

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEC-501

Course Title: Reaction engineering in bioprocesses

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Basics of reaction kinetics, enzyme kinetics, multi-substrate enzyme kinetics, immobilized enzyme kinetics, microbial growth kinetics, batch and continuous growth kinetics, maintenance coefficient, metabolic flux analysis, metabolic control analysis, batch and continuous sterilization kinetics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEC-503

Course Title: Unit operations in Biomanufacturing

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Fundamentals of biomanufacturing, Understanding of bioproducts, cell culture, and fermentation as the foundation of bioprocesses. Understanding types of unit operations, Bioreactor selection, Scale-up consideration, computational fluid dynamics (CFD) modeling and simulation as tool for scale-up, downstream operations

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEC-505

Course Title: Plant Design and Technoeconomic Analysis

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Introduction to plant design concepts and methodologies. General design considerations, Process Flow sheeting and Material Balances, Principles of process flow diagram (PFD), Energy Balances and Process Integration, Plant Layout and Piping Design, Equipment Selection and Sizing, Introduction to Technoeconomic Analysis

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEC-507

Course Title: Biomanufacturing Lab

L-T-P: 0-0-6

Credits: 3

Subject Area: PCC

Course Outlines: Microbiology and cell biology experiments, biochemistry and molecular biology techniques, Biochemical engineering experiments for reactor operation, downstream processing experiments for isolation and recovery of products.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT./CENTRE/SCHOOL: Department of Biosciences and Bioengineering

Subject Code: BEC-511

Course Title: Essentials of Biosciences and Mathematics

L-T-P: 3-1-0

Credits: 4

Subject Area: PCC

Course Outlines: Explore life's fundamental principles, biomolecules, cellular structure, and function. Probability, linear algebra, calculus, applications in genomics, transcriptomics, proteomics, metabolism and statistical analysis in biological research.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT./CENTRE/SCHOOL: Department of Biosciences and Bioengineering

Subject Code: BEC-513

Course Title: Computer Programming

L-T-P: 2-0-2

Credits: 3

Subject Area: PCC

Course Outlines: Linux, Python, and R essentials for computational biology. Linux commands, shell scripting for automation, Python programming for data analysis and module creation, R for statistical analysis and visualization, Final project applying programming skills in structural or computational biology.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT./CENTRE/SCHOOL: Department of Biosciences and Bioengineering

Subject Code: BEC-515

Course Title: Structural Biology

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Intricacies of Structural Biology, covering X-ray Crystallography, NMR Spectroscopy, Cryo-EM, and Integrative Structural Biology. Principles of protein structure determination, data collection, analysis, and integration; Structure-function relationships in biological processes and drug design.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT./CENTRE/SCHOOL: Department of Biosciences and Bioengineering

Subject Code: BEC-517

Course Title: Bioanalytical Techniques

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outlines: Advanced biophysical and biochemical analysis techniques, including light-matter interaction, microscopy, mass spectrometry, and structural biology. Electrophoresis, chromatography, spectroscopy, and gene editing techniques. System biology concepts: network analysis, stochasticity, and gene regulation networks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF THE DEPT./CENTRE/SCHOOL: Department of Biosciences and Bioengineering

Subject Code: BEC-519

Course Title: SCB Laboratory-I

L-T-P: 0-0-6

Credits: 3

Subject Area: PCC

Course Outlines: Techniques in biochemistry and structural biology through practical experiments including various chromatography methods, spectroscopy, NMR, electron microscopy, crystallization, and computational analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-521

Course Title: Advanced Biochemistry

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Concepts in biochemistry, biological systems, basic principles of physics and thermodynamics; primary building blocks of life and biological macromolecules, structure of proteins and their correlation to biological functions; biological catalysis, catalytic mechanisms, metabolic pathways, and signaling processes.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-523

Course Title: Cell and Molecular Biology

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Introduction to Cell, Functional Structural and components of Cell, Cellular Processes, Chromatin structure and dynamics, DNA Replication and DNA Repair, Gene Expression in Prokaryotes & Eukaryotes, Manipulating and studying cells, Genome instability and cell transformation, Oncogenes.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-525

