
5. Nanotechnology Environmental health and safety, Hull

DATA WAREHOUSING AND DATA MINING

Subject Code	: 12BBT252	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to Data Warehousing

Heterogeneous information; the integration problem; the Warehouse Architecture; Data Warehousing; Warehouse DBMS. Aggregations SQL and aggregations; aggregation functions; grouping.

Data Warehouse Models and OLAP Operations

Decision support; Data Marts; OLAP vs OLTP; the Multi-Dimensional data model; Dimensional Modeling; ROLAP vs MOLAP; Star and snowflake schemas; the MOLAP cube; roll-up, slicing, and pivoting.

Some Issues in Data Warehouse Design

Monitoring; wrappers; integration; data cleaning; data loading; materialized views; warehouse maintenance; OLAP servers; metadata.

Building Data Warehouses

Conceptual Data Modeling, Entity-Relationship (ER) modeling, Dimension modeling. Data warehouse design using ER approach. Aspects of building data warehouses.

Introduction to Data Mining

Data Mining; View of the KDD Process; Problems and Techniques; Data Mining Applications; Prospects for the Technology.

The Crisp-Dm Methodology

Approach; Objectives; Documents; Structure; Binding to Contexts; Phases, Task, Outputs.

Data Mining Inputs and Outputs

Concepts, Instances, Attributes; Kinds of Learning; Providing Examples; Kinds of Attributes; Preparing Inputs. Knowledge Representations; Decision Tables and Decision Trees; Classification Rules; Association Rules; Regression Trees and Model Trees; Instance-Level Representations.

Data Mining Algorithms

One-R; Naïve Bayes Classifier; Decision Trees; Decision Rules; Association Rules; Regression; K-Nearest Neighbor Classifiers.

Evaluating Data Mining Results

Issues in Evaluation; Training and Testing Principles; Error Measures, Holdout, Cross Validation; Comparing Algorithms; Taking Costs into Account; Trade-Offs in the Confusion Matrix.

TEXT BOOKS

1. M. Jarke, M. Lenzerini, Y. Vassiliou, P. Vassiliadis (ed.), Fundamentals of Data Warehouses, Springer-Verlag, 1999.
2. Ralph Kimball, The Data Warehouse Toolkit, Wiley 1996.
3. I. Witten and E. Frank, Data Mining Practical Machine Learning Tools and Techniques with Java Implementations, Morgan Kaufman, 1999.
4. J. Han and M. Kamber, Data Mining Concepts and Techniques, Morgan Kaufman, 2000.

REFERENCE BOOKS

1. Principles of Data Mining by D. Hand, H. Mannila and P. Smyth., MIT Press, 2001.
2. M. H. Dunham. Data Mining
3. Introductory and Advanced Topic. Prentice Hall, 2003.
4. Intelligent Data Warehousing By Zhengxin Chen
5. Design and implementation of data mining tools, Wang, CRC Press
6. Data Mining, Thuraisingham, CRC Press (Ane books)
7. Data mining methods and applications, Kenneth D. Lawrence, CRC Press

MOLECULAR MODELING AND SIMULATION

Subject Code	: 12BBT253	IA Marks	: 25
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Total No. of Lecture Hrs.	: 52	Exam Marks	: 100

Introduction to Molecular Modeling

Modeling basics. Generation of 3D Coordinates Crystal data, Fragment libraries, and conversion of 2D Structural data into 3D Form, Force fields, and Geometry optimization, Energy minimizing Procedures, use of Charges, Solvent effects and Quantum Mechanical methods. Conformational analysis. Computational tools for Molecular modeling, conformational analysis using - Systematic Search Procedures, Monte carlo and molecular dynamics methods. Determining features of proteins(Interaction potential, Molecular Electrostatic Potential, molecular interaction fields, properties on molecular surface and Pharmacophore identification. 3D QSAR Methods.

