**BT 450 Lab III Molecular Biology** **L0-T0-P3-CR3**

**Course outcome**

CO1: *Ability to isolation of vectors and cloning of gene into vectors for protein expression and purification.*
CO2: *Ability to apply these practical knowledge and experience in biotech industries.*
CO3: *Ability to fundamental and applied research in the field of biology.*

**Course content**

1. Plasmid DNA isolation and DNA quantitation: Plasmid minipreps
2. Restriction digestion
3. Preparation of competent cells.
4. Restriction Enzyme digestion of DNA
5. Agarose gel electrophoresis
6. Purification of DNA from an agarose gel
7. DNA Ligation
8. Transformation of E.coli with standard plasmids
9. Polymerase Chain reaction using standard primers

**Practical books**

1. Microbiology Laboratory Manual, 5th Edition, James G. Cappucciino and Natalie Sherman 2. Molecular Cloning A Laboratory Manual 1 3rd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
3. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis

**BT 452 Lab IV Immunology** **L0-T0-P3--CR3**

**Course outcome**

CO1: *Ability to conduct immunological experiments.*
CO2: *Ability to conduct different antigen and antibody interactions.*
CO3: *Ability to isolate different lymphocyte cells etc. and use them in respective research work.*

**Course content**

1. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. Complement fixation test.
5. Isolation and purification of IgG from serum or IgY from chicken egg.
6. SDS-PAGE, Immunoblotting, Dot blot assays.
7. Blood smear identification of leucocytes by Giemsa stain.
8. Separation of leucocytes by dextran method.
9. Demonstration of Phagocytosis of latex beads and their cryopreservation.
10. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation.
11. Demonstration of ELISPOT.
12. Demonstration of FACS.

**Practical books**

1. Molecular Cloning A Laboratory Manual 1 3rd Edition, J. Sambrook, E.F Fristsch and T. Maniatis
2. Molecular Cloning A Laboratory Manual 2 2nd Edition, J. Sambrook, E.F Fristsch and T. Maniatis

**BT 455 Lab II Microbiology** **L0-T0-P2- CR2**

**Course outcome**

CO1: *Ability to isolate, characterize and identify common bacterial organisms.*
CO2: *Ability to determine bacterial load of different samples and preserve bacterial cultures.* CO3: *Ability to perform antimicrobial sensitivity test and determine the mechanism of antibiotic action.*

**Course content**

**Detail Syllabus**

1. Sterilization, disinfection and safety in microbiological laboratory.
2. Preparation of media for cultivation of bacteria.
3. Isolation of bacteria in pure culture by streak plate method.
4. Study of colony and growth characteristics of some common bacteria:
5. *Bacillus, E. coli, Staphylococcus, Streptococcus, etc.*
6. Preparation of bacterial smear and Gram's staining.
7. Enumeration of bacteria: standard plate count.
8. Antimicrobial sensitivity test and demonstration of drug resistance.
9. Maintenance of stock cultures: slants, stabs and glycerol stock cultures 10. Determination of phenol co-efficient of antimicrobial agents.
11. Determination of Minimum Inhibitory Concentration (MIC)
12. Isolation and identification of bacteria from soil/water samples.

**Practical books**


1. Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. BenjaminCummings Publishing Company.
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). *Collins and Lyne's Microbiological Methods* (8th ed.). Arnolds.
3. Tille, P. M., & Forbes, B. A. *Bailey & Scott's Diagnostic Microbiology*

**BT 461: Bioprocess Engineering and Technology** **L3-T0-P0-CR3**

**Course outcome**

CO1: *Ability to isolate and grow microorganism which have industrial relevance. CO2: Ability to do stoichiometric calculations for growth and yield by microrganisms. CO3: Ability to operate fermenters for bio-based products.*

**Course content**

**Unit I: Basic principles of biochemical engineering**

Isolation, screening and maintenance of industrially important microbes; microbial growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); strain improvement for increased yield and other desirable characteristics.

**Unit II Stoichiometry and models of microbial growth**

Elemental balance equations; metabolic coupling – ATP and NAD+; yield coefficients; unstructured models of microbial growth; structured models of microbial growth.