Course Title: Applied Microbiology

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Introduction to microbiology and microbes, history & scope of microbiology, Sterilization, disinfection and antisepsis, control of microorganisms, Microbial taxonomy and evolution of diversity, Virus and bacteriophages, Microbial interactions and infection, host-pathogen interactions, antibiotic resistance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-527

Course Title: Genetics

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Classical and molecular genetics, advanced Mendelian genetics, human pedigree analysis, inheritance, gene mapping, mutation, repair mechanisms for mutations, alteration of chromosomes, population genetics, mobile genetic elements and genetics of cancer, genetics in human diseases.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-529

Course Title: Developmental Biology

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Basic concepts of development, Production of gametes, embryogenesis, Cell aggregation, development and regeneration in vertebrates, Characteristics of plant growth and development, cellular differentiation, de-differentiation and regeneration, Shoot and root development, Vascular development, Cell-cell communication during plant development.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTER/SCHOOL: Department of Biosciences and Bioengineering

Subject code: BEC-531

Course Title: BSBE Laboratory-I

L-T-P: 0-0-8

Credits: 4

Subject Area: PCC

Course Outline: Basic and advanced techniques and methods in microbiology, cell culture, molecular biology and recombinant DNA technology, gene cloning and expression in bacteria.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEL-503

Course Title: Mass and Heat Transfer Operations

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Definition and classification of mass and heat transfer operations. Distinction between steady-state and transient processes. Introduction to diffusion, convection, and radiation mechanisms. Applications of mass and heat transfer in various industries, Fundamentals of Mass Transfer and Heat Transfer, Types of mass transfer operations, Design of heat exchange equipment.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Biosciences and Bioengineering

Subject Code: BEL-510

Course Title: Microbiology and Biochemistry

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Organization of prokaryotic and eukaryotic cells. structure and functions of cell organelles, microbial nutrition and cell growth principles, energy transduction in microbial systems, Non-covalent interactions in biological systems. Structure and characteristics of carbohydrate, protein, lipid and nucleic acid, Protein purification techniques, introduction to enzymes, vitamins and coenzymes. Lipid and biological membranes, Transport across cell membranes, design of metabolism, metabolic pathways, electron transport chain, gluconeogenesis and control of glycogen metabolism, signal transduction

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEC-522

Course Title: Immunology

L-T-P: 3-0-0

Credits: 3

Subject area: PCC

Course Outlines: Introduction to immune cells and tissues, inflammation, Hematopoiesis, B, and T cell activation. Complement factors, hypersensitivity, autoimmunity, cancer immunology, transplantation immunology, vaccines, monoclonal antibodies, and immunotechniques.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEC-524

Course Title: Genetic Engineering

L-T-P: 3-0-0

Credits: 3

Subject area: PCC

Course Outlines: Molecular tools and techniques of recombinant DNA technology; Gene cloning and expression vectors; Restriction and modification enzymes; Gene expression analysis; Gateway cloning technology; Approaches and applications of genetic manipulation; Functional characterization of genes; Genetic, physical and regulatory interaction studies.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEC-526

Course Title: Animal Biotechnology

L-T-P: 3-0-0

Credits: 3

Subject area: PCC

Course Outlines: Introduction to animal cell culture; Various methods of animal cell cultures; Introduction to transgenic animals; Various methods of making transgenic animals; Applications of transgenic animals for wellbeing of human.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL-507

Course Title: Enzyme Production and Industrial
Fermentation

L-T-P: 3-1-0

Credits: 4

Subject area: PEC

Course Outlines: Overview of industrial fermentation process, upstream processing, downstream processing, various classes of enzymes, submerged fermentation, solid state fermentation, process flowsheet for specific products, regulatory requirements of different class of fermentation products, use of recombinant culture for various products, process economics, sensitivity analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL-508

