<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Title</th>
<th>Semester</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>Core 1 – Bioprocess Technology</td>
<td>I</td>
<td>5</td>
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<tr>
<td>2</td>
<td>Core 2 – Bio-reaction Engineering</td>
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<td>3</td>
<td>Core 3 – Advanced Modeling Techniques</td>
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<td>4</td>
<td>Core 4 – Applied Biology</td>
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<td>Core 5 – Advanced Transport Phenomena</td>
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<td>6</td>
<td>Elective I</td>
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<td>Elective III</td>
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<tr>
<td>9</td>
<td>Open Elective I</td>
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<td>10</td>
<td>Open Elective II</td>
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<tr>
<td>11</td>
<td>Seminar –I (Advanced Topic based on courses in semester I)</td>
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<td>12</td>
<td>Seminar –II (Advanced Topic based on courses in semester II)</td>
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<td>13</td>
<td>Advanced Mathematics</td>
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<tr>
<td>14</td>
<td>Advanced Technologies in Materials and Mechanical Engineering/ Computer and Information Sciences/ Life and Biological Sciences/ Electronics and Electrical Engineering</td>
<td>III</td>
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<td>15</td>
<td>Research Methodology</td>
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<tr>
<td>16</td>
<td>Seminar III on Literature review of Research Problem/ Field Works/ Assignments</td>
<td>III</td>
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<td>17</td>
<td>Research Progress Seminar I and Report</td>
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<td>Research Progress Seminar II and Report</td>
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<td>19</td>
<td>Research Progress Seminar III and Report</td>
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<tr>
<td>20</td>
<td>Research Progress Seminar IV and Report</td>
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<td>21</td>
<td>Thesis Submission</td>
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</table>

**Note**

Candidates are expected to perform minimum four (4) assignments for every core and elective course, and submit report as a bona fide document to supervisor/course instructor. The assignment may be in the form of modeling/ simulation/ programming/ experimental investigation/ fieldwork.
**Electives to be selected from following list**

<table>
<thead>
<tr>
<th>Course Code</th>
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<tbody>
<tr>
<td>CBE1</td>
<td>Fermentation Technology</td>
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<tr>
<td>CBE2</td>
<td>Advanced Biomaterials</td>
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<tr>
<td>CBE3</td>
<td>Genomics &amp; Proteomics</td>
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<td>CBE4</td>
<td>Advanced Downstream Processing</td>
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<tr>
<td>CBE5</td>
<td>Biofuel &amp; Bioenergy</td>
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<tr>
<td>CBE6</td>
<td>Advanced Genetic Engineering</td>
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<tr>
<td>CBE7</td>
<td>Nutrition &amp; Food Processing</td>
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<tr>
<td>CBE8</td>
<td>Herbal Drug Technology</td>
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<td>CBE9</td>
<td>Enzyme Technology</td>
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<tr>
<td>CBE10</td>
<td>Alcohol and Brewery Technology</td>
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<tr>
<td>CBE11</td>
<td>Stem Cell &amp; Cancer Biology</td>
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<tr>
<td>CBE12</td>
<td>Advanced Bioinformatics</td>
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<tr>
<td>CBE13</td>
<td>Metabolic Engineering</td>
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<td>CBE14</td>
<td>Structural Biology</td>
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<td>CBE15</td>
<td>Nanotechnology</td>
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<tr>
<td>CBE16</td>
<td>Intellectual Property Rights &amp; Bioethics</td>
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<tr>
<td>CBE17</td>
<td>Analytical Chemistry</td>
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<tr>
<td>CBE18</td>
<td>Instrumentation &amp; Process Control</td>
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<td>CBE19</td>
<td>Thermodynamics</td>
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<tr>
<td>CBE20</td>
<td>Strain Development</td>
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**Open Elective**

The syllabi of open elective will be framed by supervisor of Ph. D. candidate in consultation with project sponsoring company. It has to be sent to concern Board of Studies for approval. The open elective should be relevant to the area of Ph. D. work.

**Evaluation**

1. The concerned course faculty will assess the candidate throughout the semester through quizzes/test/mid-term test/assignments etc. and submit the grades to the department

2. There shall be mandatory end semester theory examination of 100 marks of duration of three hours for each course
CBC1: Bioprocess Technology

Cell disruption methods: Chemical method (detergent, alkali), physical (Osmotic shock, grinding with abrasive, solid shear, liquid shear) and enzymatic lysis, the release of intracellular products Removal of insoluble and recovery of intracellular components: Flocculation and sedimentation, decanting, centrifugation and filtration methods Principles, operation, design and scale-up, Material balance and numerical examples of these processes; Extraction and Leaching Selection of solvent, Single stage extraction, multistage crosscurrent, countercurrent and co current extraction, Types of extractors – stage type and differential type Solid – Liquid Extraction (Leaching): Definition, Preparation of the solid, Factors affecting leaching operations, Methods of operation, Single stage leaching, Continuous counter current leaching, Constant and variable underflow, Leaching equipments, Calculation of single stage and multistage leaching processes.

Adsorption and Ion Exchange: Types, Adsorption Isotherms - Langmuir, Freundlich, BET, Heat of adsorption, Pressure Swing Adsorption (PSA), and Temperature Swing Adsorption (TSA), Equipments for adsorption, Principles of Ion Exchange, Techniques and applications, Equilibria and rate of ion exchange; Chromatography –Separation Technique, Classification of chromatographic techniques, General description of column chromatography, chromatography column dynamics, Chromatographic terms and parameters, Practice of chromatography, HPLC; scale up of chromatography, planar chromatographic techniques, process consideration in preparative chromatography. Introduction to types of chromatography.

Crystallization and drying: Crystallization, Principle rate of crystal growth, Population balance and size distribution, Calculations of yield, Enthalpy balances, Equipment Drying, Definition, Principles, Equilibrium in drying, Drying hysteresis, Types of moisture binding, Drying operations, Batch drying, Rate of batch drying, Rate of drying curve, Mechanism of batch drying, Mechanism of moisture movement in solid continuous drying, Time required for drying, Classification of drying equipments, Numerical relating drying operations; Importance of separation techniques in biotechnology, its scope from research to industry, Synthesis of Bioseparations Processes, Process analysis, Process Economics, Illustrative Examples, Industrial applications with examples, Separation of bioconversion products/ secondary metabolites e.g. Steroids and antibiotics.