**Unit III Bioreactor design and analysis**

Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.

**Unit IV Downstream processing and product recovery**

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging.

**Unit V Fermentation economics**

Isolation of micro-organisms of potential industrial interest; strain improvement; market analysis; equipment and plant costs; media; sterilization, heating and cooling; aeration and agitation; bath-process cycle times and continuous cultures; recovery costs; water usage and recycling; effluent treatment and disposal.

**Unit VI Applications of enzyme technology in food processing**

Mechanism of enzyme function and reactions in process techniques; enzymaticbioconversions e.g. starch and sugar conversion processes; high-fructose corn syrup; interesterified fat; hydrolyzed protein etc. and their downstream processing; baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

**Unit VII: Applications of microbial technology**

Fermented foods and beverages; food ingredients and additives prepared by fermentation and their purification; fermentation as a method of preparing and preserving foods; microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; bacteriocins from lactic acid bacteria – production and applications in food preservation; biofuels and biorefinery

**Textbooks**


1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.

**BT 463: Plant Biotechnology** **L3-T0-P0- CR3**

***Course outcome***

*CO1: Ability to to manipulate plants using biotechnological tools.*
*CO2: Ability to use biotechnological intervention in plant for benefit of human being*
*CO3: Ability to conduct experiments like tissue culture, genetic transformation and molecular breeding of plants*

**Course content**

**Unit I: Plant tissue culture**

Historical perspective; totipotency; organogenesis; Somatic embryogenesis; tissue culture media- nutrients and plant hormones, sterilization techniques; initiation and maintenance of callus and suspension cultures; single cell clones, applications of tissue cultures micropropagation.

**Unit II**: **Somaclonal variation**

Androgenesis and embryogenesis, their applications. Protoplast culture and somatic hybridization - isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production. Synthetic seed production

**Unit III**: **Genetic engineering**

*Agrobacterium*-plant interaction; Ti and Ri plasmids: disarmed Ti plasmid, opines and their significance; Molecular mechanism of T-DNA transfer; Genetic transformation - *Agrobacterium*-mediated gene delivery; cointegrate and binary vectors and their utility; screenable and selectable markers; characterization of transgenic plants.

**Unit V: Othe**r **methods of gene transfer into plants**

Direct gene transfer - PEG-mediated, electroporation, particle bombardment, alternative methods, chloroplast transformation; marker-free methodologies; advanced methodologies - cisgenesis, intragenesis and genome editing (ZFN, CRISPR/Cas, TALEN)

**Unit VI: Application of transgenics**

Insect resistance, virus resistance, abiotic stress tolerance, longer shelf life (including strategies for suppression of endogenous genes), male sterility, enhanced nutrition (golden rice), edible vaccines, phytoremediation, synthetic biology- production of biochemicals for healthcare (Phytopharmaceuticals) and industry

**Unit VII: Omics technologies**

Genomics, Transriptomics, Metablomics; genome sequencing strategies, Bioinformatics tools and genome annotation, forward and reverse genetic strategies; gene, promoter and enhancer traps for gene discovery, differential gene expression analysis- microarray and RNAseq. VIGS and RNAi.

**Textbooks**


1. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.


**Suggested Readings**


1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
2. Umesha, S. (2013). *Plant Biotechnology.* The Energy And Resources.

**BT 465: Animal Biotechnology** **L3-T0-P0- CR3**

**Course outcome**

*CO1: Ability to manipulate animal using biotechnological tools*
*CO2: Ability to improve the quality and yield of animals using biotechnological interventions. CO3: Ability to do experiments related to genetic transformation and molecular breeding of animals.*

**Course content**

**Unit-I: Animal Cell Culture:**
Brief history of animal cell culture; Basic requirement for animal cell culture; Cell culture media, serum and reagents; Culture of mammalian cells; tissue and organs; Primary and secondary cell culture; Continuous cell lines; Suspension culture; Common cell culture contaminants; Application of animal cell culture for toxicity study and production of vaccines and pharmaceutical proteins; Stem cells and their application.

**Unit-II: Animal Reproductive Biotechnology:** structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and in vitro fertilization; cryopreservation of embryos; embryo transfer technology.