Modeling and Simulation Technique

Modeling and Simulation of Dopamine D3 Receptor Antagonists. Comparative Protein Modeling – Conformational Properties of Protein Structure, Types of Secondary Structural Elements, Homologous Proteins. Procedures for sequence Alignments, Determination and Generation of Structurally Conserved Regions, Construction of Structurally Variable Regions, Side-Chain modeling, Secondary Structure Prediction, Threading Methods. Optimization and Validation of Protein Models.

Virtual Screening and Docking

Introduction to Docking – Preparation of Partners, Compound Library, representation of Proteins and Ligands. Docking Algorithms. Simulation approaches for Protein model. Simulation of a Fluid Phase Lipid Bilayer Membrane, de novo Simulations of the Folding of GCN4 and its Mutants. Building a model of HIV-I Reverse Transcriptase (possible mechanisms for AZT resistance).

TEXT BOOKS

1. Molecular Modeling By Hans-Dieter Höltje, Wolfgang Sippl, Didier Rognan, Gerd Folkers.
2. Modelling of Biomolecular Structures and Mechanisms By Alberte Pullman, Joshua Jortner
3. Mathematical Approaches to Biomolecular Structure and Dynamics By Jill P. Mesirov, Klaus Schulten, De Witt L. Sumners

REFERENCE BOOKS

1. Systems Biology By Isidore Rigoutsos, G. Stephanopoulos, Published by Oxford University Press US
2. Foundations of Molecular Modeling and Simulation By Peter T. Cummings, Phillip R. Westmorland, Brice Carnahan, Published by American Institute of Chemical Engineers, 2001.
3. Understanding Molecular Simulation, By Daan Frenkel, Berend Smit, academic Press – Publisher

DOWNSTREAM PROCESSING AND PRODUCT RECOVERY LAB

Subject Code	: 12BBT26	IA Marks	: 25
No. of Practical Hrs./ Week	: 03	Exam Hrs	: 03
No of Experiment	:	Exam Marks	: 50

1. Cell disruption techniques for Proteins and Intracellular enzymes by
 - a. Mechanical method.
 - b. Chemical method.
 - c. Enzymatic method.
2. Solid-liquid separation methods:
 - a. Sedimentation by flocculating agents.
 - b. Filtration.
 - c. Centrifugation.
 - d. Membrane Filtration (fruit juices).
3. Concentration of material
 - a. Drying – vacuum tray drier, Atmospheric Tray drier, Spray drier.
 - b. Evaporation.
 - c. Lyophilizer.
4. Product Enrichment Operations
 - a. Extraction [liquid –liquid extraction & Aqueous two phase extraction (hydroxy citric acid from garcinia)].
 - b. Distillation [simple, steam (geranial oils, lemon grass oils) and vacuum distillation].
 - c. Reverse micellar extraction.
5. Separation and purification of products by
 - a. Centrifugation.
 - b. Chromatography – TLC (protein separation), Column Chromatography, GC, HPLC.
 - c. Gel Electrophoresis – PAGE & SDS PAGE.

BIOINFORMATICS LAB

Subject Code	: 12BBT27	IA Marks	: 25
No. of Practical Hrs./ Week	: 03	Exam Hrs	: 03
No of Experiment	: 15	Exam Marks	: 50

1. Survey of biological and chemical databases
2. Sequence formats and analysis (nucleic acid and protein)
3. Phylogenetic analysis
4. Secondary structure prediction of proteins.
5. Text to 2D molecular models
6. IUPAC naming and physicochemical analysis of constructed molecular models
7. Analysis of geometry and energy of constructed molecules
8. QSAR assay of constructed molecular models
9. Quantum mechanics of constructed molecules and assay of molecular mechanics of database molecules
10. Calculation of molecular dynamics of molecules and analysis of graphical data of molecules
11. Target/active site determination of disease protein or subject protein
12. 3D searching and collection of probable lead molecules
13. Creation of lead library for selected target protein
14. Physicochemical analysis of probable drug molecule for selected protein
15. Pharmacophores determination of selected lead molecules

SEMINAR

Subject Code : 12BBT29 **IA Marks** : 25
Field work/Assignment Hrs./Week : 03

Seminar Mechanism

8. A list of contemporary topics will be offered by the faculty members of the department.
9. Student can opt for a topic of their own choice and indicate their option to the department at the beginning of the semester.
10. Students have to do a literature survey of the selected topic from journals and web resources.
11. A draft copy of the report should be submitted one week before the presentation, to the seminar coordinator.
12. Students have to give a presentation in power point for about 30 minutes followed by the Q/A session.
13. The Evaluation will be done by committee constituted by the department.
14. The final copy of the report should be submitted after incorporating any modifications suggested by the evaluation committee.

