Course Contents
of
Integrated B.Tech.- M.Tech.

(Biotechnology) Programme

Applicable to 2016 (Sem IX), 2017 (Sem VII) & 2018 (Sem V) Batches

Animal & Plant Tissue Culture [BT 301]

Animal Tissue Culture

Unit-I: Introduction to Animal Tissue Culture: Background, Advantages, Limitations, Application, Culture environment, Cell adhesion, Cell proliferation, Differentiation.

Unit-II: Design, Layout and Equipment: Planning, Construction Layout, Essential Equipments, Aseptic Technique, Sterile Handling, Safety, Risk Assessment, biohazards.

Unit-III: Media: Role of Physicochemical properties, Introduction to the balanced salt solutions and simple growth medium, Complete Media, Role of serum and supplements. Serum free media, Advantages, disadvantages and their applications.

Unit-IV: Basic techniques of Mammalian Cell Culture: Isolation of the Tissue, Primary culture Subculture and Propagation. Cell line finite and continuouous cell line, Cell line designation and Routine maintenance and Cell separation. Use of roller bottles, reactors. Epithelial, Mesenchymal, Tumor cell culture. Measurement of viability and cytotoxicity.

Unit-V: Contamination and stem cell: Sources of contamination, Cross contamination, Type of microbial contamination, Eradication and Cryopreservation. introduction to stem cell, embryonic stem cell method, microinjection method, mouse as an animal model and application of stem cells for human welfare.

Plant Tissue Culture

Unit 1: Introduction (Definition, history, present status, future prospects of tissue culture), Cell totipotency, Composition of different culture Media, Role of chemicals and growth regulators in tissue culture, pH, temperature, solidifying agents, Sterilization of media, tissues and other accessories, Inoculation of cultures, Maintenance of cultures, Environmental Conditions. **(8 hrs)**

Unit 2: Isolation and maintenance of Callus and suspension culture, Micropropagation and its Applications, Somatic embryogenesis, shoot tip culture, production of virus free plants, Embryo culture, Somaclonal variations and in vitro selections towards crop improvement **(8 hrs)**

Unit 3: Haploid production (through anther and ovary culture, diploidization and its applications,homozygous lines), Endosperm culture, protoplast isolation, culture and fusion, somatic hybridization, cybrids, artificial seeds production **(8 hrs)**

Unit 4: cryopreservation, DNA Banks and germplasm conservation, green house and green home technology **(6hrs)**

Ref/ Text Book:

1. Razdan M K : An Introduction to Plant Tissue Culture
2. Kalyan Kumar D : An introduction to Plant Tissue Culture
3. Guptha P K : Elements of Biotechnology
4. Narayanaswamy, S. (1994) Plant cell and tissue culture. Tata McGraw Hill Publishing company,Ltd. New Delhi.
5. Purohit, S S and Mathur, S K. Fundamentals of Biotechnology. Agrobotanical-publishers, India.
6. Butcher, D and Ingram, D S. Plant tissue culture. Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
7. Kalyan Kumar D.E.1992. Plant tissue culture, Agrobios, New Delhi.

Suggested Readings / Books:

1. Culture of animal cells: A manual of Basic Technique, by Freshney R. Ian, Willey-Liss Publisher, 5th edition (2005).
2. Textbook of Biotechnology by H.K. Das, Wiley India, 4th edition, (2010).
3. Animal Cell Biotechnology: Methods and Protocol by Jenkins N, ed. Humana Press (1999).
4. Mammalian Cell Biotechnology- A Practical Approach, by Butler, M, IRL Oxford University Press (1991)

Developmental Biology [BT 303]

Unit 1: History & Basic Concepts: The origins and importance of developmental biology, principles of developmental biology, evolution of developmental patterns. Identification of developmental genes, Cell commitment & differentiation, Determination & induction of cell fate, Genomic equivalence. Cell-cell communication in development (paracrine factors, juxtacrine signaling and signal transduction cascades).

(12Hrs)

Unit 2: Animal Developmental Biology: Introduction of model vertebrate and invertebrate animals used for development studies (*X. laevis*, Chicken, Mouse, Zebrafish, *D. melanogaster, C. elegans*), advantages

of each system with special emphasis on model animal: Mouse. **(6 Hrs)**

Unit 3: Features of development – Gametogenesis, Fertilization, Cleavage, Morulation and Blastulation, Phenomenon of the organization with respect to morphogenesis, cell differentiation & migration and

organogenesis. **(9Hrs)**

Unit 4: Signals in development: Developmental signals in cell division, migration, proliferation & differentiation, embryonic induction and formation of neural crest cells, role of gene expression in development, Hox genes. Cell commitment & differentiation, Determination & induction of cell fates. Anterior/posterior, Dorsal/ventral polarity development. Cell-cell communication in development

(paracrine factors, juxtacrine signaling and signal transduction cascades). (**10Hrs)**

Unit 5: Clinical relevance of development biology: Medical implication of development biology with respect to teratogenesis, infertility, genetic errors of human development, regeneration, growth and aging.

(4 Hrs)

Text/Reference Books

Developmental Biology, By Scott F Gilbert, Sinauer associates Inc
Developmental Biology Paperback – 2008, by Werner A. Muller, Springer

Industrial Microbiology [BT 305]

Unit 1: Microbial cell growth, nutrition and metabolism: Brief introduction to microbial cell growth kinetics under different nutrient conditions, Auxotrophs, Prototrophs, Selective and Differential or Rich media, Metabolic pathways for utilization of 5C and 6C sugars, Primary and secondary metabolites. 8hrs

Unit 2: Industrial microbes and their improvement: Isolation of microbes from environment, their improvement by natural recombination, mutagenesis, Genetic engineering tools, their stability and storage. 6hrs

Unit 3: Microbial production, development, regulation and safety: Introduction to fermentation (fed batch, Continuous, Submerged) Downstream processing, Product quality and safety genetically modified organisms, Quality assurance, GMP, GILSP, standard operating procedures (SOP). 6hrs

Unit 4: Biofactories: Industrial Production of amino acids, organic acids, antibiotics, vaccines, Biopolymers, Biopesticides, biofuels, food additives from microbes. Prebiotics, Probiotics, Synbiotics, metabiotics an introduction and their applications, drawbacks and efforts to improve their therapeutic efficacy. 10 hrs

Biophysical Chemistry [BT307]

Unit 1: Conformational analysis and forces stabilizing structure of bio molecules: Intra and inter molecular forces, electrostatic and Hydrogen bonding interactions, dipole moments, covalent bond distances, van der Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weakinteractions, conformational entropy. **(4Hrs)**

Unit 2: Biological Chemistry: Structure and conformation of polysaccharide cellulose, Amylase, Chitin, Carbohydrates conjugates, lipids. Liposome and application in drug development, Practical handling of Biomolecules. Folding of polysaccharides. Methods of analysis of carbohydrates and lipids. Macromolecular crowding. Water as a biological solvent. Buffering against pH changes in biological systems. Bond distances and bond energies. Interaction of water with Biomolecules. Proton hoping. Coulomb's Law and Electrostatic Forces, Electrolytes and Water, Thermodynamics of Ion Solvation Conductivity of Aqueous Solutions, Ion Mobilities, Chemical Potential of Electrolytes, Debye-HückelTheory, Salting-in and Salting-out. **(9 Hrs)**

Unit 3: **Proteins**: Classification and properties of amino acids and proteins, pH titration of amino acids and proteins, peptide bond, synthesis and sequencing of proteins, structural organization of proteins: primary, secondary, tertiary and quaternary structure of proteins. Peptide synthesis and sequencing. Conformational properties of polypeptides, folded conformation of globular proteins, denaturation ofproteins, Steric contour diagrams, stability of proteins**. (11Hrs)**

Unit 4: Nucleic acids Helix-coil transition, Conformational parameters of Nucleic acids, Types &structure of RNA, mRNA, rRNA, tRNA & modified nucleotides. **(7 Hrs)**

Unit 5: Molecular Biophysics: From genes to structure to function. Three dimensional structure determination of macromolecules, Spectroscopic and x-ray diffraction techniques, Neutron diffraction,Nuclear magnetic resonance spectroscopy. Protein crystallization; Theory and methods**. (9 Hrs)**

Text/Reference Books

- Biophysical chemistry by Canter and Schimmel, W. H. freeman and company.
- Introduction to protein structure by Carl Branden & Tooze, Garland publishing.
- Principles of Biochemistry by A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
- Biochemistry by Lubert Stryer, W H Freeman and company
- Biochemical calculations by Segel, John Willey and sons.
- Biochemistry: molecular basis of life (Colour edition) by McKee
- Biochemistry by Mathews, van Holde , Ahern
- Modern experimental biochemistry by R.F. Boyer, Pearson

Entreprenurship Development [BT309]

Principles of Management

Unit 1: Theories of Management, Functions of Management, Planning, Organising, Staffing, Directing, Coordinating, Motivation. Managerial role and skills.