Course Title: Biorefinery for Energy and Value-added Products

L-T-P: 3-1-0

Credits: 4

Subject area: PEC

Course Outlines: Introduction to Biorefinery synthesis and design, Types of biorefinery platforms- Biochemical, thermochemical, and hybrid approaches, Economic and environmental analysis of biorefineries cycle assessment of biorefinery products, challenges and opportunities in biomass supply chain management, Sustainability and environmental impact of biomass sourcing, Emerging technologies in biorefinery (algae-based biorefineries), Policy and regulatory frameworks for biorefineries.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-514

Course Title: Computational Biology

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Introduction to computational biology, genome assembly, pairwise sequence alignment, multiple sequence alignment, phylogenetic trees, protein-DNA binding motifs, RNA structure analysis, Markov chains, hidden Markov models, sequence alignment algorithms, dynamic programming, phylogeny construction, RNA structure prediction, transformational grammars, Systems biology, transcriptomics, gene expression analysis, single-cell RNA-seq, medical imaging informatics, image segmentation, pathway analysis, Bayesian networks.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL-516

Course Title: Advanced Cell and Tissue Engineering

L-T-P: 2-0-0

Credits: 2

Subject area: PEC

Course Outlines: Introduction to various plant growth regulators; Various plant hormones and tissue culture techniques; Various methods of animal stem cell cultures; Applications of stem cells and therapeutics; Stem cell differentiation and functions.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL- 517

Course Title: Genomics, Proteomics and Metabolomics

L-T-P: 3-0-0

Credits: 3

Subject area: PEC

Course Outlines: Genomics, proteomics, and metabolomics: principles, techniques, applications, mass spectrometry, identification of genes, proteins and metabolites, multivariate analyses, prediction models and biomarker discovery.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL- 518

Course Title: Neuroscience

L-T-P: 3-0-0

Credits: 3

Subject area: PEC

Course Outlines: Introduction to basic understanding of neuron structure and its function, neurochemistry, brain functions at cellular level and classical studies, neurological conditions, Technologies relevant to unravelling and manipulating CNS functions.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-511

Course Title: Protein Design and Engineering

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Review of protein structure and function; Principles of Protein Stability and Engineering; Protein Engineering Techniques: Direct evolution, Random mutagenesis, focused mutagenesis, site saturation mutagenesis, Homologous and non-homologous recombination, Screening and selection techniques; Computational Protein Design: Rational designing of proteins, Multiple sequence alignment, Co-evolutionary analysis of protein surfaces, Structure-based designing of novel proteins using ab-initio methods, fragment-based methods, homology modeling and protein threading; De Novo Protein Design; Biotechnological Applications of Engineered Proteins.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-512

Course Title: Molecular Dynamics Simulations

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Principles of classical mechanics, potential energy functions, thermostat algorithms, integration methods, software utilization (e.g., GROMACS, AMBER), system setup, simulation running, data analysis, advanced topics like free energy calculations, enhanced sampling techniques, coarse-grained simulations, and QM/MM simulations.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-513

Course Title: Structural and Translational Bioinformatics

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Basic Concepts of Bioinformatics; Fundamentals of protein, DNA and RNA structure; Study of macromolecular structures; Structural comparison and alignment; Protein-Protein and Protein-DNA interactions; Structure: function and application; Sequence analysis; Structural informatics; Health informatics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-515

Course Title: Probabilistic Machine Learning

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outlines: Introduction to Machine Learning; Development environment; Visualization libraries; Exploratory Data analysis; Supervised learning algorithms: Linear and Logistic regression, SVMs, Decision Trees and Random Forests, k-NN, and more; Unsupervised learning algorithms: k-means clustering, Gaussian Mixture Models, PCA; Evaluation metrics; Building machine learning models with examples.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL-523

Course Title: Drug Discovery and Development

L-T-P: 3-0-0

Credits: 3

Subject area: PEC

Course Outlines: Attributes of a drug, Mode of action of drugs, Target identification for drug action, Lead drug optimization strategies, High throughput screening, Pharmacokinetics and pharmacodynamics of drugs, Pre-clinical studies and development, Drug manufacturing, Clinical trial design, Fundamentals of regulatory aspects and bioethics.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences & Bioengineering