Guidelines for Evaluation

The following are the weightages given for the various stages of the seminar:

- | | |
|---|-----------------|
| 5. Selection of the topic. | 05 Marks. (20%) |
| 6. Literature survey. | 05 Marks. (20%) |
| 7. Understanding and presentation of the given topic. | 05 Marks. (20%) |
| 8. Reporting and Documentation. | 10 Marks. (40%) |

RESEARCH METHODOLOGY

Subject Code	: 12BBT31	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

What is research? – Reflection, Science & Research. Basic & Applied Research, Steps in Research

Literature Collection: Review of literature, review process and bibliography, research / discriminative reading, consulting source material, major libraries subscribing journals related to biotechnology in the region and country
Formulation of Research Objectives and Testing of hypothesis, Research method and materials, Research action, Data collection and analysis plan,

Research budget and resources. Funding agencies: National and international funding agencies for R & D. Preparation of R & D projects for funding: Organization of a research project, identification of gap areas in the subject, aims and objectives of the projects, possible outcome of the project, funds requirements and justification(s).

Introduction – identification of the research question, hypotheses, and justification for the topic
Literature review – updated version of the initial literature review developed for the research proposal

Planning of experiments, Sampling – representative sampling, random and systematic sampling, sample and population parameters, Data Gathering – thorough description of methods of data gathering and sources. Analytical Techniques – detailed discussion of data gathering and analytical methods, including explanation of their suitability of these techniques compared with others and any possible problems arising from the methods selected. Data Analysis and Presentation – application and execution of analytical techniques, and interpretations of findings.

Statistical analysis: Analysis of Variance, Correlation, Regression, Frequencies, Transformation of data, Principle designs: Randomized Design, Randomized Complete block design, Latin square design

Scientific Writing: Writing scientific English. Organization and writing of a research paper, short communications, review articles, monographs, technical and survey reports, authored books and edited books, and dissertation. Format for manuscript writing, documentation, organization of reference material, bibliography, end note etc to be discussed with case studies.

Other Issues: Ethical issues, Issues related to plagiarism, copyright laws, acknowledging the sources etc to be discussed with case studies.

Patents and patents writing: Parts of Patent applications characteristics of the disclosure for a biotechnology invention, marketing of biotechnological invention.

TEXT BOOKS:

1. Ivan Valiela (2000) Doing Science: Design, Analysis, and Communication of Scientific Research, Oxford university press, USA
2. [William I.B. Beveridge](#)(2004) The Art of Scientific Investigation, Blackburn press pages 178

GMP AND GLP

Subject Code	: 12BBT321	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Basic Principals : Regulation, standards and guidelines of GMP & GLP, Basic terminology and validation overview, validation master plan, scope, documentation format, elements of qualification, numbering system, risk based assessment, Revalidation and its applications.

GMP (Good manufacture practice)

Basic components of GMP Facilities, Design, Materials, Flow, Environment Control, Prevention of Cross Contamination. Quality, concept of GMP, Quality Assurance & Quality control. Legal requirements pertaining to GMP.

GMP Practices in Animal and Human Products: Regulatory considerations in application of encapsulated cell therapies: GMP on cell-Based Therapies, FDA regulations of human tissues and products. Treatment of Diabetes with Encapsulated Islets: Concepts of Encapsulation, Intravascular Designs, Biocompatibility and Microcapsule Composition.