Unit 2: Types of Organizational structure, Management practices, Management styles: Indian, Western, Japanese.

Entrepreneurship

Unit 3:Entrepreneurship and Entrepreneurial decision: Meaning and concept, Preparing for a new venture: opportunity scanning, Innovation, creativity and entrepreneurship, Entrepreneurship and Intrapreneurship, Business planning and evaluation, Business plan preparation, Financial strategy and sourcing

Text Books/References:

- Principles of Management by Koontz
- International Management by Fred Luthans
- Management by Freeman, Stones
- Entrepreneurship by Kuratko D.F., Hodgetts R.M.
- Creating New Ventures for 21st century by Jeffery Timmans
- Entrepreneurship Development by Ramachandran

Introductory Medical Microbiology [BT311]

Unit 1: Historical aspects of medical microbiology, Structure of bacterial cells, Classification of medically important bacteria, Normal micro flora and their significance, Dynamics of Host-pathogen interaction.

Unit 2: Sterilization and disinfection, Anti microbial drugs against bacteria, virus and fungi, Antibiotics and their mode of action, Anti-viral drugs and their mechanism of action, Mechanism of multi-drug resistance.

Unit 3: Host defenses, Cells of the immune system, Antigen, Immunogen, hapetns, adjutants etc., Structure of antibody types of immunity, Overview of the immune system, Basic concepts of vaccination, different types of vaccines their advantages and limitations.

Unit 4: Common microbial diseases: Causative agents, diagnosis, Mechanism of pathogenesis and treatment of tuberculosis, hepatitis, AIDS, Encephalitis, dengue, chickenguniya and Polio.

Unit 5: Diagnostic tools and their uses: Complete blood count (DLC and TLC, platelet count) HIV test, Mantoux test, ELISA, Widal test, VDRL test, PCR based detection techniques of microorganisms.

Animal Tissue Culture Lab [BT313]

1: To prepare the materials required for various cell culture practices in sterile condition.
2: Preparation of media for cell culture and its sterilization.
3. Routine cell culture and its maintenance.
4: Isolation of Peripheral blood mononuclear cells (PBMCs) from human whole blood sample.
5: Sectioning and staining of the animal tissues samples.
6: Identification of different blood cells by using Leishman's stain method.
7: Microscopic analysis of permanent tissue's slides.
8: Study of microbial contamination in cell culture medium (RPMI-1640/DMEM).
9.Counting cells (HepG2) and cell viability assay byTrypan blue exclusion test.
10. To preserve the cells in viable condition for future works by using properpreservative

Plant Tissue Culture Lab [BT315]

1) Principle and applications of Autoclave, Hot air oven, Incubator, Laminar Air Flow, Sepctrophotometer and pH meter.
2) Tissue culture media preparation (Preparation of MS media stock solution and hormones, Slant Preparations) and Sterilization process (Surface/ Heat/ Filter/sterilization of glassware/ Media/ Explant)
3) Preparation of explants, aseptic inoculation and incubation and Sub-culturing
4) Callus induction and plant propagation: Preparation of callus from explants, effect of plant growth regulators on callus induction, plant propagation from callus
5) Micropropagation through axillary bud culture
6) Preparation of synthetic seeds
7) Hardening and Acclimatization

Molecular Biology [BT302]

UNIT 1 INTRODUCTION TO MOLECULAR BIOLOGY - DNA AND RNA: Scope and History. Structure of DNA-Nucleoside, Nucleotide, Base pairing, Base stacking, Double Helix, features of Watson and Crick model, major and minor groove, Supercoiling- twist, writhe and linking number. Forms of DNA- A, B, Z. Structure and function of mRNA, rRNA, tRNA. Secondary structures in RNA.

UNIT 2 REPLICATION AND REPAIR: Types and functions of DNA polymerases in Prokaryote and Eukaryote. Replication in prokaryote and Eukaryote. Proof reading activity, 5'Æ 3' exonuclease activity, topoisomerase activity, Telomeric DNA replication and Plasmid Replication-theta model, strand displacement model and rolling circle model. DNA Repair- Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation, recombination repair and SOS repair.

UNIT 3 TRANSCRIPTION AND POST TRANSCRIPTIONAL MODIFICATIONS: Fine structure of prokaryotic and eukaryotic gene, structure and function of the promoters in mRNA, rRNA, tRNA genes. RNA polymerases in prokaryote and eukaryote, types and function. Transcription of mRNA, rRNA, and tRNA genes in Prokaryote and eukaryote. Post transcriptional processing of mRNA – 5'capping, splicing (including different types), polyadenylation and RNA editing Nuclear export of mRNA.

UNIT 4 TRANSLATION AND POST TRANSLATIONAL PROCESSING: Genetic code and Wobble hypothesis. Translation in prokaryote and eukaryote. Post translational modifications. Principles protein sorting and targeting into endoplasmic reticulum, mitochondria, chloroplast, and nucleus.

UNIT 5 GENE REGULATION: Principles of gene regulation- Transcriptional and post transcriptional gene regulation-activators, co-activators, suppressors, co-suppressors, moderators, silencers, insulators, enhancers. Operon-lac operon, trp operon, ara operon and gal operon. Gene silencing: transcriptional and post-transcriptional gene silencing, Antisense RNA, Ribozymes..

TEXT BOOKS:

1. Molecular Biology of Gene – Watson
2. J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
3. Alberts et al; Molecular Biology of the Cell, 4th edition, Garland Science.
4. Cell and molecular biology, Gerald Karp, 6th edition, 2011, John Wiley and Sons.

Food Biotechnology [BT304]

Unit 1: Introduction to Industrial Biotechnology: Introduction and scope of industrial biotechnology,Types of biotechnology industry, Impact of industrial biotechnology on science and society. (4 Hrs)

Unit 2: Production of modern biotechnology products: General aspects of the production of: biofertilisers, biopolymers (xanthan gum, PHB etc), monoclonal antibodies, industrial enzymes, organic acids,secondary metabolites, bioplastics and antibiotics. (10 Hrs)

Unit 3: Development of industrial food Ingredients: Production of biopreservatives (Nisin), cheese, polysaccharides, low calorie sweeteners, naturally produced flavor modifiers, amino acids, vitamins, food supplements, food coloring, nutraceuticals, water binding agents, single cell protein, mycoproteins.

(8 Hrs)

Unit 4: Food spoilage and preservation: General principle of spoilage, microbial toxins (endotoxins and exotoxins), contamination and preservation, factors affecting spoilage. Methods of food preservation (thermal processing, cold preservation, chemical preservatives & food dehydration). Food preservation using irradiation, Characteristics of radiations of interest in Food preservation, Principle underlying the destruction of microorganisms by irradiation, Indicator and food- borne pathogens, Food borne diseases,
Consumer perspective and future of food biotechnology (10 Hrs)

Unit 5: Food Processing: Types of food processing: Bioprocessing of meat, poultry, fisheries, vegetables, dairy products, enzymes and chemicals used for food processing, Newer concepts in food processing including organic foods, processing of organic raw material, genetically modified foods, Fermented and
functional foods. (8 Hrs)

Text/Reference Books

1. Food Microbiology by Frazier, W.C. and Westhoff, D.C., Tata Mc-Graw Hill.
2. Biotechnology by Gupta, P.K., Rastogi Publication
3. Industrial Microbiology by Casida Jr, L.E., New Age International (P) Ltd.
4. Industrial Microbiology by Presscott Dunn, Agrobios (India).

Virology [BT306]

Unit 1: **Introduction:** History and principles of virology. Virus structure and morphology, viruses of veterinary importance and plant viruses. The Function and Formation of Virus Particles. Capsid Symmetry and Virus Architecture. Enveloped Viruses. Complex Virus Structures. Protein-Nucleic Acid Interactions and Genome Packaging.