References

2. McCabe W.L. and Smith J.C., Unit Operations of Chemical Engineering, McGraw Hill
5. Foust A.S., Principles of Unit Operations in Chemical Engineering,
6. Smith B.D., Design of Equilibrium Stage Processes
CBC2: Bio-reaction Engineering


Mechanisms and Kinetics of Enzyme Action: Mechanisms of Enzyme Action; Concept of active site and energetics of enzyme Kinetics, substrate complex formation; Specificity of enzyme action; Kinetics of single substrate reactions; turnover number; estimation of Michaelis-Menten parameters. Importance of KM, Multi-substrate reaction mechanisms and kinetics. Types of Inhibition- kinetic models; Substrate and Product Inhibition; Mass Transfer effects In Heterogeneous Reactions : Mass and heat Transfer coefficients in packed beds, Quantitative treatment of external transport effects, modeling diffusion with and without reaction. Intrapellet mass and heat transfer, Evaluation of effectiveness factor, mass and heat transfer with reaction; Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme, Mass Transfer Effects In Immobilized Enzyme Systems Heterogeneous Catalytic Reactors Introduction to multiphase reactor design, Chemostat, Two phase fluidized bed model, slurry reactor model, Trickle bed reactor model; Stoichiometry of cell growth and product formation- elemental and available electron balances, degrees of reduction, maintenance coefficient, online data analysis for measurement of biochemical parameters, state and parameter estimation technique, Immobilized System, different types of reactors used in biological transformations, key differences from conventional reactors.

References

4. Bishoff and Fromment, Reactor design and analysis, Oxford University Press
CBC 3. Advanced Modeling Techniques

Introduction to modeling Introduction, definition of Modeling and simulation, different types of models- Unstructured and structured models, Deterministic and stochastic models, Segregated and unsegregated models, compartmental models genetically structured models. Continuity equation, Energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics, Model building, application of mathematical modeling, scope of leverage. Model adaption and checking, preparing the data, parameter determination, model checking simplification, validation, calibration, optimization of models, analytical methods, and numerical methods; Immobilized Enzymes: Effect of mass transfer resistances (external:: Damkohler Number, Effectiveness Factor and internal :: Thiele Modulus etc.) Effective Diffusivities in gels


Cell Kinetics: Microbial, Animal, Plant Cell Cultivation Growth measurement: hemocytometer, Pertoff-Hausser Counting Number, Cell Mass Growth Kinetics, Cell kinetics and fermenter design, Distributed and segregated Cell Kinetics, various growth phases of cell : Lag phase, Accelerated growth phase, Exponential Growth Phase, Decelerated Growth phase, Stationary growth phase, Death phase, Batch F, CSTF, PFF, CSTF and PFF in series, Cell recycling in all above fermenters, Other Fermenters; Agitation Equipment: Basic mass transfer modeling, mass transfer coefficients, Interfacial area measurement, Correlations for a, Da, Gas hold up, Power consumption, Oxygen absorption rate, correlation for kLa, Scale up, Shear sensitive mixtures. Scope of modeling: All types of fermentations, Activated sludge process, Anaerobic digesters, All types of Enzymatic reactions, Cell Kinetics, Aerobic digesters, Modeling of gene regulation (Genetic switches)

References

1. Steven C Chopra and Reynolds P Canale, Numerical method for Engineers with software and programming application
CBC 4. Applied Biology


Nitrogen fixation, Genes involved in nitrogen fixation and their regulation, Assimilation of nitrogen, dinitrogen, nitrate nitrogen, ammonia, synthesis of major amino acids, Polyamines, Synthesis of polysaccharides, Biofertilizers: Production technology and storage methods for Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Azolla, PSM, Cellulolytes, VAM and PGPR. Biopesticides: Organisms, their targets, ideal candidates, biology of commercialized biopesticides. Chemistry of biocidal component, effect on target pests, Production technology and storage methods for Bacillus thuringiensis and Baculovirus

Microbial growth, continuous and batch cultures, Industrial production of lactic acid, citric acid, enzymes viz. Proteases, amylases, cellulases, Acetic acid, Production and diversification of antibodies, Steroid conversions and their industrial applications. Biogums, Bioplastics, Biochips, Biosensors, Nanotechnology, DNA structure: Watson- Crick model, A,B, Z structures, physicochemical properties, DNA supercoiling and packaging in eukaryotes, Euchromatin, heterochromatin, UV absorption, thermal denaturation, Tm, hyperchromicity, nucleic acids in mitochondria, chloroplasts, viruses and bacteria, DNA replication, semiconservative replication model, rolling circle model, enzymes in replication, gyrases etc. repair enzymes, DNA unwinding, recombination, telomeres, telomerases, RNA types, RNA types, tRNA, mRNA, rRNA structural features, introns and exons, RNA splicing, ribozyme, post-transcriptional modifications, inhibitors of transcription, reverse transcriptase, Transcription, structure of gene, regulation of gene expression, operon concept (lac, trp, his operon), repression, promoters, enhancers, silencers Genetic code, Protein biosynthesis, translation, factors required for translation, inhibitors, regulation, post-translational modifications, protein synthesis in prokaryots and eukaryotes. Introduction to recombinant DNA technology, Restriction enzymes, Vectors used-plasmids, phagemids, phage vectors, cDNA, Genomic libraries, cloning, PCR cloning, selection of clones. Applications of rDNA
technology in health and disease, recombinant proteins, Factor VIII, erythropoietin, vaccines, genetherapy, genetically modified crops

References

3. Freifelder D. Molecular Biology, Jones and Bartrlett Publishers 1987
7. BIOTOL. Biotechnological innovations in chemical synthesis
15. T.A. Brown, ‘Genomes’ John Wiley and Sons PTE Ltd.
18. I Edward Alcamo, HAR cour Academic Press’DNA Technology’
CBC 5. Advanced Transport Phenomena

Review of Mathematics: Scalar, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems, frame of reference (Eularian and Lagrangian), Review of Basic Concepts: Newton’s law of viscosity, Classification of fluids, Newtonian & non-Newtonian fluids, flow curves for non-Newtonian fluids with examples, basic equation of fluid flow—Continuity equation, Momentum balance equation, Hagen-Poiseuille equation

Thermal conductivity, Fourier’s law, Temperature distributions in solids and laminar flow, one dimensional steady state heat conduction, Natural and forced convection, concept of heat transfer coefficient and overall heat transfer coefficient, dimensionless numbers in heat transfer, Thermal boundary layer Diffusivity and the mechanisms of mass transport, Ficks law of diffusion, Concentration distributions in solids and laminar flow, review of classical flow problems using shell balances, Momentum, Heat and mass transfer analogies, Flow Systems and Heat Transfer: Viscosity, momentum transport, laminar and creeping flow,

The equations of change for isothermal flow: Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems, the equations of change for incompressible non-Newtonian fluids The equations of change for non-isothermal flow: Equations of energy, the energy equation in curvilinear coordinates, and use of equations of change to set up steady state heat transfer for problems, mass transfer in multicomponent systems: The equations of change for multi component systems: The equations of continuity for a binary mixture, the equation of continuity of A in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multi component fluxes in terms of the transport properties, use of equations of change to set up diffusion problems, Interphase transport, Microscopic and macroscopic balances