GLP (Good laboratory practice)

Principles; Commodities; Apparatus; Reagents and materials; Pest control; Cryogenic safety - General Precautions; Storage; Test Systems; Standard protocols; Quality assurance; Laboratory signage - Biosafety level; Treatment and disposal –sharps, cultures, stock & labware; Biotxin and pathological waste – fixed tissues & bedding; Storage and retention of records.

Implementation of GLP

Implementation As A Project, Stepwise Implementation of GLP Requirements. Quality Assurance and GLP Compliance of Laboratory Suppliers with GLP Principles, The Application of the GLP Principles to Field Studies, The Role and Responsibilities of the Study Director in GLP Studies, The Application of the Principles of GLP to in-vitro Studies, Establishment and Control of Archives that Operate in Compliance with the Principles of GLP

Food Safety and Regulations

The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Biosafety assessment procedures in India and abroad. International dimensions in biosafety: bioterrorism and convention on biological weapons. Biosafety regulations and national and international guidelines with regard to rDNA technology, transgenic science. Experimental protocol approvals, levels of containment.

Agriculture and Pharmaceutical Sector

Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Examples of patents in biotechnology. Special application of patent laws in biotechnology. Licensing and cross licensing.

Legal Issues:

The legal and socioeconomic impacts of biotechnology, Public education of the processes of biotechnology involved in generating new forms of life for informed decision making.

TEXT BOOKS

1. Mindy J. Allport-Settle Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference by Mindy J. Allport-Settle CreateSpace (September 17, 2009)
2. Erik Kopp Pharmaceutical Good Manufacturing Practices / DRUG GMPs plus Electronic Records; Electronic Signatures Regulations EKPublications; 1 edition (December 21, 2010)

REFERENCES BOOKS

1. Carol DeSain Documentation Basics That Support Good Manufacturing Practices and Quality System Regulations Tamarack Associates, LLC (July 1, 2004)
2. Graham Bunn, Joseph D. Nally Good Manufacturing Practices for Pharmaceuticals, Sixth Edition (Drugs and the Pharmaceutical Sciences Informa Healthcare; 6 edition (December 26, 2006)
3. Safety pharmacology in pharmaceutical developmental approach, Shayne C Gad, CRC press

BIOETHICS, BIOSAFETY AND IPR

Subject Code	: 12BBT322	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Biosafety and Risk Assessment

Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety levels; specific microorganisms; Recommended biosafety levels for Infectious agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, GMP and GLP.

Bioethics and Legal Issues

Ethical issues; Public perception related to Biotechnology from developed and developing countries. Legal and socio-economic impacts of biotechnology, public awareness on genetically modified life forms (case study). Ethical implication of biotechnological products and technique. Social and ethical implication of biological weapons.

Introduction to Intellectual Property

Types of IP Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to biotechnology with case studies; Introduction to GATT, WTO, WIPO and TRIPS.

Biotechnology and Intellectual Property Rights

Biotechnology and the Law-Objective, Evolution, Basic Structure of Gene Techniques, Applications, Commercial Potential of Biotech Inventions, Rationale for Intellectual Property Protection. Patenting Biotechnology Inventions-Objective, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions. Plant varieties Protection-Objectives, Justification, International Position, Plant Varieties Protection in India, Bio-Propecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime

Concept of 'Prior Art' and Basics of Patents

Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation. Types of patents; Indian Patent Act 1970; Recent Amendments; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application

Patent Filing, Infringement and Enforcement of IPR

Patent application- forms and guidelines, fee structure, time frames; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Types of patent applications provisional and complete specifications; International patenting-requirement, procedures and costs; Financial

assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives, Patent infringement- meaning, scope, litigation, case studies and examples. Enforcement of Intellectual Property Rights - Civil Remedies, Criminal Remedies, Border Security measures. Practical Aspects of Licensing - Benefits, determinative factors, important clauses, licensing clauses.

TEXT BOOKS

1. J.A Thomas., R.L Fuch; Biotechnology and Safety Assessment; Academic Press; 2nd edition; 2002.
2. D.A Fleming., D.L Hunt; Biological safety Principles and practices; ASM Press; 1st edition; 2000.
3. P. L Traynor, Biosafety management; Virginia polytechnic Institute publication 2000.