Viral Genomes: The Structure and Complexity of virus Genomes. Viral Genetics. Virus Mutants. Genetic Interactions between Viruses. Non-genetic Interactions between Viruses. Positive-Strand RNA Viruses. Negative-Strand RNA Viruses. Segmented and multipartite Virus Genomes. Baltimore Classification

Unit 2: **Virus-cell Interaction:** Cellular receptors and virus entry: Definition, structure and methods of discovery of viral receptors (polio, herpes, VSV, HIV). Cellular interactions—clathrin coated pits, lipid rafts, caveolae, endocytosis and virus uncoating mechanisms Nuclear localization signals and nuclear pore transit, virus – cytoskeletal interactions, chaperons.

Unit 3: **Viral Replication:** General strategies, replication of plus stranded RNA virus (polio), negative strandRNA viruses (VSV and influenza).Replication of double stranded RNA virus (rota), andretroviruses (HIV and HTLV). DNA viruses Replication of double stranded DNA viruses (SV40, pox), ssDNA virus (AAV) proteins, replication of plant virus.

Unit 4: Viral gene expression: Initiation of transcription,Viral regulation of transcription, capping and tailing, pre-mRNA splicing. Post-transcriptional Gene Silencing, Regulation of translation during viral infection

Unit 5: Intracellular trafficking and exit of virus: Import of viral proteins, assembly, selective packaging, release of virus particle

Unit 6: Viral Diseases: Viral Diarrhoea: Clinical course, disease burden, risk factors, epidemiology, prevention, and treatment. Rotavirus.

Viral Cancers: Role of papilloma, HIV, Epstein Barr Virus, HTLV and herpes in pathogenesis of cancers, diagnosis, prevention.

Viral Hepatitis: Structure & genomic organization, Viral respiratory diseases (Biology of respiratory viruses). HIV-AIDS, Genetic Engineering Plants for Virus Resistance

TextBooks:

1. Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses. S. J. Flint, V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka Latest edition / Pub. Date: December 2003 Publisher: American Society Microbiology.

Environmental Biotechnology [BT308]

Unit 1

Environment: Basic concepts and issues; Management and remediation of soil problems; Toxicants, Bioaccumulation (characteristics, evolutionary concept, factors affecting bioaccumulation of toxicants, measurement and kinetic modelling of bioaccumulation). Role of genetically engineered microbes in environmental management, recycling & up gradation technologies, production of products.

Unit 2

Biological Treatment of Waste water (Aerobic System): Biological processes for domestic and industrial waste water treatments; activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed bio-film reactor (IFBBR) packed bed reactors air spared reactors.

Biological Treatment of Wastewater (Anaerobic System): Anaerobic biological treatment - contact digesters, packed column reactors.

Unit 3

Bioremediation and Metal Biotechnology: Introduction, constraints and priorities of Bioremediation, Bio-stimulation of naturally occurring microbial activities, Bio-augmentation, in-situ, ex-situ, intrinsic & engineered bioremediation; Phytoremediation; Environmental monitoring through microorganism, microbial biosensors in environmental monitoring. Metal Biotechnology (Mining with special reference to Copper & Iron, Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects)

Unit 4

Bio Fuels: Production of nonconventional fuels - Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery. Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, land fills, microbiology of anaerobic fermentation.

Unit 5

Hazardous Waste Management: Introduction, Xenobiotic compounds, recalcitrance, biodegradation of Xeno-biotics, biological detoxification, Microbes assisted waste bio-treatment, market for hazardous waste management; biotechnology application to hazardous waste management. Energy form waste.

Unit 6

Novel Methods for Pollution Control: Vermitechnology, waste water treatment using aquatic plants, root zone treatment. Aiming for biodegradable and ecofriendly products.

Text Books/References:

- Asthana D.K. and Asthana M.(2001),Environment : Problems and Solutions, S.Chand and Company Ltd, New Delhi.
- Chatterji A.K.(2002),Introduction to Environmental Biotechnology, Prentice Hall of India Pvt. Ltd ,New Delhi.
- Biodegradation & Bioremediation (1999), Martin Alexander, Academic press.
- Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd., 1987.
- Evan G.M.and Furlong J.C (2003), Environmental Biotechnology: Theory and Applications, John Wiley and Sons Ltd., England.
- Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London, 1989.
- T. cookson, Bioremediation engineering: design and application (1995) John. Jr. Mc Graw Hill, Inc.
- Kalaichelvan P.T., I Arul Pandi (2007), Bioprocess Technology, MJP Publishers, Chennai.
- Murugesan A. G.and Rajakumari C. (2005), Environmental Science and Biotechnology: Theroy and Techniques, MJP Publishers, Chennai.
- Rittmann B. E. And McCarty P. L. (2001), Environmental Biotechnology Principles And Applications, McGraw Hill,USA.

Developments in Therapeutics [BT310]

Principles of drug design and action: Agonists, antagonists, potency and efficacy. Drug-receptor interactions, stereospecificity and selectivity in drug action and design. Identification of therapeutic targets and rational drug design. Pharmacokinetics, pharmacodynamics, pharmacogenetics and pharmacogenomics. Case studies on drug action and design.

Gene and protein therapy: Vector engineering, viral vectors, strategies of gene delivery, gene replacement, gene correction, gene editing, gene regulation and silencing. MicroRNAs as therapeutic targets. Immunological approaches: Immunomodulation and immunotherapy. Translational medicine: New approaches, Disease models (in vitro, in vivo and in silico), Biomarkers.

Molecular pharmacology: Targeted therapy – development of new drugs: identification of new molecular targets, high-throughput screening, risk/benefit ratio, economical and ethical aspects in the development of new drugs. Principles of biological therapy – monoclonal antibodies, small inhibitors – rational drug design, drug transport (liposomes, immunoglobulins, nano-technologies and supramolecular systems). Strategies for immunotherapy (cytokine and vaccine therapy). Antiviral chemotherapy. Actions of cytotoxic drugs: alkylating agents, antimetabolites, antibiotics, mitotic inhibitors, enzymes and hormones.

Cancer immunotherapy: Essentials and basic principles of cancer immunotherapy, cancer antigens peptides, dendritic cells vaccine, tumor infiltrating lymphocytes. Approaches in cancer immunotherapy: Immunomodulation (definition and concept), Immune adjuvant and tumor vaccine therapy, Biological Response Modifiers (BRMs) and their application in cancer therapy and in other diseases.

Stem cell therapeutics: Stem Cells in therapy: Introduction, cellular and molecular aspects of adult and embryonic stem cells, concepts of tissue engineering and clinical applications, Nuclear reprogramming and induced pluripotent stem cells.

Molecular Biology Lab [BT312]

1. Agarose gel electrophoresis, preparation of buffers, loading dye and gel
2. Isolation of protein from plant/animal/microbial samples.
3. SDS-PAGE for separation of proteins
4. Isolation of genomic DNA from animal/plant tissue.
5. DNA estimation (Qualitative and Quantitative)
6. E coli culture and plasmid isolation
7. Restriction Digestion of plasmid/Genomic DNA
8. Primer designing for PCR amplification
9. Polymerase Chain reaction
10. Restriction digestion analysis of the PCR product

Food Biotechnology Lab [BT314]

1. To study antimicrobial activity of onion and ginger on Gram negative and Gram positive bacteria.
2. To study antimicrobial activity of various medicinal plant extracts on eukaryote and prokaryote microbes.
3. Preparation of flavoured cheese.
4. To study effect of fruit extracts on suitability and stability of flavoured cheese.
5. To study effect of consumable plant extracts on stability of various fruit juices.
6. To estimate Vitamin C levels in various citrus fruit extracts.
7. To study and compare growth of *Saccharomyces cerevisiae* in different fruit extracts and rich growth media.
8. To test the presence of gluten in different type of flour samples.
9. To estimate the levels of sugar, fat and protein in different type of Biscuits/food samples.
10. To study presence of free amino acids in different pulses through paper chromatography.