Simultaneous Transfer Processes: Velocity, temperature and concentration distributions with more than one independent variables, unsteady flow, stream function, potential flow, boundary layer theory, steady state two dimensional flow for momentum, heat and mass transfer, Turbulence: Turbulent flow: Introduction, Theories of turbulence—Phenomenological and statistical, Turbulent transfer processes in single and multiphase systems, Temperature distribution in turbulent flow, fluctuations and time smoothened equations for velocity, temperature and concentration, time smoothing of equation of change , equation of energy, equation of continuity of A, Reynolds stresses

References

2. Unit Operations of Chemical Engineering: McCabe, Smith & Harriot, TMH, 5th edition
5. Beeks W. J. and Muttzall, Transport Phenomenon, John Wiley & Sons
8. Geankopolis, Transport Processes & Unit operations: 3rd edition, PHI
9. Coulson & Richardson, Chemical Engineering, Vol-I & II; Butterworth Heinemann
CBE1. Fermentation Technology

The isolation, preservation and improvement of industrial microorganisms: The isolation of industrially important microorganisms, Isolation methods not utilizing selection of the desired characteristic, The preservation of industrially important microorganisms, The selection of induced mutants synthesizing improved levels of enzymes of industrial, Significance. The use of recombination systems for the improvement of industrial microorganisms, The economics and scale of microbial product fermentations. Different products need different fermentation processes. Fed-batch culture as the paradigm for many efficient microbial processes

Media for industrial fermentations, sterilization & Inocula Development: Introduction Typical media Energy sources Carbon sources Nitrogen sources Buffer Oxygen requirements Antifoams Medium sterilization The design of batch sterilization processes, design of continuous sterilization processes, Sterilization of the fermenter, feeds and air Filter design Development of inocula for bacterial processes, Development of inocula for fungal processes, Development of inocula for streptomycete processes, aseptic inoculation of plant fermenter


Control of Fermentations: An Industrial Perspective: Introduction Basic components of on-line process monitoring and control Enzymes- Transducers, Applications reported in the literature, Requirement for control Sensors Controller - Design of a fermentation control system, Fermenter control specification, Control of Incubation Advanced Incubation Control, Other advanced fermentation control options, Bioprocess scale up: Concerns and criteria: Introduction, Scale up concerns of microbial, mammalian and plant cell processes, Scale up criteria, Selection of scale up criteria, Scale up of genetically engineered cell culture fermentation

References

1. El-Mansi E.M.T. and Bryce C.F.A. ‘Fermentation Microbiology and Biotechnology’
2. Stanbury P.F. and Whitaker A. ‘Principles of Fermentation Technology’
CBE2. Advanced Biomaterials

Introduction to Biomaterials: Definition and Characteristics of biomaterials according to US Pharmacopeia; Classes of biomaterials; Structure and properties of synthetic biomaterials: Bonding and crystal structure of metals and ceramics, Bio-polymers and types of polymerization, Composite materials, Physical, chemical, and mechanical properties; Structure and Properties of Biological Materials: Extracellular matrix, Hard and soft tissues, Interaction between cells and materials, In vitro and In vivo Evaluation and testing of biomaterials, characteristics for biomedical application; Characterization of biomaterials: Bulk properties, surface properties, mechanical properties, bio-inertness, Fundamentals of Manufacture and Processing of Biomaterials: relationship between material properties, processing methods and design; Molding, forging, casting, welding, hydrofoaming, Sintering: conventional, spark plasma; Design and development of bioreactor or bio-inspired methods for the production of structured biomaterials, challenges involved in developing shape-memory alloys; Modern techniques: Laser Assisted Net Shaping (LENS), Rapid Manufacturing techniques: Continuous 3D Printing, Fused Deposition, Modelling, Laser Sintering, Direct Laser Forming and Indirect Rapid Manufacture

Fundamentals of Synthesis and Processing of Polymers: methods of synthesis, Analysis of polymer surface characteristics; Synthesis of polymers with advanced properties for controlled drug delivery, targeted drug delivery; Biomimetics: processes, substances, devices, systems that imitate nature or copy biological systems, Efficient and active biomimetic materials with biological actuation, sensing, and conduction; Molecular Imprinting: chemical modification and organic and bioorganic synthesis, application of Biomaterials: Cardiovascular system, Dentistry, Bioadhesives, Ophthalmology, Orthopedics; Tissue Regeneration: Porous scaffolds for regenerative medicine: Design of new complex materials with hierarchical 3D structures and tailored mechanical and degradation properties; Trabecular metals, porous ceramics, synthetic and natural polymers; hard tissue and soft tissue regeneration

Nanomaterials: Synthesis, Characterization, Design and development for biomedical applications; Nanostructures of carbon; Biomedical Imaging – New materials for use as image enhancers and contrast agents, polymeric and nanoparticle-based contrast agents; Nanomaterials and quantum dots; Applications in protein and DNA delivery; Biosensors, Implant design and manufacture: Rapid Prototyping, sterilization; Regulatory approval; Informatics and modeling tools for the rational design and structure-properties development in biomaterials; New methods to access biocompatibility: low cost in vivo and in vitro models for reliability, accelerated testing, failure analysis, imaging, and improved understanding of the biology-biomaterials interface.

Reference

4. D. L. Wise et al. (Eds.): Encyclopedic handbook of Biomaterials and Bioengineering (4Vols.), Marcel Dekker, New York, 1995
**CBE3. Genomics and Proteomics**

Introduction to Genomics and Proteomics, Human Genome project, sequencing strategies for whole genome analysis, sequence data analysis. The Structure, function and evolution of human genome, strategies for large scale sequencing, comparative Genomics: Protein evolution from exon shuffling, Protein structural, genomics, Gene function by sequence comparison, Global expression profiling: whole genome analysis of mRNA and protein expression, microarray analysis, types of microarrays and their applications, Functional genomics

High through put technologies in genomics, Next Gen sequencing, Pyrogen sequencing Capillary electrophoresis, SNPs and whole genome scans, Microarrays, disease genes, association studies, toxic genomics, Pharmacogenomics, Metagenomics, Applications of Genomics in drug discovery, molecular diagnostics, New target discovery, gene knockouts and miRNAs, Genomics of cancer and autoimmune diseases case studies

Proteomics; Protein structure, secondary structure and super-secondary structure, Mechanisms of protein folding, tertiary folds. Formation of oligomers, Relationship between protein structure and function, Prions, Structure prediction and human proteomics, Mutant proteins. Use of computer simulations and knowledge-based methods in the design process. De-novo design; making use of databases of sequence and structure. Protein structure and drug discovery, Proteins in disease


**References**

   [http://www.oup.com/uk/orc/bin/9780199265114/resources/figures/](http://www.oup.com/uk/orc/bin/9780199265114/resources/figures/)
13. SCBEncence, Human Genome special issue [http://www.sCBEncemag.org/content/vol291/issue5507/index.atl](http://www.sCBEncemag.org/content/vol291/issue5507/index.atl)
CBE4. Advanced Downstream Processing