REFERENCE BOOKS

1. F H Erbisch., and Maredia K M; IPR in Agricultural Biotechnology; Orient Longman Ltd, 1st edition; 2004.
2. J.E. Smith; Biotechnology, Cambridge Univ. Press; 3rd edition; 1996.
3. F. H. Erbisch and K. M. Meredia, Intellectual Property Rights, Orient Longman Ltd. 2004.

MANAGEMENT, ENTREPRENEURSHIP AND BIOBUSINESS

Subject Code	: 12BBT323	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Management

Introduction Meaning nature and characteristics of Management, scope and functional areas of management, Management and administration, roles of management, levels of management. Development of Management Thought Early management approaches and modern management approaches. Functions of Management Planning and Forecasting, Organizing, Directing and Controlling.

Managing Engineering Design and Development

Product and Technology Life Cycles, Nature of Research and development, Research Strategy and organization, selecting R & D Projects, Protection of Ideas. Creativity, Nature of Engineering Design, Systems Engineering / New Product Development, Control System in Design, Product Liability and Safety, Designing for Reliability, other “abilities” in Design.

Managing Production Operations

Assuring product quality, Productivity, Work measurement, Maintenance and Facilities (Plant) engineering and other manufacturing functions.

Entrepreneur

Meaning of an Entrepreneur, Role of entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship Barriers. Role of Micro Small & Medium Enterprises (MSME) in Economic Development, Impact of Liberalization, Privatization and Globalization on MSME, Effect of WTO/GATT. Different Schemes; TECSOK, KIADB, KSSIDC, KSIMC, DIC-Single Window Agency, MSME, NSIC, SIDBI, KSFC.

Preparation of Project

Meaning of Project, Project Identification, Project Selection, Project Report – Contents, Formulation and Project Appraisal. Identification of Business Opportunities Market Feasibility studies, Technical Feasibility Studies; Financial Feasibility Studies and Social Feasibility studies.

Technologies and Bio-Safety

Principles of business management and concept of Biobusiness, Fundamentals and constituents of Biotech for biobusiness, SWOT analysis of Indian Biobusiness. Recombinant DNA technology, Monoclonal antibody technology, Bioprocess technology, Fermentation, recovery and purification techniques. Guidelines for recombinant DNA research, release of genetically modified organisms (GMOs).

Commercialization

Analysis of factor influencing international competitiveness in biotechnology, type of firms commercializing biotechnology, financing, tax incentives, issues and policies. Bioscience enterprises- raw biocommodities, hybridization, tissue culture, biofermentation, biofertilizers.

Project Cost and Market Potential

Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, manufacturing cost estimation for an intracellular protein, using cost analysis for R & D decision making.

TEXT BOOKS

1. Harold Koontz and Heinz Weihrich, Essentials of Management, TMH.VII Edition.
2. Daniel L Babcock and Lucy C Morse Managing Engineering and Technology, 3rd Edition, Pearson Education.
3. David Finegold, Cecile Bensimon and Abdallah S. Daar. Bioindustry ethics, Elsevier Academic Press, 2005.

REFERENCE BOOKS

1. Gurinder Shahi. Biobusiness in Asia How Asian Countries Can Capitalize on the Life Science Revolution, Person Prentice Hall, 2004.
2. Cynthia Robbins. Roth from Alchemy to IPO The Business of Biotechnology, HarperCollins, 2001.
3. Gurinder Shahi. Biobusiness A Strategic Perspective Global BioBusiness Books, 2005.

CLINICAL BIOTECHNOLOGY

Subject Code	: 12BBT331	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Introduction

Introduction to clinical study and design of clinical studies. Epidemiological research and treatment studies Double-blind and Single-blind Randomized controlled trial, Non-blind trial, Nonrandomized trial-quasi-experiment. Observational studies Cohort study- Prospective cohort and Retrospective cohort. Time series study, Case-control study and Nested case-control study. Community survey and Ecological study. Seasonal studies Conduction of studies in seasonal indications such as Allergies and Influenza.