Environmental Biotechnology Lab [BT316]

1. Determination of BOD
2. Determination of COD
3. Determination of Nitrogen Organic and Ammonical nitrogen
4. Determination of orthophosphates
5. Bacteriological quality measurement: MPN, plate count
6. Determination of Oil & Grease in wastewater
7. Determination of cations Ca+, Mg+, Na+ and Ni by Flame Photometer
8. Color Measurement

Recombinant DNA Technology [BT 501]

Unit 1: Cloning Vectors and host strains: Compatibility of vectors and host strains, Plasmids (PUC19, Bluescript vectors, gateway vectors), Bacteriophage (Lambda and M13) vectors, Phagemids, cosmids, Bacterial expression vectors (pMal; GST; pET), Eukaryotic expression vectors: Yeast cloning vectors, Animal viruses (SV40), Baculovirus and Pichia vectors system, retro viral vector, vaccinia vector. Plant based Ti and Ri vectors, . Protein purification tags (His-tag; GST-tag; MBP-tag etc); Intein-based vectors;artificial chromosome vectors (YAC, BAC), shuttle vectors. **(9 Hrs)**

Unit 2: Enzymes in genetic engineering: Restriction endonucleases Type I & II, DNA polymerase (proof reading, non-proof reading, single subunit, thermostable), Polynucleotide kinase, T4 DNA ligase, alkaline phosphatase, terminal deoxynucleotidyl transferase, Reverse transcriptase, nucleases (DNA/RNAspecific, 5'/3' end specific), Methylases, helicases. **(5 Hrs)**

Unit 3: Cloning and subcloning strategy: DNA digestion and restriction fragment analysis and sequencing. Ligation (Cohesive and blunt end ligation), transformation. cDNA synthesis strategies – Linkers – Adapters – Homopolymer tailing; Making genomic and cDNA libraries in plasmids and phages, PCR product cloning (TA cloning). Cloning strategies in yeast, *E. Coli*. Cloning in expression vectors. GATEWAY cloning, multisite gateway. Bacterial and yeast hosts used in cloning and expression.onstruction of cDNA library, genomic DNA library, BAC library and YAC library. Yeast two hybridsystem; Phage display; Principles in maximizing gene expression. **(8 Hrs)**

Unit 4: PCR and its applications: Cloning of genes by PCR (gene specific and degenerate primers), Optimization of PCR, nested PCR, inverse PCR, TAIL PCR, touchdown PCR, hot start PCR, multiplex PCR, colony PCR, 5' and 3' RACE-PCR. site-directed mutagenesis, PCR in molecular diagnostics; Mutation detection: SSCP, DGGE, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification),PTT (Protein Truncation Test). **(9 Hrs)**

Unit 5: Selection of r-DNA clones and their expression products: Direct and indirect methods. Labeling of DNA: Nick translation, random priming, radioactive and non-radioactive probes, DNA hybridization, colony hybridization and *in-situ* hybridization (Southern, Dot blots and immunological techniques) FISH, DNA finger printing, Techniques for gene expression detection: Northern and western blotting, Gel retardation techniques, DNA foot printing, Primer extension, S1 mapping, Reporter assays,Phage display. **(9 Hrs)**

Text/Reference Books

- Gene cloning and DNA analysis– An introduction by T.A. Brown, Wiley
- Genetic engineering by Smita Rastogi and Neelam Patha, Oxford University Press.
- Recombinant DNA by J.D. Watson, W.H. Freeman and Company.
- Principles of Gene Manipulation: An Introduction to Genetic Engineering by R.W. Old and S. B Primrose, Blackwell Science Inc.
- Molecular Biotechnology: Principles and Applications of Recombinant DNA By B.R. Grick and J.J. Pasternak, ASM Press
- Molecular Cloning: A Laboratory Manual by J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press.

Principles of Immunology and immune-technology[BT503]

Unit 1: Introduction to innate and adaptive immunity, lymphoid organs and cells, Antibody structure and function, Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, Multigeneorganization of immunoglobulin genes, Generation of antibody diversity. **(8Hrs)**

Unit 2: Antigens- immunogens, haptens; antigenic determinants/epitopes, Antigen processing and presentation, Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness anddisease susceptibility, HLA typing. **(6 Hrs)**

Unit 3: Effector mechanisms of Immune responses, cytokine cell signaling, B cell maturation, activation and differentiation, B-cell receptor, Immunoglobulin superfamily, T-cell maturation, activation and differentiation and T-cell receptors, Functional T Cell Subsets, Generation of humoral and cell mediatedimmune responses, Cytokines-properties, receptors and therapeutic uses, Complement system **(6 Hrs)**

Unit 4: Immunotechnology: Antigen-antibody interactions, Ouchterlony double diffusion, Immunoelectrophoresis, ELISA, Indirect, Sandwich and Competitive, ELISPOT, Flow cytometry and fluorescence. Recombinant Monoclonal antibody technology, Hybridoma technology, Chimeric antibodies, Humanization technology, Antibodies from Transgenic mice, Antibody phage displaytechnology, Human antibody libraries, cytotoxicity assays, Gene knockouts**.** **(10Hrs)**

Unit 5: Immune response to virus, fungus, bacteria and parasites, Hypersensitivity, Tolerance and Autoimmunity, Immunodeficiency, Vaccines: Active and passive immunization, Types of vaccines (DNA vaccines, recombinant vaccines, adjuvants, peptides, immune-modulators (cytokines), Geneticengineering in vaccine designing, Designing of peptide/epitope-based vaccines. **(10 Hrs)**

Text/Reference Books

- Kuby Immunology by R.A. Goldsby, T.J. Kindt and B.A. Obsorne, Freeman.
- Basic Immunology by A.K. Abbas and A.H. Lichtman, Saunders W.B. Company.
- Immunology (Sixth Edition) by Roitt, Brostoff, Male, Panima Publication.
- Fundamentals of Immunology by W. Paul, Lippincot Williams and Wilkins

Nanobiotechnology [BT 505]

Unit 1: Introduction to nanotechnology and nanobiotechnology, development of nanotechnology - timelines and progress, overview. Nanomaterial in biotechnology - nanoparticles, quantum dots, fullerenes, nanotubes and nanowires, nanocomposites etc. Synthesis of nanaomaterial methodology: plasma arcing, ball milling, sol-gel, Micromulsion, CVD, PVD, molecular beam epitaxy, vapor (solution)-liquid-solid growth, (VLS or SLS), spary pyrolysis, lithography , plant and microbial basedsynthesis, magnetototac bacterial based natural synthesis of magnetic nanoparticle. **(12 Hrs)**

Unit 2: Characterization of nanostructures by transmission electron microscopic, scanning tunnelingmicroscopy, auger electron microscopy, X-ray, photoelectron spectroscopy; Nano-biosafety **(6 Hrs)**

Unit 3: Introduction to nano-fabrications, (Bio-MEMS/NEMS/ AFM/SAM), nano-fluidics (LOC, Bio-fluidic devices), nano-medicine, nano-biosensor, interaction between bio-molecules and nano-particle surface, molecular self assembly, intelligent drug delivery system (DDS), microchip for drug delivery,bio-electronic sensor, electrochemical DNA sensor, nanomachine. **(9 Hrs)**

Unit 4: Molecular mimics: Catenanes & rotaxanes, molecular switches, molecular shuttle switch, chemical rotors, prodders, flippers, atomic shuttles, actuators; nano-biometrics & its biological functions.**(6 Hrs)**

Unit 5: Medical applications of nanobiotechnology: nanoparticles cytotoxicity; Applications of nanostructures in drug: discovery, delivery, and controlled release; Nanostructures in cancer research: Examples of nanostructures in research and therapy; Nanotechnology for tissue engineering: applicationsin regenerative therapy. **(7 Hrs)**

Text/ReferenceBooks

Nanobiotechnology: Concepts, Applications and Perspectives by Christof M.Niemeyer, Chad A. Mirkin, Wiley VCH.

Nanobiotechnology - II more concepts and applications by Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.

Nanostructures and Nanomaterials: Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press.

Nano: The Essentials Understanding nanoscience and nanotechnology by T. Pradeep, Tata McGraw-Hill. Nanomaterials Synthesis, Properties and Applications Edited by A S Edelstein and R C Cammarata, IOP .

Stem Cell Biology [BT507]

Unit I:
Introduction to Stem Cells: History and timeline stem cell research. Types of Stem Cells, Multipotent or Adult Stem cells, Pluripotent Stem Cells, Embryonic Stem Cells, induced pluripotent stem cells. 8 hours

Unit II:
General properties of embryonic stem cells. Isolation and cultivation of embryonic stem cells (human and mouse) in vitro. Induced Pluripotent Stem Cells, precaution and limitation of culturing of embryonic stem cells. Intracellular and cell surface marker of embryonic stem cells. Application of Embryonic stem cells. 10 hours

Unit III:
Phenotype and general properties adult Stem Cells like Bone marrow stem cells, Mesenchymal Stem Cells, Endothelial Progenitor Cells, Cord blood stem cells, Tissue-specific stem cells. Plasticity of adult stem cells. Adult stem cell markers. Culture and propagation of adult stem cell in vitro. Applications and Limitations. 11 hours

Unit IV:
Translational and therapeutic aspects of stem cell technology: Gene therapy and tissue engineering. Regenerative medicine, therapeutic cloning and reproductive cloning. Applications and limitations of stem cell cloning. 11 hours

Unit V:
Ethical concerns, challenges, recommendations and current regulation of human stem cell research. Ethical considerations of using embryonic stem cells. 5 hours

Reference Book:

☐ Regenerative medicine stem cells and their applications, written by K.R.S. Sambasiva Rao and K. Ananda Krishna, 2010.
☐ Culture of human stem cells, written by R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach, Wiley & sons, New Jersey, 2007.