Role of Downstream Processing in Biotechnology: Bio-molecules of commercial importance – Organic acids and alcohols, antibiotics, vaccines, steroids, vitamins, enzymes, proteins, antibodies etc, major contaminants, requirement of purification, Pitfalls and challenges in bio-separation processes, Product quality requirements, Regulatory aspects and validation, Economics of downstream processing, membrane based separation techniques: Membrane based separations- micro and ultra filtration theory, resistance in series model, other models for membrane separations, membrane modules, pervaporation, dialysis, design and configuration of membrane separation equipment, Molecular properties and selection of separation conditions, Equilibrium calculations

Product purification / Enrichment Extraction-Solvent selection and equipment design in extraction processes, aqueous two phase extraction, supercritical extraction, Precipitation - using salts, organic solvents, and polymers, crystallization of small and large biomolecules, product Resolution / Fractionation Adsorptive separation- Definition; Types of adsorption; adsorbents types, their preparation and properties; Types of adsorption isotherms and their importance Chromatographic Separations-Mechanism and modes of chromatographic separation, Reverse Phase, Hydrophobic interaction, Size exclusion, Affinity, Ion exchange, Gel Filtration, Equilibrium theory and column design, Process configurations (packed bed, expanded bed, simulated moving beds) Electrophoretic Separations-Various electrophoresis techniques, capillary electrophoresis Hybrid separation technologies- Membrane chromatography, electro chromatography etc, polishing of bioproducts

Downstream processing: overall strategy: Process integration-combining many bioseparation techniques, computed aided design, design and scale up of process-from biomass to product, emerging trends like pseudo-affinity chromatography, metal ion affinity chromatography, inclusion bodies-processing and refolding, case studies: Protein purification-sources of proteins (microbes, plants and animal sources using classical and modern biotechnology), Conventional strategies, associated problems, new trends, large scale separation and purification of E. coli, yeast and mammalian proteins; other examples: Baker's yeast, Ethanol, Power alcohol, Citric acid, Gluconic acid, Penicillin, Streptomycin, Insulin, Casein, interferon, Recombinant products

References

3. Aenjo J.A. and J.Hong, Separation, Recovery and Purification in Biotechnology
7. C.A. Costa and J.S. Cabral, Kluwer, Chromatographic and Membrane Processes in Biotechnology Academic Publisher
8. J.P. Hamel, J.B. Hunter and S.K. Sikdar, Downstream Processing, American Chemical Society
9. M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, Protein Purification, American Chemical Society, Verlag
CBE5. Biofuel and Bioenergy

Energy resources and their utilization: Energy sources, present scenario, energy demand, Energy supply, Energy planning, Energy parameters (energy intensity, energy-GDP elasticity), conventional and renewable sources, Renewable Energy: Introduction to various sources of energy, biofuel, Solar thermal, Photovoltaic, Water power, Wind energy, Biomass, Ocean thermal, Tidal and wave energy, Geothermal energy, Hydrogen energy systems, Fuel cells, biofuel – Biodiesel Definition, advantages of biodiesel, properties of biodiesel, feedstocks - jatropha, Karanja, Neem, plantation, Transesterification, process issues, homogeneous and heterogeneous catalysis, biodiesel from microalgae, algae cultivation, types of photobioreactor, Indian perspective, biofuel – Bio-alcohols Feedstock for alcohol fuels, common methods for alcohol production, ethanol production from lignocellulosic materials, pretreatment-dilute acid, hot water, steam explosion, Ammonia; enzymatic hydrolysis, detoxification, fermentation, butanol fermentation, challenges in ethanol and butanol production, case studies, concept of biorefinery


References

3. Rai G.D, Non-Conventional energy Source, Khanna Publishers, New Delhi, 2004
CBE 6. Advanced Genetic Engineering

Agarose gel electrophoresis, DNA hybridization, Southern Blotting, PCR-design and optimization, Reverse Transcriptase PCR, Real Time PCR, micro arrays. Enzymes used in GE: DNA modifying enzymes, restriction enzymes, modifying enzymes, DNA ligase, polymerase for GE, Cloning vectors, Plasmids, Multiple cloning sites, selection markers, lambda phage, phgemids, cosmids, M13 vectors, vectors for cloning in eukaryotic cells, Expression Vectors, artificial chromosomes (BACs, YACs)

Overview of cloning, Construction of Genomic libraries, random, arrayed and ordered libraries C-DNA library, DNA cloning, cDNA synthesis, amplification of gene libraries, isolation, selection of recombinants various cloning strategies, Screening of recombinant clones by hybridization, by PCR and by immunodetection, techniques of DNA sequencing, artificial DNA synthesis, PCR cloning

Gene transfer technologies, Transformation, Transfection, Translocation, Conjugation. Modification of bacteria and viruses: live vaccines, transgenesis and cloning, Animal transgenesis, Application of transgenic animals, transgenic plants and their applications, Applications of rDNA technology in health and agriculture: Humulin, Hep B, factor VIII, DNA diagnostics, BT cotton, Golden rice etc, DNA markers for improvement of quality and yield of crops. RFLP, RAPD, AFLP, Gene therapy, Human genome project

References

1. Primrose and Twyanman, Principles of Gene manipulation and Genomics (Blackwell Publishers)
2. Dale, J. W. and Schantz M.V. From genes to genomes: concepts and applications of DNA technology by (Wiley Publishers.)
3. Winnacker, From Genes to clones, PANIMA.
5. Sambrook, et al Molecular cloning
CBE 7. Nutrition and Food Processing

Human nutritional Requirements – Development and Recent Concepts. Methods of determining human nutrient need, Basic terms and concepts in human nutrition Guidelines, Recommendations & Development of International and National Nutritional Requirements, Translation of nutritional requirements into Dietary Guidelines, Significance of body composition and changes through the life cycle, Methods for assessing body composition (both classical and recent) and their applications; Components of energy requirements: BMR, RMR, thermic effect of feeding, physical activity. Factors affecting energy requirements, methods of measuring energy expenditure, Estimating energy requirements of individuals and groups, Regulation of energy metabolism and body weight: Control of food intake – role of leptin and other hormones

Nutritional significance of Biomolecules: Carbohydrates: Review of nutritional significance of carbohydrates and changing trends in dietary intake of different types of carbohydrates and their implications Dietary fibre: Types, sources, role and mechanism of action Resistant starch Proteins: Overview of role of muscle, liver and GI tract in protein metabolism Amino acid and peptide transporters Therapeutic applications of specific amino acids Peptides of physiological significance Proteins, amino acids and gene expression; Lipids: Nutritional significance of fatty acids – SFA, MUFA, And PUFA: functions and deficiency Role of n-3 and n-6 fatty acids, Prostaglandins, Trans Fatty Acids Conjugated linoleic acid Nutritional Requirements and dietary guidelines (International and National) for visible and invisible fats in diets. Lipids and gene expression Vitamins (A, D4, D10, E3, E8, K3, K8)historical background Structure and chemistry Food sources Metabolism (digestion, absorption, transport, storage and elimination), Bioavailability and factors affecting bioavailability, Biochemical and physiological functions, Assessment of status Interaction with other nutrients, regulation of gene expression (wherever applicable) Pharmacological and therapeutic effects