**Unit-III: Diagnostic methods:**
Radio immunoassays; Immunoblotting; nucleic acid probe hybridization; PCR, Real time PCR; Nucleic acid sequencing; Molecular diagnostics of pathogen in animals.

**Unit-IV: Vaccinology:**
History of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.

**Unit-V: Animal genomics:**
Different methods of characterization of animal genomes; SNP, STR, QTLs, RFLP, AFLP, RAPD; Genetic basis for disease resistance in animals; Gene knock out technology and Animal models for human genetic disorders.

**Unit-VI: DNA forensics:**
Immunological and nucleic acid based methods for identification of animal species; detection of adulteration in meat using DNA based methods; identification of wild animal species using DNA based methods using different parts including bones, hair, blood, skin and other parts of the confiscated by anti poaching agencies; Human forensics; bio-terror agents; Bio-crimes and Bioterrorism.

**Textbooks**

1. Pörtner, R. (2007). Animal Cell Biotechnology: Methods and Protocols. Totowa, NJ: Humana Press.

2. Glick, B.R., & Pasternak, J.J. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, D.C.; ASM Press.

**Suggested Readings**

1. Pinkert, C. (2006). Transgenic Animal Technology, Academic Press.
2. Masters, John R.W. (2000). Animal Cell Culture – A Practical Approach, Oxford University Press.
3. Gordon, I. (2005). Reproductive Technologies in Farm Animals. Oxford. CAB International.

**BT 466: Bioentrepreneurship** **L2-T0-P0-CR2**

**Course outcome**

CO1: *Ability to identify scope for entrepreneurship in biosciences.*
CO2: *Ability to begin a career in entrepreneurship.*
CO3: *Ability to build up a strong network within the industry.*

**Course content**

**Unit I: Innovation and entrepreneurship in bio-business**

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (*e.g.* pharmaceuticals *vs.* Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.

**Unit II: Bio markets - business strategy and marketing**

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

**Unit III: Finance and accounting**

Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

**Unit IV: Technology management**

Technology – assessment, development & upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

**Textbooks:**


1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.

**Suggested Readings**


1. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
2. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

**BT 467: Microbial Technology** **L3-T0-P0- CR3**

**Course outcome**

CO1: *Ability to conduct experiments in microbial technology.*
CO2*: Ability to apply the knowledge of microbial technology for cleaning environment.*
CO3: *Ability to apply the knowledge of microbial technology in food and pharmaceutical industries.*

**Course content**

**Unit I Introduction to microbial technology**

Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Advanced genome and epigenome editing tools (*e.g.*, engineered zinc finger proteins, TALEs/TALENs, and the CRISPR/Cas9 system as nucleases for genome editing, transcription factors for epigenome editing, and other emerging tools) for manipulation of useful microbes/strains and their applications; Strain improvement to increase yield of selected molecules, *e.g.*, antibiotics, enzymes, biofuels.

**Unit II Environmental applications of microbial technology**

Environmental application of microbes; Ore leaching; Biodegradation - biomass recycle and removal; Bioremediation - toxic waste removal and soil remediation; Global Biogeochemical cycles; Environment sensing (sensor organisms/ biological sensors); International and National guidelines regarding use of genetically modified organisms in environment, food and pharmaceuticals.

**Unit III Pharmaceutical applications of microbial technology**

Recombinant protein and pharmaceuticals production in microbes – common bottlenecks and issues (technical/operational, commercial and ethical); Attributes required in industrial microbes (*Streptomyces* sp., Yeast) to be used as efficient cloning and expression hosts (biologicals production); Generating diversity and introduction of desirable properties in industrially important microbes (*Streptomyces*/Yeast); Microbial cell factories; Downstream processing approaches used in industrial production process (*Streptomyces* sp., Yeast).

**Unit IV Food applications of microbial technology**

Application of microbes and microbial processes in food and healthcare industries - food processing and food preservation, antibiotics and enzymes production, microbes in targeted delivery application – drugs and vaccines (bacterial and viral vectors); Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (*e.g.*, Yeast) - exploiting the existing natural diversity or the artificially introduced diversity through conventional acceptable techniques (mutagenesis, protoplast fusion, breeding, genome shuffling, directed evolution *etc*.).