Molecular Toxicology [BT509]

Unit 1: General concepts in Toxicology: Introduction, Passage of chemical through the body, Absorption, Distribution, Metabolism, Excretion.

Unit 2: Phase I Metabolism in Toxicology: Introduction, Cytochrome P450 in toxicology, Nomenclature of cytochrome P450, pharamacogenetics of cytochrome P450, Flavin mono-oxygenase-mediated toxicity.

Unit 3: Phase II Metabolism in Toxicology: Introduction, Glucuronide conjugation, Sulphate conjugation, Glutathione conjugation, Glutathione transferase pharmacogenetics, Glutathione transferase-mediated toxicity.

Unit 4: Response to toxicity: Immediate response to toxic insult, Chemical-mediated signaling, Genotoxicity, Repair of cellular damage (DNA and protein repair), Apoptosis and Necrosis, Nephrotoxicity, Hepatotoxicity, Neurotoxicity, Teratogenesis.

Text/ Reference Books:

- Molecular Toxicology. By David Josephy and Bengt Mannervik. Oxford University Press, 2006.
- Molecular Toxicology. By Nick Plant. BIOS Scientific Publishers. Taylor and Francis group. 2003.
- Essential Concepts in Toxicology by Prof P K Gupta. PharmaMed Press.2014

Recombinant DNA Technology Lab [BT 511]

1. Computational and manual Primer designing for PCR
2. DNA fragment amplification by polymerase chain reaction PCR
3. Isolation of desired gene (DNA) fragment by PCR/restriction digestion
4. Purification of desired DNA fragment by gel elution/PCR purification
5. Preparation of cloning/expression Vector :-

a. Plasmid Isolation b. restriction digestion c. Gel elution and quantitation of prepared vector Ligation of desired vector and insert.

6. i Preparation of E. coli (DH5α/BL21 DE3) competent cells; ii. Transformation of recombinant DNA in *E coli*.
7. Screening of transformants and estimation of transformation efficiency
8. Confirmation of positive recombinants

Immunology and immunotechnology Lab [BT 513]

1. To identify different leucocytes in the blood by leishman's stain
2. To study agglutination by blood group typing
3. To study quantitative agglutination
4. To study radial immunodiffusion
5. To study Ouchterlony double diffusion
6. To quantify antibody titer in the serum by Indirect/Competitive Enzyme linked Immunosorbant assay
7. To quantify antibody titer in the serum by Sandwich Enzyme linked Immunosorbant assay
8. To study agglutination of microbes by a lectin
9. To culture lymphocytes from blood
10. To study lymphoproliferation in presence of a mitogen

Genomics & Proteomics [BT502]

GENOMICS

Unit 1: **Functional Genomics**

Transcriptome analysis: (ESTs, SAGE, MPSS, Fluorescent differential display, SSH, microarray). AFLP-Based RNA Fingerprinting, Gene Identification Signature-Paired End diTagging (GIS-PET). Microarray technology introduction, Types of DNA-microarrays- cDNAs and Oligonucleotides spotted chips. Quantitative real-time PCR; Taqman, SYBR Green systems, Applications of quantitative RT-PCR. Emerging Technologies:Nanotechnologies and Fluorescent Proteins for *in planta* functional genomics; Next Generation Sequencing Technologies: 454, Illumina-Solexa, SOLiD. RNA sequencing, Chip-sequencing. TILLING as a functional genomics tool. Introduction to *in silico* genomics and metabolomics.

Unit 2: Comparative genomics

Sizes and organization of genomes. Comparative genomics of bacteria, organelles and eukaryotes. Variation at the level of individual nucleotides, duplications, comparisons at chromosome level (synteny). Sequence similarities across organisms and conserved sequences (Genomes of chimpanzees and humans). Evolution and phylogenetic relationships of genomes in prokaryotes and eukaryotes.

Unit 3: Gene mapping and sequencing

DNA sequencing methods, Genetic mapping (introduction), physical and cytological mapping (chromosome walking, FISH, Radiation hybrid, Chromosome banding pattern maps etc). Sequence Mapping (STS). High-resolution maps based on DNA sequences, restriction maps, SNPs, haplotypes and SNP genotyping. Organizing large sale genomic projects (BAC to BAC genome sequencing, whole genome physical mapping and shotgun sequencing, contig assembly. Human genome project, Integration of Physical and Genetic Maps. Genome annotation and gene clustering. Applications of genomics.

PROTEOMICS

Unit 1:Methods of quantitation of proteins. Calculation of extinction coefficients. Extraction and handling of membrane proteins. Stabilizing forces for enzymes and proteins. Salting out and salting in phenomena. Precipitation of proteins.

Unit 2:Differential expression proteomics: gel and non gel-based methods, Two dimensional gel electrophoresis, DIGE, ICAT, MudPIT, ITRAQ, SILAC, Mass Spectrometry. Recent developments in the use of mass spectrometry coupled with purification techniques to identify proteins and their interactions with other molecules. Peptide mass fingerprinting (PMF) using enzymatic fragmentation of proteins, Matrix assisted Laser desorption Ionization Time of Flight Mass Spectrometry (MALDI-TOFMS), LC-MS/MS, SELDI-TOF. Introduction, different types of protein chips, detection and quantification of proteins bound to protein chips, emerging protein chips technologies. Chromatographic techniques used in protein purification: Size exclusion, Ion exchange, IMAC, RPC, HPLC etc. and their application in proteomics

Unit 3:Bioinformatics tools for proteomics, Techniques for detection of protein-ligand interactions: two-hybrid systems, ITC, Dynamic light scattering, fluorescence spectroscopy, Surface Plasmon Resonance, gel filtration, x-ray crystallography and sedimentation velocity method.

Text Books/References:

- Functional Genomics: A Practical Approach (Practical Approach Series) by Stephen P. Hunt, Rick Livesey.
- PCR Applications: Protocols for Functional Genomics By Innis, Michael A. (Sninsky, John J. , Gelfand, David.
- Introduction to Genomics, 2007. Arthur Lesk, Oxford University press.
- Principles of gene manipulation and genomics, 2008. Primrose and Twyman, Blackwell publishing.
- Gibson G, Muse SV. A primer of genome science (3rd ed.). Sunderland, MA: Sinauer Associates.
- Mapping Genomes - From Genomes by T. A. Brown, 2002.
- The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, 2005.Editor(s): Khalid Meksem, Günter Kahl, Wiley publishers.
- The Handbook of Plant Functional Genomics: Concepts and Protocols Guenter Kahl (Editor), Khalid Meksem (Editor), Wiley publishers.
- Protein Engineering, H. J. Gross, Caroline Köhrer, Uttam L. RajBhandary.
- Proteomics and Protein-Protein Interaction,s Gabriel Waksman.
- Introduction to protein structure, Carl Branden & Tooze, Garland publishing.
- Protein structure, Creighton, Oxford
- Protein Engineering, H. J. Gross, Caroline Köhrer, Uttam L. Raj Bhandary.
- Principles of Protein X-Ray Crystallography, by j. Drenth
- Protein Analysis and Purification, Ian M. Rosenberg
- Protein Folding Kinetics, Bengt Nölting

Computational Biology [BT504]

Unit 1: Introduction to computational biology & Biological Databases: Major Bioinformatics Resources; Biological databases:- Sequence databases- Nucleotidesequence database, Protein sequence databases, Protein Family Databases, Structural databases,Repositories for high throughput genomic sequences: EST, etc.;Enzymes and metabolic pathways databases, Literature databases.

Unit 2: Sequence Comparison and Alignment Techniques:
Pairwise sequence alignments: basic concepts of sequence alignment: local and global alignments, Dot Plot & Dynamic programming (Needleman and Wunsch, Smith and Waterman algorithms) for pairwise alignments, gap penalties, Scoring Matrices; use of pairwise alignments for analysis of Nucleic acid and protein sequences and interpretation of results

Multiple sequence alignments (MSA): Basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.) & interpretation of results, concept of dendrogram and its interpretation.