Subject code: BEC-528

Course Title: Plant Biotechnology

L-T-P: 3-0-0

Credits: 3

Subject area: PCC

Course Outline: Principles and application of plant biotechnology, plant tissue culture, direct and indirect organogenesis, haploid and doubled haploid in plants, protoplast fusion, soma clonal variation, genetic transformation, genome editing and molecular breeding of plants, plant cell culture and value-added plant products, plant factories, biotech crops for abiotic and biotic stress resistance.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEC-530

Course Title: BSBE Laboratory-II

L-T-P: 0-0-8

Credits: 4

Subject Area: PCC

Course Outline: Cell and tissue culture media preparation, callus culture, somatic embryogenesis, artificial seeds, genetic transformation by Agrobacterium, confirmation of transgene by PCR, GUS reporter assay, Immunoassays, antigen-antibody interactions, Isolation of immune cells, Purification of monoclonal and polyclonal antibodies, adherent mammalian cells, trypan blue assay, Mass-Spec analysis of cell lysate.

List of practicals:

1. Prepare culture media with various supplements for plant tissue culture.
2. Prepare explants for inoculation under aseptic conditions.
3. Attempt callus development and regeneration in plants.
4. Culture Agrobacterium tumefaciens and attempt transformation.
5. Undertake plant genomic DNA isolation by CTAB method and its quantitation by visual as well as spectrophotometric methods.
6. Perform PCR amplification of transgene and GUS reporter assay.
7. Isolation and separation of bioactive secondary metabolites from plant cell cultures
8. Essential oil analyses from aromatic herbs (Ocimum sanctum)
9. Induction of Agrobacterium rhizogenes induced hairy roots in potato
10. Isolation and quantification of terpenes, polyphenols and antioxidant activities from plants
11. Development of artificial seed using somatic embryo.
12. Accessing antigen-antibody interactions by immunotechniques.
13. Isolation of immune cells from healthy donors.
14. Purification of monoclonal and polyclonal antibodies for immunoassay development.
15. Demonstration of subculturing of adherent mammalian cells.
16. Demonstration of live and dead cell count by trypan blue assay.
17. Demonstration of Mass-Spec analysis of prepared mammalian cell lysate.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences & Bioengineering

Subject code: BEL-502

Course Title: Fluid Mechanics for Biological Engineers

L-T-P: 3-1-0

Credits: 4

Subject area: PEC

Course Outline: Concepts of fluids, Mass, energy and momentum balances, Bernoulli equation, fluid friction in pipes, flow in noncircular ducts. Circulation system in the human body, nature of blood and rheology of blood, Viscoelastic behavior, steady blood flow theory and pulsatile blood flow theory. Differential analysis of fluid flow: vector operations, convective derivatives, differential form of mass and momentum balances, Navier -Stokes equation, boundary layer separation. Dimensional analysis.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL-522

Course Title: Cancer Cell Signaling

L-T-P: 3-0-0

Credits: 3

Subject Area: PEC

Course Outline: Transformation mechanisms of normal cells into cancer cells. Signaling processes that operate in the normal cell. Abnormalities in signaling that convert normal cells into cancer cells. Drug targets to kill the cancer cells based on altered signaling pathways adapted by cancer cells. Brief description of immune signaling and cancer immunotherapy.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences & Bioengineering

Subject code: BEL- 525

Course Title: Nano-biotechnology

L-T-P: 3-0-0

Credits: 3

Subject area: PEC

Course Outline: Introduction to nanomaterials, Synthesis of nanomaterials by physical, chemical and biological methods, Characterisation of nanomaterials, Bio-nanotechnology, Carbon nanotube and its bio-applications. Nanomaterials for cancer diagnosis and therapy, Nanotechnology in tissue engineering and organ printing, Nano artificial cells, Role of nanotechnology in point-of-care diagnostics, Nanopharmacology, Cellular uptake mechanisms of nanomaterials, Methods to study the toxicity of nanomaterials.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences & Bioengineering