Introduction to Physical and chemicals methods of food preservation: Principles and methods of food preservation- Refrigeration, Freezing, heating, dehydration, drying, canning, extrusion cooking, hydrostatic pressure cooking, dielectric heating, microwave processing, aseptic processing, juices and concentrates, membrane technology, additives, irradiation. Storage of food, modified atmosphere packaging advanced Food Processing Role of Enzymes in Food Processing: Starch and sugar conversion processes or baking by amylases; de-oxygenation and desugaring by glucose oxidase; beer mashing and chill-proofing or cheese making by proteases and various other enzyme catalytic actions in food processing. Enzyme in bakery and cereal products, production of pectinases and utilization in food Processing

Technologies for Food Ingredients: Technologies used for microbial production of food ingredients, Biotechnology of microbial polysaccharides in food, Microbial biotechnology of food flavor production, microbial production of oils and fats, food applications of algae, butanol production from agricultural biomass, concept of public nutrition Relationship between health and nutrition. Role of public nutritionists in the health care Delivery Sectors and Public Policies relevant to nutrition and health; Primary Health Care of the Community. National Health Care Delivery System Determinants of Health Status, indicators of Health population Dynamic, demographic transition population structure Fertility behavior Population policy Fertility inter-relationship between Nutrition and Quality of Life
References

1. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E Levin, Food Biotechnology (Second Edition)–Taylor and Francis
2. Frazier, Food Microbiology,
CBE8. Herbal Drug Technology

General Introduction: Definition, source of herbal raw materials, identification, authentication, standardization of medicinal plants as per WHO guidelines & different herbal pharmacopoeias. Collection and processing of herbal drugs, Seasonal & geographical variations; natural & artificial drying methods, Packaging & labeling of herbal drugs prior to extraction, standardizations: Determination of physical and chemical constants such as extractive values, moisture content, volatile oil content, ash values, bitterness value and foreign matters applicable to the various herbal drugs, herbal Formulations: Principle, methods, single herb formulation, poly-herbal formulation & their merits and demerits. Standardization of various herbal formulations. Stability testing, Characterization, Bioavailability, analysis of Bioactive Components of Natural Sources: Phytochemical standardization of raw herbal extracts and their formulation by using TLC, HPTLC, GC, HPLC, UV & IR techniques. Heavy metal contaminations, pesticides, aflatoxins, microbial, nutraceuticals, Functional foods, regulations, DISHE, Types of nutraceuticals Supplementation, case examples Chyavanprash, shatavari etc, WHO GMP

Plant Tissue Culture Techniques & its Application in Pharmacy: Introduction, techniques of initiation and maintenance of various types of cultures. Immobilized pt cell techniques & biotransformation studies including recent developments in production of biological active constituents in static, suspension and hairy root cultures. Molecular methods in Herbal Drug standardizations like DNA fingerprinting and microarrays

Reference

1. S.S. Agrawal & M. Paridhavi, Herbal Drug Technology
3. Peach & Tracey, Modern Methods of Plant Analysis
4. S.S. Purohit, Biotechnology
5. Pulok K. Mukherjee, Quality control of herbal drugs: an approach to evaluation of botanicals
6. C.K. Kokate, A.P. Purohit and S.B. Gokhale, Pharmacognosy
CBE9. Enzyme Technology

Historical aspect of enzyme, Nomenclature and classification of enzyme, Enzyme cofactors - prosthetic groups, coenzymes, co-substrates, Role of Metal ions in enzyme catalyzed reaction, structure of enzymes - the monomeric and oligomeric enzymes. Concept of Active Site , Lock and Key and Induced Fit hypotheses. Multienzyme systems - basic concepts and significance with examples, structural aspects of pyruvate dehydrogenase and fatty acid synthetase, Isoenzymes - basic concepts with examples and their significance to the cells and to the medical field; Basic concept of enzyme catalysis - activation energy barrier and the transition state theory, Catalytic mechanisms in Chemistry and in Enzymes - acid-base, covalent and electrochemical reactions. Factors enhancing the catalytic efficiency of enzymes proximity and orientation, orbital steering, distortion and strain. Functional groups involved in the catalytic mechanisms – example of chymotrypsin, Isolation and purification of enzyme, criteria’s of purity of enzyme, Enzyme turnover: Kinetics of enzyme turnover. Measurement of enzyme turnover, Ks and Kd. Correlation between the rates of enzyme turnover and structure and function of enzymes, significance of enzyme turnover.


Immobilization of enzymes: - Introduction, Methods of immobilization, kinetics of immobilized enzymes & application in production of L-amino acids, Other uses of immobilized enzyme, Industrial enzymes: like glucose-isomerase, cellulases, pectinases etc., their importance, source and production, enzyme based biosensors: Introduction to biosensors, Classification of biosensors based on various transducers, different biocomponents employed for the construction of biosensor of the sensor, Selected examples and further development of biosensors

References

1. Lubert stryer Biochemistry, Freeman WH & Company, New York
5. I.A.L. Lehninger, DL Netz, MM Cox Principles of Biochemistry, CBS Publishers and Distributors
CBE10. Alcohol and Brewery Technology

An overview of Brewing: Introduction, Raw Materials: Barley, Hops, Water, Yeast, outline of the Brewing steps, Malting, Milling and Adjunct Use, Mashing, Wort separation, Wort boiling, Trub removal, Wort cooling/Aeration, Yeast handling, Yeast pitching, Fermentation, Yeast removal, Aging, Clarification, packaging warehousing and distillation, vine cultivation: Pruning the vines; Methods of cultivation. Vine Pests & Diseases: Vine diseases; Vineyard pests; Phylloxera; Bacterial diseases of the Grapevine, grapevine and its varieties including Indian Varieties of grapes: white wine grape Red wine grape varieties, Adjuncts: Introduction, Corn Grits, Rice, Barley, Sorghum, Refined Corn Starch, wheat starch, cereals, liquid adjuncts, Malt from cereals other than barley. Wheat Malt, Oats and Rye Malt, Sorghum

Malt Production drying of the intake grain, storage, Screening of the barley to produce an even size corn, dust removal etc. Two or three immersions under water, design of kiln Beer Production: Fermentation, Maturation, Filtration, Stabilization Filling the beer: Glass Bottles, PET, Cans, Kegs, Cleaning and disinfection Water usage in the Brewery, Brewery water consumption, Brewery water, Calgary’s: Brewing water, water standards: chemical and microbial for ingredient use and influence of inorganic ions from water on Beer Quality, ingredient effect of ions on Beer flavor and quality, control of pH, water treatment systems; processing: Equipment configuration, milling, mashing Lautering, Boiling time, Fermentation Temperature, Maturation time, filtration, Packaging, Marketing, Cultural Origins of style, Analytical and Sensor variables, Beer style guidelines, analysis, tasting &, Brewing Beer. The Beer Styles-Ales British Origin, Irish Original, German Origin, Belgian and French Origin, Lager Beer, European- Germanic origin, North American Origin