**Unit V Advances in microbial technology**

Microbial genomics for discovery of novel enzymes, drugs/ antibiotics; Limits of microbial genomics with respect to use in human welfare; Metagenomics and

metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental cleanup, global nutrient cycles & global sustainability, understanding evolution), Global metagenomics initiative - surveys/projects and outcome, metagenomic library construction and functional screening in suitable hosts – tools and techniques for discovery/identification of novel enzymes, drugs (*e.g.*, protease, antibiotic) *etc.*

**Textbooks**


1. Lee, Y. K. (2013). *Microbial Biotechnology: Principles and Applications*. Hackensack, NJ:
   World Scientific.
2. Moo-Young, M. (2011). *Comprehensive Biotechnology*. Amsterdam: Elsevier.


**Suggested Readings**


1. Nelson, K. E. (2015). Encyclopedia of Metagenomics. *Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools*. Boston, MA: Springer US.
2. *The New Science of Metagenomics Revealing the Secrets of Our Microbial Planet*. (2007). Washington, D.C.: National Academies Press.
3. Journals: (a) Nature, (b) Nature Biotechnology, (c) Applied microbiology and biotechnology, (d) Trends in Biotechnology, (e) Trends in Microbiology,
   (f) Current opinion in Microbiology, (g) Biotechnology Advances, (h) Genome Research)
4. Websites: http://jgi.doe.gov/our-science/

***Course outcome***

*CO1: Ability to isolate gene and clone in cloning and expression vectors.*
*CO2: Ability to transform and express recombinant protein in expression host.* CO3: *Ability to isolate and characterize the recombinant protein.*

**Detail syllabus**

1. Amplification of gene of interest by Polymerase Chain Reaction and analysis by agarose gel electrophoresis
2. Restriction digestion of insert and vector; Ligation of digested insert and vector
3. Transformation of recombinant vector into expression host and confirmation of the insert by Colony PCR and Restriction mapping
4. Induction of expression host using IPTG and over expression of recombinant protein,
5. Purification of His-Tagged protein on Ni-NTA columns. Concept of soluble proteins and inclusion body formation in *E. coli*, SDS-PAGE analysis

**Practical book:**

1. Green, M. R., & Sambrook, J. (2012). Molecular Cloning: a Laboratory Manual. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

**BT 473: Lab VI Bioprocess Engineering and Technology L0-T0-P3-CR3**

**Course outcome**

*CO1: Ability to investigate, design and conduct experiments, analyze and interpret data, and apply the laboratory skills to solve complex bioprocess engineering problems.*

*CO2: Ability to apply the skills and knowledge in solving problems typical of bio industries and research.*

**Course content**

1. Basic Microbiology techniques
   Isolation of microorganisms from soil samples and Scale up from agar plate to shake flask culture.
2. Experimental set-up
   a) Assembly of bioreactor and sterilization.
   b) Growth kinetics, c) Substrate and product inhibitions. d) Measurement of residual substrates.
3. Data Analysis
   a) Introduction to Metabolic Flux Analysis (MFA).
4. Fermentation
   a) Batch. b) Fed-batch. c) Continuous. Unit operations a) Microfiltrations: Separation of cells from broth. b) Bioseparations: Various chromatographic techniques and extractions.
5. Bioanalytics
   Analytical techniques like HPLC, FPLC, GC, GC-MS etc. for measurement of amounts of products/substrates.

**Textbooks:**


1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York:M. Dekker.


Suggested Readings


1. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology.
   Boca Raton: CRC/Taylor & Francis.

**BT 477: Computational Biology** **L3-T0-P0-CR3**

**Course outcome**

CO1: *Ability to use computational tools in biological systems.*

CO2: *Ability to investigate specific contemporary biological questions using computational tools.*

*CO3: Ability to design experiment or develop appropriate tools for understanding biological system.*

**Course content**

**Unit I: Introduction to computational Biology basics and biological databases**

Computers in biology and medicine; Overview of biological databases, nucleic acid & protein databases, primary, secondary, functional, composite, structural classification database, Sequence formats & storage, Access databases, Extract and create sub databases, limitations of existing databases.