Unit 3: Phylogenetic analysis: Concepts in taxonomy & phylogeny; Definition and description of phylogenetic trees and various types of trees Evolutionary Change in Nucleotide Sequences, Rates and patterns of nucleotide substitution, Types of Trees, Methods for Phylogenetic estimation: Maximum parsimony, Distance Matrix Methods and Maximum Likelihood Methods, Validation methods.

Unit 4: 3D- Structure Prediction: Fundamentals of the methods for 3D structure prediction, Homology/comparative Modeling.

Unit 5: Gene Finding Tools: Basic concept of tools for Gene Finding

Text Books/References:

- Introduction to Bioinformatics by Arthur C. Lesk
- Introduction to Bioinformatics by T.Attawood and D. Parry-Smith
- David W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring harbor
- Malcolm Campbell, Laurie J. Heyer. Discovering Genomics, Proteomics, & Bioinformatics. 2003. Cold Spring Harbor Laboratory Press. 0805347224.
- Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Second Edition, Wiley.

Bioprocess Emgineering & Technology [BT506]

Unit.1 Introduction to Bioprocesses, Outline of an integrated bioprocess and the various unit operations involved in bioprocesses, Concepts of basic mode of fermentation processes, Types of fermentation- Batch, fed batch and continuous and extractive fermentation, Aerobic and anaerobic fermentation, surface, submerged and solid state fermentation, Conventional fermentation v/s biotransformation, Fermentation economics, Media Formulation and statistical methods of medium optimization, Instrumentation and Control Systems, Strain improvement.

Unit.2 Background of bioreactors, Bioreactor & its parts and functions, design of bioreactors: Batch, fed-batch, and continuous flow types (Airlift bioreactors, Airlift pressure cycle bioreactors, Loop bioreactor, Stirred tank bioreactors, Fluidized bed bioreactor, Packed-bed reactors, Trickle bed bioreactor, Bubble column bioreactor, Multiphase bioreactors, Disposable bioreactors and Wave bioreactor). Reactors with non ideal mixing, Immobilized enzyme/cell bioreactors, High cell-density and High-Performance Bioreactors, Plant and mammalian cell bioreactors for production of bioproducts.

Unit.3 Metabolic Stoichiometry and Kinetics: Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients, Kinetics of Microbial Growth, Product Formation Phases of cell growth in batch cultures, Simple unstructured kinetic models for microbial growth, Monod model, growth of filamentous organisms, growth associated and non-growth associated product formation kinetics, substrate and product inhibition on cell growth and product formation, Introduction to structured models for growth and product formation.

Unit.4 Fermentation Broth Rheology: Viscosity, Rheological Properties of Fermentation Broths, Factors affecting broth viscosity, Oxygen transport to microbial cultures-Gas-liquid mass transfer fundamentals, oxygen requirement of microbial cultures, Oxygen transfer by aeration and agitation, Determination of oxygen mass transfer coefficient by various methods including dynamic gassing out and oxygen balance methods, Flow regimes with and without baffles, various types of impellers, Power Requirements for Mixing, Ungassed Newtonian Fluids, Gassed Fluids, Role of Shear in Stirred bioreactors.

Text Books/References:

- Principles of Fermentation Technology, P.F. Stanbury and A. Whitaker, Pergamon Press
- Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
- Biochemical Engineering – Kinetics, Mass Transport, Reactors and Gene Expression, W.F. Veith, John Wiley and Sons Inc.
- Biochemical Engineering, S. Aiba, A.E. Humphrey and N.F. Millis, University of Tokyo Press
- Bioprocess Engineering, B.K. Lydersen, K.L. Nelson, B.K. Lyderson and N. D'Elia, John Wiley and Sons Inc.
- Biochemical Engineering Fundamentals, J.E. Bailey and D.F. Ollis, McGraw-Hill.

Vaccine Design & Development [BT508]

Unit 1: History and Relevance of Immunology, Components of Innate and acquired immunity, Organs and cells of immune system, Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue.(MALT&CALT);, Antigens- immunogens, haptens; antigenic determinants/epitopes, Antibody structure and function, Immunoglobulins-basic structure, classes and subclasses of immunoglobulins. Connection between innate and acquired immunity, Inflammation, soluble and membrane associated receptor, Toll Like Receptor (TLR). cells type of innate immunity, signal transduction pathway (TLR only)

Unit 2 Overview of Vaccine Strategies: History of vaccines, bacterial, viral and parasitic vaccines, overview of conventional vaccine strategies, designing of live attenuated or killed whole organism-based vaccines sub-unit vaccines, DNA vaccines, recombinant vaccines, adjuvants, peptides, immune-modulators (cytokines). Vaccine delivery systems, mucosal vaccines, parental vaccines, edible vaccines, monoclonal antibodies as vaccines. The advantages and disadvantages of each approach, eluding to various considerations, such as efficacy, safety and cost of production. General specifications and pharmaceuticals release criteria for the existing vaccines, Cold chain management of vaccines.

Unit3: Genetic engineering in vaccine designing, Designing of peptide/epitope-based vaccines, T cell and B cell epitope prediction, screening and selection of the vaccine composition, structural approaches for vaccine designing, Reverse vaccinology and immunoinformatics, Databases in Immunology, Principles of B-cell and T-cell epitope prediction

Unit 4: Novel approaches in designing of glyco-conjugate vaccines, cancer vaccines, use of bacterial toxins as vaccines, adjuvants, vaccines against opportunistic pathogens, vaccines for neglected diseases.

Unit 5: Vaccines Against Viral Diseases: Hepatitis-B, Herpes simplex virus, Zika, and influenza virus. Designing Bacterial vaccines for: TB, pneumococcal, malaria, cholera, streptococcal.

Unit 6: New strategies for vaccine development**:** Reverse genetic and temperature-sensitive mutation, reassortment, Viral recombinant and deletion mutants, codon deoptimization, increased replication fidelity, replication vector recombined with gene from pathogens, Replication-defective VLPs, DNA plasmid, reverse vaccinology, Prime boost, Fusion proteins, Gene delivery by invasive bacteria,, Inmmune refococusing, Transcriptomics, proteomics, DNA shuffling, transcutaneous vaccination, adjuvant.

Text Books/References:

- Vaccine Design: Innovative Approaches and Novel Strategies Publisher: Caister Academic Press, Editor: Rino Rappuoli and Fabio
- Vaccines, 4th Edition by Stanley A. Plotkin, Elsevier publication
- Vaccines and Immunotherapy by Stanley J. Cryz Elsevier science publishing co.
- Review: Vaccines: the fourth century by Stanley Plotkin

Regulation, Ethics & patenting in Biotechnology [BT510]

Unit 1: **Biotechnology in international relations:** Introduction to Intellectual Property Rights forms of Intellectual Property, Copyrights and related rights, Industrial Design, Trademarks and Geographical indications. Introduction to history of GATT, WTO, WIPO and TRIPS.

Unit 2: **Patents and patent filing**: Introduction and importance of patent in biology and biotechnology, Basic criterion and essential requirement for patent, patenting authorities, types of patent and its application, Indian Patent Act 1970 and recent Amendments, patent cooperation treaty (PCT) and its implications, Role of a Country Patent Office, farmer's and plant breeder's rights, patenting law, controversies over the patenting of living organism, Case study: Basmati case, Neem controversy, Turmeric Case. Types of patent applications: provisional and complete specifications; International patenting-requirement, procedures and costs; Publication of patents-gazette of India, 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. Patent databases; Searching International Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation

Unit 3: **Bioethics**: Introduction to bioethics, ethical implication of: Human genome project; parental diagnosis; GMOs & LMOs; stem cell research; animal and human cloning; drug testing; organ transplantation.

Unit 4: **Biosafety**: Concept and issues; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; biosafety guidelines and their implementation, 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. Guidelines for research involving DNA molecule; microorganism, public and non-govermental organization (NGOs) in biosafety.