Sugar cane molasses, beet molasses and sweet Sorghum: Composition and Usage, Grain Milling and Cooking for Alcohol Production: Designing for the Options in Dry Milling Wet Milling and Mash Preparation, Molasses dilution practices adopted and design of diluter, quality of dilution water used, pre clarification of molasses advantages and draw back, molasses sterilization/pasteurization, Batch Fermentation and Fermenter Design, Continuous Ethanol Fermentation, Management, process of Batch fermentation, factor influencing efficiency of fermentation, characteristics of Batch Fermentation Process, Control over fermentation

operation, contamination control, design and material of construction of fermenters, maintenance of fermenter and operational conditions on plant scale, flow sheet of Batch Fermentation process, Efficiency of Fermentation and Attenuation data calculations – Related examples and solutions, distilled Beverage Production: Unique Aspects ,Whiskey: Grain Mashing and Fermentation ,Beverage Alcohol Distillation ,Whiskies Around the World Vodka, Gin, and Flavoured Spirits ,Rum: Fermentation and Distillation

References

3. Satyanarayana Rao, Alcoholometry
4. A.C. Chatterjee, Handbook of Fermentation and Distillation
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**CBE 11. Stem Cell and Cancer Biology**

Introduction to stem cell biology and regenerative medicine; Definitions: stem cell, progenitor cells, precursor cells, transit amplifying cells; General properties of stem cells; Defining Totipotency, pluripotency, multipotency, unipotency of stem cells; Differentiation and trans-differentiation. Stem cell niche, growth and differentiation factors. Stem cell lineage tracing: adult and embryonic stem cells, pluripotent stem cells, germ line, neuronal stem cells, hematopoietic stem cells, pancreatic stem cells, cancer stem cells. Isolation and culture of various stem cell types, stem cell research: Techniques. Lineage tracing technique, gene knock-out and knock-in studies, inducible gene expression or repression, DNA sequencing, Chromatin Immunoprecipitation, Fluorescent-Activated Cell Sorting (FACS), Immunolabeling and Magnetic separation (AUTOMACS Miltenyi Biotech, Dynal Biotech Dynal technology), confocal microscopy

Stem cell research: legal and ethical issues; Guidelines for stem cells research and therapy in India: introduction, general mechanisms, aim and scope, categorization of research on stem cells, clinical application of umbilical cord blood stem cells, criteria on use of placental / fetal stem cells for research, approval of procurement. Human embryonic stem cell Bank: preservation and distribution of cells. International collaboration and patent issues, Ethics for stem cell research, stem cells and degenerative diseases: Introduction to Parkinson disease, diabetes, burn, retinal replacement therapy, cardiomyopathies; derangement patterns, clinical manifestations: symptoms and diagnosis; treatment; Application of stem cells in degenerative medicine: Stem cell therapy; Cell replacement and cell regeneration: principles and techniques; Cell and tissue regeneration; Regeneration of different types of stem cells for different degenerative diseases; gene therapy

Cancer Biology: Cell cycle, Cell proliferation, Differentiation and Apoptosis, Initiation, Progression: tumor microenvironment, translational and transcriptional mechanisms Invasion and metastasis; Cancer Genetics: Oncogenes, Tumor suppressor genes; Tumor immunology: dysregulation of signal transduction, cancer therapy: Molecular diagnosis: PCR, FISH, RFLP and Southern Blotting, Microarray technology, Biomarkers, Therapy: Chemotherapeutic agents, endocrine therapy, Biotherapeutics, Stem cell therapy

**References**

CBE12. Advanced Bioinformatics

Macromolecular Structure as Protein - Primary, Secondary, Supersecondary, Tertiary and Quaternary structure Nucleic acid–DNA and RNA, Carbohydrates, 3D Viral structures,
Protein–protein interactions, protein–DNA interactions, DNA binding proteins, Different forces involved in the interactions, Methods to study 3D structure - Principles of crystallography, Principles of protein folding and methods to study protein folding, Mass spectrometry and computational approaches in structural biology

Introduction to cheminformatics, History and evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular modeling and structure elucidation, chemical database design, basic database theory, Types of database system, Relational model, Object based model, Structure databases, Reaction databases, Chemical abstracts file, Crystallographic databases, Inorganic Crystal Structure Database (ICSD), Cambridge Structural Database (CSD)

Structure representation systems, 2D and 3D structures, General introduction to chemical structure-hybridization, tetrahedron geometry etc, Wiswesser Line Notation and Applications ROSDAL and Applications, the SMILES coding and Applications, Reaction transformations notation like SMIRKS, characterization of chemicals by Class & by Pharmacophore, application in HTS Analysis as Introduction to pharmocophore, Identification of pharmocophore features Building pharmocophore hypothesis, Searching databases using pharmocophores, Introduction to Quantitative Structure Activity Relationship

References

4. Chemometrics and Chemoinformatics by Barry K. Lavine, ACS Symposium series 894
CBE13. Metabolic Engineering

Introduction, Synthesis of primary metabolites, Biosynthesis of secondary metabolites, Bioconversions, Regulation of enzyme production, Induction-Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feed back regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, amino acid regulation of RNA synthesis, energy charge, regulation, amino acid regulation of RNA synthesis, energy charge, regulation, permeability control passive diffusion, active transport, group transportation, biosynthesis of primary metabolites: Alteration of feed back regulation, limiting accumulation of end products, feedback, resistant mutants, alteration of permeability, metabolites; Biosynthesis of secondary metabolites: Precursor effects, prophophase, idiophase relationship, enzyme induction, feedback regulation, catabolite, regulation by passing control of secondary metabolism, producers of secondary metabolites

Bioconversions: Advantages of Bioconversions, specificity, yields, factors important to bioconversion, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances, regulation of enzyme production, Strain selection, improving fermentation, recognising growth cycle peak, induction, feed back repression, catabolite repression, mutants resistant to repression, gene dosage, case studies in metabolic engineering, enhancing yield of shikimate, APS and other economically important secondary metabolites. Industrial applications