Subject Code: BEL-515

Course Title: Machine Learning Essentials: Theory and Practice

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course Outline: Introduction to Machine Learning; Development environment; Visualization libraries; Exploratory Data analysis; Supervised learning algorithms: Linear and Logistic regression, SVMs, Decision Trees and Random Forests, k-NN, and more; Unsupervised learning algorithms: k-means clustering, Gaussian Mixture Models, PCA; Evaluation metrics; Building machine learning models with examples.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-521

Course Title: Molecular Diagnostics

L-T-P: 2-0-0

Credits: 2

Subject Area: PEC

Course Outline: Genome biology in health and diseases, genetically detrimental adverse result to drugs; Various tools for genome detection and analysis; Biomarkers detection in the body fluid and tissues using NMR and MS; Detection of not cultivable or slow growing pathogen; Fragile X syndrome and Von Hippel-Lindau syndrome (VHL) relation to cancer; Molecular Oncology, types of cancer causing alteration reveal by NGS, predictive biomarkers.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL- 528

Course Title: IPR, Biosafety and Bioethics

L-T-P: 2-0-0

Credits: 2

Subject Area: PEC

Course Outline: Intellectual Property Rights, Biosafety, and Bioethics: principles, IPR policy, implication of IPR on biological research and product development, biosafety and risk assessment of products derived from biotechnological processes, genetically modified organisms, ethical issues in biological research, consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEL- 529

Course Title: Bio-entrepreneurship

L-T-P: 2-0-0

Credits: 2

Subject Area: PEC

Course Outline: Introduction and scope in Bio-entrepreneurship, Entrepreneurship development programs, Road from lab to the market, Business plan preparation, Patenting & commercialization strategies. Technology readiness levels (TRL), Market readiness level (MRL), IPR, Bio-entrepreneurship Introduction it's types, Marketing strategy for product commercialization, pricing calculation, basics of financial market.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject code: BEC-533

Course Title: Gene Regulation

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course Outline: Gene regulation in prokaryotes, eukaryotes and Bacteriophages; Chromatin structure, arrangement and Methylation, Transcriptional, Post-transcriptional, Translational and Post-translational; Operons; Transcription attenuation; Alternate splicing; Alternative Polyadenylation; Basic and special Transcription Factors; Small RNAs: miRNA, siRNA; RNA Interference, Promoter and regulatory elements, IRES and Riboswitches; Gene Regulation in development, stress and diseases.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEC-535

Course Title: Biophysical Techniques

L-T-P: 3-0-0

Credits: 3

Subject Area: PCC

Course outline: Introduction to biomolecules, Analytical and preparatory techniques, Light-matter interaction: Spectroscopic Techniques – Circular Dichroism, Fluorescence Spectroscopy, Light Scattering, Thermodynamics and Macromolecular Interaction Techniques: DSC, ITC, SPR, Mass spectrometry, proteomics, X-ray diffraction, NMR, TEM and Cryo-EM, SAXS, AFM, FRET, Fluorescence Correlation Spectroscopy (FCS), Super-Resolution Imaging with Stochastic Optical Reconstruction Microscopy (STORM) and Photoactivated Localization Microscopy (PALM).

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT: Department of Biosciences and Bioengineering

Subject Code: BEL-504

Course Title: Advanced Bioreactor Design

L-T-P: 3-1-0

Credits: 4

Subject Area: PEC

Course outline: Different types and component of bioreactor. Batch, chemostat, enzyme catalysis, PFR, Fed batch, chemostat with cell recycle. mass transfer in bioreactor, correlations with k_{La} , power number, determination of k_{La} , power requirement for agitated and non-agitated tanks. Residence time distribution, non-ideal and multiphase bioreactor; Bubble column reactors, bubble generation, coalescence and breakup, gas holdup, interfacial area, design of bubble columns. Heat transfer and sterilization of bioreactor, scaling up, sensors in bioreactor; feedback and feedforward control of bioreactor.