Molecular Medicine [BT512]

Unit 1. Advanced Molecular and Cellular Biology Technologies: Nucleic acids, RNA transcription, protein synthesis and processing, Vectors, Polymerase chain reaction (PCR) and DNA sequencing, Gene mapping technologies. Animal model system, Knock-out technology, Cell culture Technology , Stem Cell Therapeutics, Regenerative Medicine (**15hours)**

Unit 2. Gene Expression and Disease: GeneExpression of Complement, Growth Factors, Differentiation factors, Cytokines, Hormones, Regulatory Peptides, Viral Expression, Oncogenes, Tumour suppressors, Cell cycle control, Signalling pathways, Apoptosis.**(15 Hours)**

Unit 3. Molecular Genetics and Disease: Genetic Basis of Cancer, Viruses in Cancer, Leukaemia, Haemophilia, Breast Cancer, Colon Cancer, Invasiveness, Cancer Vaccines and Gene Therapy, Diabetes, Muscle Cell Disease, Lipoprotein Metabolism, Endocrine disorders, Genome structure and Inherited disorders, Gene targeting, viral diseases.
(15hours)

Recommended Books

- Principles of Molecular Medicine by Runge and Patterson, Springer 2006
- Animal Cell Technology by Asok Mukhopadhyay, 2008
- T.A. Brown – Gene cloning and DNA analysis – An introduction, 2012
- Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.
- Benjamin Lewin, Gene X, Jones and Barlett Publishers, 2007.
- Alberts et al; Molecular Biology of the Cell, 4th edition, Garland Science.
- Principles of Gene Manipulation: An Introduction to Genetic Engineering, R.W. Old and S. B Primrose, Blackwell Science Inc.

Genomics & Proteomics Lab [BT514]

1. RNA pre-amplification
2. Real-time PCR using different dyes
3. Data analysis of Real-time PCR (methodological steps in quantitative RT-PCR, Cycle threshold (CT), delta (CT)
4. Designing a DNA-microarray experiment. Analysis of a given microarray data through computational methods
5. DNA sequencing by Sanger or alternative methods.
6. Analysis of gene expression in single cells using three prime end amplification PCR
7. To identify single nucleotide polymorphisms in a candidate gene in a relevant group of study
8. To study biomarkers and/or differential gene expression in a gene in a relevant group of study
9. Protein isolation for proteomic analysis.
10. Protein fractionation by ion exchange chromatography
11. Protein fractionation using gel filtration chromatography
12. Silver staining/ponceau staining of proteins.
13. Quality analysis of protein samples for proteomic analysis
14. Sample preparation for the MALDI-TOF MS analysis
15. Analysis of the MALDI-TOF peptide mass fingerprinting data

Computational Biology Lab [BT516]

A. Biological Databases: Study of different Biological databases Uses and Applications:

1. Literature database: PubMed
2. Sequence databases: GenBank, Uniprot
3. Secondary Protein database: Prosite, Pfam
4. Structure database: PDB, CATH , SCOP
5. Retrieving a sequence from database
6. Finding Open Reading Frame
7. Determination of physicochemical properties of proteins
8. Pair wise sequence alignment: BLAST
9. Multiple Sequence alignment
10. Phylogenetic Tree construction
11. Visualisation and analysis of 3D-structures of Proteins
12. 3D structure prediction of proteins using comparative modelling, threading and abinitio methods.

References:

- Baxevanis, A.D. and Francis Ouellette, B.F. 2004 Bioinformatics: A Practical Guide tothe Analysis of Genes and Proteins. Second Edition, Wiley.
- On line bioinformatics tools and resources.

Bioprocess Engineering & Technology Lab [BT518]

1. Demonstration of working of laboratory scale fermenter.
2. Production and purification of alkaline protease and determination of its kinetic constants.
3. Production and estimation of Lactic acid through Sauer Kraut fermentation.
4. Extraction of amylase from sprouted grains and immobilization of enzyme using sodium-alginate method.
5. Production and estimation of alcohol through different substrates.
6. Comparison of aerobic and anaerobic process.
7. Determination of mixing time of provided medium.
8. Determination of volumetric mass transfer coefficient of fermentation broth.
9. Estimation of growth kinetics of microbe.
10. . Measuring time course of an enzyme
11. Effect of varying enzyme concentration
12. Estimation of Km and Vmax for an enzyme
13. Effect of temperature on enzyme activity
14. Effect of pH on enzyme activity
15. Enzyme inhibition

Research Methodology & Data Validation [BT 601]

Unit 1. Objectives and Types of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory, Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Unit 2. Research Formulation: Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Unit 3. Research Design and methods: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit 4. Data Collection and analysis: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response, Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size. Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association.

Unit 5. Reporting and thesis writing: Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes Reference Management Software - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Unit 6. Application of results and ethics - Environmental impacts - Ethical issues - ethical committees - Commercialisation – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability. 9. Use of Encyclopedias, Research Guides, Handbook etc.,

Books Recommended:-

1. Research Methodology – C.R.Kothari

Advanced Animal Biotechnology [BT 603]

Unit 1: Animal tissue culture: Types of culture, culture environment. Basic techniques of cell cultures: Primary and secondary cell culture, Adult and embryonic stem cell culture, Growth factors used in culture, subculture and propagation, immortalization of cell lines. Characterization and quantification of Cell line: Direct and indirect methods for quantification, characterization of cultured cells, morphology, phases of cell growth. Cloning of Cell Lines, Organ/Embryo Culture. Cryopreservation and contamination: Need of cryopreservation, source of contamination, eradication of contamination andcross-contamination. **(10 hrs)**

Unit 2: Stem Cell Cultures: Isolation and expansion, Growth factors used in stem cell culture, characterization (FACS and immunocytochemistry), measurement of proliferation, adult stem cell cultureand embryonic stem cell culture. **(6 hrs)**

Unit 3: Applications of Animal Biotechnology: Genetic engineering of animal cell cultures, Large Scale Animal Cell Cultures, Production of therapeutic proteins, antibodies, Bioreactors, tissue engineering, Invitro and In vivo disease models for research. **(9 hrs)**

Unit 4: In Vitro Fertilization and Embryo Transfer in Humans and Livestock: In Vitro fertilization (IVF) and Embryo Transfer in Humans, Superovulation and Embryo Transfer in Farm Animals,Applications of IVF. **(5 hrs)**

Unit 5: Cloning of Animals (Methods and Applications): Methods of gene Transfer, somatic cell nuclear transfer, Therapeutic and Reproductive cloning, Cloning for Production of Transgenic Animals, transgenic fishes, transgenic birds, cattle, Transgenesis in the improvement of production of traits, Human Cloning, Ethical issues and the Risks Associated with Human Cloning, Future Perspectives ofTransgenesis. **(10 hrs)**

Text/Reference Books

- Animal Cell Culture by John R.W. Masters, Oxford University Press
- Introduction to Cell and Tissue Culture, Jennie P. Mather and Penelope E. Roberts, Plenum Press, New York and London
- Molecular Biotechnology by Primrose, Wiley
- Animal Cell Biotechnology by R.E. Spier and J.B. Griffiths, Academic press.
- Textbook of Biotechnology by H.K. Das, Wiley India

Advanced Plant Biotechnology [BT 605]

Unit 1: Plant Tissue Culture: Principles and methods of preparation of Culture Media. Nutritional aspects of Plant Cell and Tissue culture, growth regulators. Techniques of organ (Shoot tip, Root, Ovary, Ovules, Endosperm, Embryo, Microspore), tissues, callus, cell-suspension cultures and Protoplast cultures, and their applications. Somaclonal Variation, Causes and Consequences; Induced variation and their Applications. Plant regeneration, Production of Haploids and methods of diplodization, Importanceof tissue culture into plant transformation **(9 hrs)**

Unit 2: Transgenic technology: Basic concepts and essential steps of the process, use of suitable promoters, transformation methodologies (direct and Agrobacterium based), vectors for plant transformation, inducible and constitutive promoters, heterologous promoters, gene silencing and methods of overcoming it, Commercial aspects of the technology. chloroplast transformation and its uses, RNA interference/silencing, Antisense RNA, role of small RNAs, VIGS, in elucidation of gene function, abiotic and biotic stress. Targeted genome engineering for trans gene expression, target site modification and development of gene knockouts to enhance crop productivity, Non-antibiotics based selection.**(12 hrs)**

Unit 3: Molecular Tagging and Marker Assisted selection: Introduction to Molecular breeding, constructing molecular maps; Genomic and proteomic approaches, map based cloning, Molecular markers: RFLP, RAPD, STS, SCAR, SSCP, AFLP, STMS, SNPs. Molecular tagging of genes/traits. Marker-assisted selection of qualitative and quantitative traits. Transposon and T-DNA tagging,TILLING. Targeted mutagenesis in plants, mutant generation and identification of the gene **(5 hrs)**