Metabolic Engineering, Cellular Metabolism, Solute transport processes in the cell, Catabolism and metabolic fueling processes, Biosynthesis of cellular building blocks, Polymerization of building blocks to macromolecules, Rare metabolic conversions, Balances and reaction models, Growth nutrients and diversity, Mass balances, rates and experiments, Data reconciliation and error detection, Black box models for growth and product formation, Metabolic models for growth and product formation, A thermodynamic description of microbial growth and product formation, Bacterial transcriptional regulation of metabolism, Transcribing metabolism genes, Regulation of secondary metabolism in bacteria, A synthetic approach to transcriptional regulatory engineering, Modeling tools for metabolic engineering, Metabolic flux analysis, Metabolic control analysis, Structure and flux analysis of metabolic networks, Constraint-based genome-scale models of cellular metabolism, Multiscale modeling of metabolic regulation, Validation of metabolic models, Developing appropriate hosts for metabolic engineering, Escherichia coli, Yeast, Bacillus subtilis, Streptomyces, Filamentous fungi, Mammalian cells, Evolutionary tools in metabolic engineering, Evolutionary engineering of industrially important microbial phenotypes, Improving protein functions by directed evolution, Engineering DNA and RNA regulatory regions through random mutagenesis and screening, Evolving pathways and genomes for the production of natural and novel compounds, Models predicting optimized strategies for protein evolution, Gene expression tools for metabolic pathway engineering, Low-copy number plasmids, Chromosomal engineering strategies, Regulating gene expression through engineered RNA technologies, Tools designed to regulate translational efficiency, Metabolic engineering of the secretory processing pathway in eukaryotes, Engineering multifunctional enzyme systems for optimized metabolite transfer between sequential conversion steps, Application of emerging technologies, Genome-wide technologies – DNA microarrays, phenotypic microarrays and proteomics, Monitoring and measuring the metabolome, Tools for experimentally determining flux through pathways, GC-MS, AEX-HPLC-ESI-MS, Applications, Biosynthesis of fine chemicals, Drug discovery, Biosynthesis of alternative fuels
References

CBE14. STRUCTURAL BIOLOGY

Introduction to structural biology: interactions in biological systems, Intra and inter molecular forces, electrostatic interactions and Hydrogen bonding interactions, van der Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weak interactions, structure of Proteins: Conformational properties of polypeptides, Primary and secondary structure α-helix, β-sheet structures etc., Tertiary and quaternary structure, Structural features of membrane proteins, Secondary and tertiary structure prediction of protein conformation, Protein Folding Mechanisms, Chaperones and Chaperonins

Multiple equilibrium: Titration of proteins to evaluate net and total charge, Scatchard and Hill plots, Folding-unfolding equilibrium and denaturation of proteins, Effect of temperature and solvent conditions on the thermodynamics of protein folding-unfolding equilibrium, Kinetics of protein folding, nucleic Acid Structure : Nucleic Acid Structure: DNA/RNA, Protein/Nucleic Acid Interactions, Genome Structure: Nucleosomes, Chromatin, Chromosome

Techniques for the study of Macromolecular Structure: Analytical Ultracentrifugation : Sedimentation velocity and equilibrium, determination of molecular weights, Micro calorimetry (DSC and ITC) and its application, Circular Dichroism spectroscopy, UV, visible and Fluorescence spectroscopy, X-ray Diffraction, Diffraction: overview, crystallization, nuclear Magnetic Resonance (NMR),Mass Spectrometry Mass spectroscopy: application to complex proteins. MALDI TOF, Gel filtration analysis of ligand binding association equilibria and kinetics

References

CBE15. Nanotechnology

Introduction: Overview of nanoscience, Theory, definitions and history; Societal implications of nanoscience – nanotoxicology, Physical basis and principles of nanotechnology: Overview of chemistry fundamentals for nanotechnology, Engineering principles for nanotechnology; Self-assembly and overview of Complex Adaptive Systems (CAS), structure: 0D, 1D, 2D and 3D nanomaterials; Properties at nanoscale: electrical, optical, mechanical, Energy at nanoscale – Surface energy, The Material Continuum- Basic quantum mechanics; Different classes of Nanomaterials – Metal and Semiconductor Nanomaterials, Quantum Dots, Wells and Wires, Molecule to bulk transitions, Bucky balls and Carbon Nanotubes, Nanofabrication and Synthesis of nanomaterials: “Top-down” approach: Nanolithography, CVD, MEMS; “Wet deposition” techniques (LB, spincoating, dip-coating); “Bottom up approach” – Sol-gel processing, colloidal, nanoparticles, organic nanomaterials and self assembly

Characterization of nanomaterials; Analysis and metrology techniques in nanotechnology; Diffraction techniques, spectroscopy and modeling; Imaging techniques: Scanning and transmission electron microscopy; Scanning probe microscopy – atomic force microscopy; Traditional surface and materials analysis techniques, industry applications: Nanomaterials in consumer markets, Electronics, photonics: solar energy conversion, storage and catalysis, nano-opto, MEMS, NEMS, Microarray, nano-bio applications, Computing technologies - present and future, Nano medicine; MEMS - Micro Electro Mechanical Systems: Overview and history of development; Industry applications, Challenges and future development

Carbon Nanotube Technologies (CNT): From graphite to buckyballs to CNT, Carbon nanotube applications and MWNT, Fabricating carbon nanotubes and nano-wall structures, Key applications of CNT and MWNT, semiconductors: Moore's Law, history 1950-2025; Materials requirements for silicon; Quantum effects - desired or not, Nanofabrication techniques in semiconductors, Quantum computing, Basic physics and Moore's Law, Quantum computing algorithms / quantum informatics, Quantum devices - e.g. quantum dots, Applications of qdots

References

4. A.Nabok, Organic and Inorganic Nanostructures, Artech House 2005
CBE16. Intellectual Property Rights and Bioethics

Ethics, definition, ICMR guidelines for ethics in biomedical research, consent form, composition of ethics committee, Ethics at workplace, various scenarios, defining the moral standards of right and wrong, morals and laws, an organizational perspective, legal vs. ethical, ethics in business, ethics and profits, Bioethics, Case studies: ethics in life sciences, ethics in medicine, ethics in biotechnology, recombinant DNA, ethics in food biotechnology, agricultural biotechnology, environmental ethics, animal ethics, discuss moral righteous of an action, procedure or policy, moral wrongness of the action, philosophical Aspects of Intellectual Property Laws, Basic Principles of Patent Law, Patent Application procedure, Drafting of a Patent Specification, Patent, objects of patent law, benefits of patenting, remedies against infringement


References

1. Frederic H. Erbisch, Karim M. Maredia, Intellectual property rights in agricultural biotechnology
2. Jonathan Morris -The ethics of biotechnology
3. Karla C. Shippey -A short course in international intellectual property rights
CBE17. Analytical Chemistry

Principle of Analytical Methods: Quantitative analysis, Precipitation, types of precipitates, impurities, co-precipitation, post-precipitation, conditions for participation, precipitation from homogeneous solution, Gravimetric determination of Fe, Ni and Cu, calculations, volumetric analysis: Acid base titrations, Indicators, Oxidation-reduction titrations, Complexation using ligands, complexometric titration with EDTA, metal ion indicators, spectrophotometry: Molecular Spectrophotometry: Absorption spectra, Lamberts Law, Beer’s Law - Combined law equation, Derivations from Beer’s Law, quantitative analysis, Spectrophotometer (UV and Visible)- Principle, single beam and double beam, factors influencing the absorption spectra, overview of empirical rules, solvent perturbation method; spectrofluorimetry: Principle and significance, Colorimetry Atomic absorption Spectrophotometry: Principle, instrumentation details, various interferences in atomic absorption spectroscopy and various applications of absorption spectroscopy in biotechnology