**Unit II: Pairwise and multiple sequence alignments**

Local alignment, Global alignment, Scoring matrices - PAM, BLOSUM, Gaps and penalties, Dot plots. Dynamic programming approach: Needleman and Wunsch Algorithm, Smith and Waterman Algorithm, Hidden Markov Model: Viterbi Algorithm. Heuristic approach: BLAST, FASTA. Building Profiles, Profile based functional identification.

**Unit III: Genome analysis**

Polymorphisms in DNA sequence, Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Comparative genomics, Probabilistic functional gene networks, Human genome project, Genomics and crop improvement. Study available GWAS, ENCODE, HUGO projects, extract and build sub databases; Visualization tools including Artemis and Vista for genome comparison; Functional genomics case studies.

**Unit IV: Structure visualization**

Retrieving and drawing structures, Macromolecule viewing platforms, Structure validation and correction, Structure optimization, Analysis of ligand-protein interactions; Tools such as PyMol or VMD.

**Unit V: Molecular Modelling**

Significance and need, force field methods, energy, buried and exposed residues; side chains and neighbours; fixed regions; hydrogen bonds; mapping properties onto surfaces; RMS fit of conformers and protein chains, assigning secondary structures; sequence alignment: methods, evaluation, scoring; protein curation: backbone construction and side chain addition; different types of protein chain modelling: ab initio, homology, hybrid, loop; Template recognition and alignments; Modelling parameters and considerations; Model analysis and validation; Model optimization; Substructure manipulations, annealing, protein folding and model generation; loop

generating methods; loop analysis; Analysis of active sites using different methods in studying protein–protein interactions.

**Unit VI: Structure based drug development**

Molecular docking: Types and principles, Semi-flexible docking, Flexible docking; Ligand and protein preparation, Macromolecule and ligand optimization, Ligand conformations, Clustering, Analysis of docking results and validation with known information. Extra-precision docking platforms, Use of Small-molecule libraries, Natural compound libraries for virtual high throughput screenings.

**Unit VII: Ligand based drug development**

Quantitative structure activity relationships; Introduction to chemical descriptors like 2D, 3D and Group-based; Radar plots and contribution plots and Activity predictions, Pharmacophore modeling, Pharmacophore-based screenings of compound library, analysis and experimental validation.

**Textbooks**


1. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
2. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.


**Suggested Readings**


1. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics*. Oxford: Oxford University Press.
2. Campbell, M & Heyer, L. J. (2006), *Discovering Genomics, Proteomics and Bioinformatics*, Pearson Education.
3. Oprea, T. (2005). C*hemoinformatics in Drug Discovery*, Volume 23. Wiley Online Library.
4. Gasteiger, J. & Engel,T. (2003), *Chemoinformatics: a Textbook*, Wiley Online Library.

**BT 479: Nano Biotechnology** **L3-T0-P0-CR3**

**Course outcome**

*CO1: Ability to design and synthesize various nano materials.*
*CO2: Ability to apply the nano materials in various biotechnological applications.*

**Course content**

**Unit I Introduction to nanobiotechnology**

Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications with example for specifc cases; Cellular Nanostructures; Nanopores; Biomolecular motors; Bio-inspired Nanostructures, Synthesis and characterization of different nanomaterials.

**Unit II Nano – films**

Thin films; Colloidal nanostructures; Self Assembly, Nano vesicles; Nano spheres; Nanocapsules and their characterization

**Unit III Nanoparticles**

Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and long circulation, strategies for enhanced permeation through various anatomical barriers.

**Unit IV Application of nanoparticles**

Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, nanodevices for biosensor development.

**Unit V Nanomaterials and Nanotoxicity**

Nanomaterials for catalysis, development and characterization of nanobiocatalysts, Introduction safety and basics of nanotoxicity, Models and assays for Nanotoxicity; Containment of nanomaterials

## Textbooks


1. GeroDecher, Joseph B. Schlenoff, (2003); Multilayer Tin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier


## Suggested Readings


1. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press