Unit 4: Applications of Gene engineering: Identification of novel plant genes, Probe based screening, Genetic engineering for various kinds of abiotic and biotic stress tolerance. Transgenic crops having Bt gene. Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nutrient uptake efficiency. Genetic engineering for quality improvement by Protein, lipids, carbohydrates, vitamins & mineral nutrients, Designer proteins. Plants as bioreactor (molecular farming), edible vaccines. Engineering Traits related to Hybrid Seed Production (e.g. Male Sterility). Beyond geneticallymodified crops. **(10 hrs)**

Unit 5: Public acceptance of genetically modified crops: Environmental and safety concerns: antibiotic resistance genes, herbicide resistance, super weeds, gene containment, food safety. Regulation of GMcrops and food safety. **(4 hrs)**

Text/Reference Books

- Transgenic plants by Lindsey and Jones, Academic
- Plants, genes and crop improvement, Cris Peels, ASPB, 2002
- Principles of Plant Biotechnology: An introduction to genetic engineering in plants, Mantal S.H., Mathews, J.A., Mickee, R.A., Blackwell Scientific Publications.
- Plant Biotechnology, Slater, Scott and Fowler, Oxford University Press.
- Introduction to genetic engineering of crop plants, A. Rashid, I.K. International.
- The Handbook of Plant Mutation Screening: Mining of Natural and Induced Alleles by Khalid Meksem, Guenter Kahl, Wiley publishers.

Advanced Microbial Biotechnology [BT 607]

Unit 1: Genomics and metagenomics of microbes: Genetics of microbes, annotation, sequencing and expression of genes, genetic manipulation of microbial DNA and proteins, , Understanding metagenomics, preparation of metagenomic library, sequence and function based metagenomics, its application, cloning of 16S RNA from unculturable microbial community, Analysis of 16S libraries usingRDB Project2, Phylogenetic analysis and applications, gut microbiota. **(13 hrs)**

Unit 2: Molecular interactions in microbial pathogenesis: Molecular pathogenesis of microbes-molecular aspects of interaction of microbes with host and among themselves, Pathogen recognition receptor, pathogen associated molecular pattern, cell signalling, ability to survive in host, bacterialcommunication, biofilms, bacteriocins, persister cells. **(10hrs)**

Unit 3: Molecular aspects of drug resistance: Identification of Drug targets, multidrug resistance, effluxpumps, evolution of drug resistance and molecular mechanism of antibiotic resistance. **(5hrs)**

Unit 4: Microbes in human therapeutics: Microbes as model system, Application of Microbes in human therapeutics, cancer, vaccine and introduction of microbial synthetic biology for human therapeutics, Role of CRISPERS in therapeutics**.** **(6hrs)**

Unit 5: Production of industrial metabolites: Microorganisms with biotechnological applications. Production of industrial metabolites: Microbial production of industrial enzymes (glucose isomerase, pectinase, amylase, lipase, protease), organic acids and secondary metabolites (tetracyclins, alkaloids and aromatic antibiotics) biopolymers, bioplastics, amino acids and antibiotics, Production of microbialpesticides, bacteriocins, and biofuels. **(6 hrs)**

Text Books/References:

- Industrial Microbiology By L.E. Casida, New Age International Publisher.
- Microbial biotechnology: Fundamentals of applied microbiology (2nd Ed) by Alexander N. Glazer, Cambridge University Press.
- Hugo and Russell's pharmaceutical microbiology, By William Barry Hugo, Stephen P. Denyer, Norman A. Hodges, Allan Denver Russell, Sean P. Gorman, Blackwell publishing House.
- Latest reviews on Metagenomics and its applications, Molecular basis of pathogenesis, microbial synthetic biology from referred journals

Industrial Environmental Biotechnology[BT 609]

Unit 1: Industrial waters-Sources, nature and characteristics, quantity and quality of industrial wastes and their impact on the environment, Industrial treatment Processes: Unit Operations & Processes, Layout of wastewater Treatment Plant, Design of wastewater treatment systems

Unit 2: Wastewater Treatment – Secondary Treatment: Kinetics of reactors, Aerobic and anaerobic digestion of sludge, Design, construction and operation of biological treatment systems. Waste stabilization, coagulation, desalination, taste and odour control, biological oxidation

Unit 3: Introduction to Environmental toxicology, Environmental changes and diseases, Dose-Response Relationships, Absorption of Toxicants, Distribution and Storage of Toxicants, Pathway analysis of intoxication

Unit 4: Biotransformation and Elimination of Toxicants, Target Organ Toxicity, Neurotoxic, nephrotoxic, hepatotoxic, Teratogenesis, Mutagenesis & Carcinogenesis, Toxic reactions with the molecules of life, Dioxin & Related Compounds

Unit 5: Risk Assessment and Risk Management-I, Hazard estimation in exposure scenarios, Risk Assessment and Risk Management- II, The tools and troubles of risk assessment and management, Selenium Ecotoxicology, Arsenic in Drinking Water, Sources, pathways, receptors and controls.

Text Books/References

- Environmental Engineering by Peavy, H.S., Rowe, D.R., Tchobanoglous, G., McGraw Hills, New York 1985.\Wastewater engineering, Treatment and Reuse by Metcalf and Eddy, Tata McGraw-Hill, New Delhi, 2003.
- Environmental Toxicology and Chemistry: Donald G. Crosby , Oxford University Press, USA (1998).
- Handbook of Environmental Risk Assessment and Management: Peter Calow, Blackwell Science Ltd. USA (1998).
- Principals of Environmental Toxicology: Ian C. Shaw and John Chadwick, Taylor and Francis, USA (1998).
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Animal Biotechnology Lab BT 611

1. GLP, sterilisation techniques and usage equipments/devices in animal cell culture.
2. Preparation of culture media (1P + 1P)
3. Animal cell culture technique:

3.1 Initiation of secondary culture (1P + 1P)

3.2 Maintenance and preservation of animal cell lines (1P + 1P)

4. Cell proliferation and cytotoxicity assay (2P + 2P)

5. Cell fractionation experiments (1P + 1P)

6. Gene transfer or transfection to recombinant mammalian expression vector into the mammalian cells

7. Expression and Detection of recombinant Protein

8. Isolation and Purification of Primary cell line

9. Transfection of siRNA into mammalian cell line

Plant Biotechnology Lab [BT 613]

1. Preparatory techniques: Media preparation and sterilization, dry and steam sterilisation, Filter

   sterilisation, Role of additives on various explant cultures.
2. Induction & Maintenance of Callus, effect of plant growth regulators on various explants

   for callus induction.
3. Micropropagation: Shoot tip and nodal sector culture
4. Exercise on anther/endosperm culture
5. Protoplast isolation
6. Organogenesis and Somatic embryogenesis
7. Cell suspension culture, growth analysis
8. Agrobacterium transformation with plant transformation vector
9. Plant transformation by Agrobacterium and/or direct methods
10. Selection of the transformants
11. Synthetic seed formation

Microbial Biotechnology Lab [BT 615]

1. Morphological study of microbes (yeast and bacteria)
2. Study IC50 of microbes to inhibitors
3. Study fitness defect of mutants in comparison to Wild type
4. Plate assays to determine mutant sensitivity to inhibitors
5. Determination of generation time of given microorganism by growth curve
6. Isolation of genomic DNA from microbes
7. Gel electrophoresis to study genomic DNA
8. Isolation of total RNA from microbes
9. Quantitation of total RNA isolated from microbes
10. Study quality of RNA by gel electrophoresis
11. Study factors contributing in fitness defect of mutant
12. Expression analysis of genes under stress conditions

Industrial Environmental Biotechnology Lab [BT 617]

1. Batch Experiments related to physico-chemical processes:
2. Sedimentation
3. Studies on Filtration
4. Characteristics of filter media
5. Kinetics of suspended growth process (activated sludge process)
6. Determination of MLSS and MLVSS & Sludge volume Index in ASP
7. Anaerobic Reactor systems / Kinetics
8. Soil Analysis: pH, Conductivity, Cation exchange capacity, Sodium Adsorption ratio
9. Coagulation and flocculation of water – Optimization of dose / pH / time of flocculation
10. Determination of Phenol, Pesticides concentrations by GC and HPLC
11. Color removal from wastewater by adsorption
12. Visit to Water and Wastewater Effluent Treatment Plants and Report writing on field visit