Statistical Analysis and Interpretation

Background and purpose, trial design consideration, parallel group design, cross over design, factorial design, and interpretation of statistical data. Introduction to Statistical Application Software (SAS), procedures and clinical data management.

Drug Design and Synthesis

Synthesis of compounds in accordance with the molecular structure and biological activity concept Analgesics, neuromuscular blocking agents, anti-fertility drugs, bactericidal and bacteriostatic agents (sulphonamides, mercury compounds and antiseptics).

Study of Therapeutic Proteins and Related Case Studies

Blood and blood products Clotting factors, anticoagulants, Thrombolytic agents, Tissue plasminogen activator and Streptokinase. Safety guidelines in blood transfusion. Therapeutic Proteins Antibodies, Enzymes, Hormones, Growth factors (Erythropoietin), Vaccines (HIV and Cancer), Interferons and Interleukins.

Cancer Biology and Therapy

Overview of molecular biology and tumor immunology. Modes of treatment Radiotherapy, chemotherapy, surgery, biological therapy, immunotherapy, gene therapy, cancer vaccines and adjunctives.

Clinical Toxicology

Basic concept in toxicology. Types and mechanism of toxin action- Epoxidation & drug toxicity, N-oxidation & drug toxicity and Sulphur xenobiotics. Hepatotoxicity and Nephrotoxicity. Biotransformation of toxins, inactivation and removal from the body.

Clinical Research Governance and Ethics

Overview on **regulatory affairs** for pharmaceuticals, nutraceuticals and medical devices. Good Clinical **Practices (GCP) and International** quality standard and related guidelines (ICH-E6). Risk assessment and trial monitoring. Legal and ethical issues on biotechnology, medical research and related clinical practice.

TEXT BOOKS

1. Designing clinical research by Stephen B. Hulley 3rd Edition, 2007
2. Principles and practice of clinical research by John I. Gallin, Frederick P. Ognibene 2nd Edition, 2006
3. Conducting GCP- Compliant Clinical Research A Practical Guide by Wendy Bohaychuk, Graham Ball University Edition John Wiley & Sons Ltd, New York, 2009.
4. Basic biotechnology by Colin Ratledge, Bjørn Kristiansen 3rd Edition Cambridge University Press, Cambridge, 2001

REFERENCE BOOKS

1. Pharmaceutical Perspectives of Cancer Therapeutics by Ram I. Mahato, Yi Lu University Edition Springer Dordrecht Heidelberg London, 2001.
2. Design and analysis of clinical trials concepts and methodologies by Shein-Chung Chow, Jen-pei Liu 2nd Edition John Wiley & Sons Ltd, New York, 2004
3. New drug development design, methodology, and analysis by J. Rick Turner University Edition John Wiley & Sons Ltd, New York. 2004
4. Biotechnology in clinical medicine by Alberto Albertin 2nd Edition Raven Press, New York, 2008

METABOLIC ENGINEERING

Subject Code	: 12BBT332	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Introduction to Cellular Metabolism

Metabolic engineering and its multidisciplinary nature; Review of cellular metabolism; Models for cellular reactions; Material balances and data consistency-Block box model, elemental balances, heat balance and analysis.

Regulation of Metabolic Pathways

Regulation of enzyme activity- Reversible and irreversible inhibition systems, regulation of enzyme concentration- Control of transcription and translation. Global control Regulation at whole cell level- regulation of metabolic networks.

Metabolic Pathway Manipulations

Enhancement of product yield and productivity- Ethanol, Amino acids and Solvents. Extension of substrate- Sucrose utilization and pentose metabolism for ethanol production. Product spectrum and novel products- Antibiotics, Polyketides, Vitamins, Biological pigments. Improvements of cellular properties-Nitrogen metabolism, Oxygen utilization, Overflow metabolism and genetic stability maintenance. Xenobiotics degradation of Polychlorinated Biphenyls (PCBs) and Benzene, Toluene, p-Xylene Mixtures (BTX).

Metabolic Flux Analysis

Methods for determination of metabolic fluxes by isotope labeling- Fractional label enrichment, complete enumeration of TCA cycle metabolite isotopomers from labeled pyruvate and acetate. Applications of metabolic flux analysis Amino acid production by Glutamic acid bacteria and mammalian cell cultures. Flux analysis of metabolic networks- Bottom-up Approach, Top-Down Approach.

Metabolic Control Analysis (MCA)

MCA theorems, determination of flux control coefficient. MCA of linear and branched pathways. Theory of large deviations

TEXT BOOKS

1. Gregory N. Stephanopoulos, Aristos A. Aristidou and Jens Nielsen. Metabolic engineering – Principles and Methodologies. Academic press, USA 1998.
2. Nestor V. Torres and Eberhard O. Voit, Pathway analysis and optimization in metabolic, Cambridge University Press, 2002.

REFERENCE BOOKS

1. Shuler M.L. and F. Kargi. Bioprocess engineering basic concepts, 2nd Edn, Prentice Hall, 2001.
2. Cortassa s., Aon, M.A., Lglesias, A.A., and L LyodD. An introduction and metabolic and cellular Engineering. World scientific publications Pvt ltd. Singapore. 2002.

TISSUE ENGINEERING

Subject Code	: 12BBT333	IA Marks	: 50
No. of Lecture Hrs./ Week	: 04	Exam Hrs	: 03
Field work/ Assignment Hrs./Week	: 02	Exam Marks	: 100

Cell and Tissue Engineering

Techniques of cell and tissue culture. Isolation, selection and maintenance of primary and early passage cultures. Stem cells Embryonic and adult stem cells. Pluripotent stem cells Ectodermal cells - skin and nervous system. Mesodermal cells - muscles, bones, heart and blood vessels. cell adhesion theory. Effect of biomaterial on physiological behaviour. Introduction to cell characteristics, regulation, assays, mathematical models for cell migration and tissue growth

Biomaterials-Tissue Interactions

The principles of materials science and cell biology. Natural and Synthetic polymers. Hydrogels based on N—isopropylacrylamide and biodegradable bioceramics Methods for biomaterials surface characterization and analysis of protein adsorption. Analysis of Molecular and cellular interactions with biomaterials in terms of unit cell processes, such as matrix by synthesis, degradation, and contraction. Mechanisms underlying wound healing and tissue remodeling following implantation in various organs. Tissue and Organ regeneration.

Scaffold Design and Fabrication

Scaffold processing methods Solvent casting, membrane lamination, freeze-drying, polymer-ceramic composite forms, phase separation, gas foam processing. Microencapsulation methods Agarose-PSS a (polyesterene sulphonic acid), alginate (Ca^{2+} -Induced gelation).

Design of Medical Devices / Implants

The principles underlying the design of medical implants, The systematic use of cell-matrix control volumes; the role of stress analysis in the design process; anatomic fit, shape and size of implants; selection of biomaterials; instrumentation for surgical implantation procedures; preclinical testing for safety and efficacy, including risk/benefit ratio assessment evaluation of clinical performance and design of clinical trials. **Case studies** orthopedic devices, soft tissue implants, artificial organs, and dental implants.

TEXT BOOKS

1. Anthony Atala and P Lanza. Methods of Tissue Engineering. Academic Press Elsevier. 2006.
2. Anthony Atola. Methods of Tissue Engineering. Academic press. 2002.
3. Buddy D Ratner. Biomaterials Science An Introduction to materials in medicine. Academic Press 1996.

REFERENCE BOOKS

1. Drioli, Taylor and Francis. Biocatalytic Membrane Reactor. 2005.
2. John P. Fisher, A G Mikos and Joseph D Bronzino. Tissue Engineering. CRC Press. 2007, Ane Books
3. Severian Dumitriu. Polymeric Biomaterials. 1994.
4. William R Moster. Biomaterials Science and Engineering Advanced Catalysis and Nanostructures Materials. Academic Press, J B Park - Plenum Press. 1994.