Chromatography: Theory of chromatography, Retention, plate theory, separation with a stationary bed column, planar chromatography, paper chromatography, RF value, thin layer chromatography, identification of spots by spraying and other methods Gas Chromatography: Principle, stationary phase for column, mobile phase, chromatogram, qualitative analysis, quantitative analysis, retention time, retention volume, capacity factor, area, normalization method, HPCL: Principles of high performance liquid chromatography, stationary phases, eluting solvents, quantitative applications, Interface of mass-spectra with liquid and gas chromatography (LC-MS and GC-MS), X-ray crystallography and X-ray diffraction X-ray diffraction and Bragg’s law, crystal systems, point groups and space group, application for molecular structure determination, nuclear Magnetic resonance :Chemical shifts, coupling constants, Karplus equation and torsion angles, application to structure determination of biomolecules, phenomena of resonance, diamagnetic shielding, anisotropy, free induction decay (FID), population distribution of nuclei, and prediction of NMR spectra on the basis of (n+ 1) rule for basic class of compounds, Overview of electron spin resonance spectroscopy (ESR) and magnetic resonance imaging (MRI)

References

3. Willand Merrit and Dean, Instrumental methods of analysis, Caps publications & Distribution, 1999
CBE 18. Instrumentation and Process Control

Review of basic concepts Laplace transforms, solving differential equations, ideal forcing functions – step, impulse, sinusoid and their characteristics, Process variables, input variables, set point, Load variables, open Loop Systems: Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series- Interacting and non-interacting system, linearization and its application in process control, second order systems and their dynamics, transportation lag

Closed Loop Systems: Closed loop control systems, Basic control actions-characteristics of two position, three positions, proportional, single speed floating, Integral and derivative control modes- PI, PD and PID control modes, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, transient response of closed-loop control systems, types of controllers and final control element: Principles of pneumatic, hydraulic and electronic controllers, problems on pneumatic, hydraulic and electronic controllers to realize various control actions, I/P Converter-pneumatic, electric and hydraulic actuators- valve positioner- control valves- characteristics of control valves - valve body-Globe, butterfly, diaphragm, Ball valves- Control valve sizing - Cavitation, flashing problem

Stability analysis: Stability of closed loop control system, Routh’s test, Root locus analysis, Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Tuning process reaction curve method - continuous, oscillation method-damped oscillation method-problems, multi-loop Control Systems: Introduction to advanced control systems, cascade control, feed forward control, model predictive control, split range control, ratio control, and adaptive control, multivariate control of biochemical processes, control and automation of fermenter operation. Computer aided design of control systems Formulating process models, input-out models, state-space model, transfer function model, Computer aided design of control systems- use of MATLAB, Supervisory control (SCADA), introduction to neural and fuzzy control

References

3. J. R. Leigh: “Modeling and control in bioprocesses”
CBE19. Thermodynamics

Availability, Irreversibility and Second-Law Efficiency for a closed System and steady state Control
Volume, Availability Analysis of Simple Cycles, Thermodynamic
Potentials, Maxwell relations, Generalized relation for changes in Entropy, Internal
Energy and Enthalpy, Generalized Relations for Cp and Cv, Clausius Claypeyron
Equation, Joule-Thomson Coefficient, Bridgman Tables for thermodynamic relations, different
Equations of State, Fugacity, Compressibility, Principle of Corresponding
States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient,
Lee-Kesler generalized three parameter tables, Fundamental property relations for
systems of variable composition, partial molar properities, Real gas mixtures, Ideal
solution of real gases and liquids, Equilibrium in multi phase systems, Gibbs phase rule
for non-reactive components

Thermo chemistry, first Law analysis of reacting systems, Adiabatic Flame temperature,
Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion
for reaction equilibrium composition, microstates and Macrostates, Thermodynamic probability,
Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation
of heat and work, Evaluation of entropy, Partition function, Calculation of the
Microscopic properties from partition functions, Collision Theory and Transport
properties, conjugate Fluxes and Forces, Entropy Production, Onsager’s Reciprocity relations,
thermo-electric phenomena and formulations. Thermodynamics of High-Gas flow, thermodynamics
of biological systems: Energy flows in biological systems, cellular thermodynamic reactions,
thermodynamic cycles, Gibb’s free energy and work obtainable from biological systems, study
interactions between living organism and surrounding quantitatively

References

5. Sonntag, R. E., and Vann Wylen, G, Introduction to Thermodynamics, Classical and Statistical, third
6. Sears, F. W. and Salinger G. I., Thermodynamics, Kinetic Theory and Statistical
8. Rao, Y. V. C., Postulational and Statistical thermodynamics, Allied Publisher Limited, New Delhi, 199
CBE 20. Strain Development

Economically important microorganisms, Industrial importance of microbial cultures, High Yielding and stable strains, maintenance and preservation of cultures for industrial use, industrial products produced by microorganisms - Enzymes (amylase, proteases), organic acids (lactic acid, citric acid, vinegar), amino acids (L-lysine, L-glutamic acid), food supplement and hormones. Production of important antibiotics - penicillin, streptomycin, erythromycin, bacitracin and tetracyclines, Production of Vitamins B12 & Ethyl alcohol, beer & wine. Baker's yeast production. Microbial transformation, Selective and enrichment techniques for isolation and screening of biotechnologically useful high yield microorganisms, Primary and secondary screening, Stability, Strain improvement through recombinant DNA technology, Bacterial genomes and basic functions, Mutations and phenotypes, Nature of mutations, mutagenesis, selection of mutants, Complementation and suppression, Transposes Conjugation Mechanisms of gene regulation

Techniques in molecular biology, Restriction enzymes, vectors for gene cloning, ligation, transformation, expression in various systems like bacteria, mammalian cells, Baculovirus etc, genomic and cDNA libraries, shotgun cloning, PCR cloning, Isolation screening and characterization of lipolytic, proteolytic, lignolytic, amylolytic microorganisms and enzymes such as cellulose, xylanase, laccase, etc, Screening of antibiotics producing bacteria from marine source and other sources, Bioassays for new products, media optimization and yield improvement, metabolic pathways and metabolic engineering

Strain improvement: Isolation from natural habitats, Rational selection of habitats, Isolation techniques, Preliminary characterization, Growth curve, growth rate, doubling time, Substrate utilization rate, Screening based on product of interest, Culture preservation, Stability checking. Long term, short term, High throughput techniques, Non culturable microbes, Why Unculturable, How to utilize such microbes, Related techniques, Isolation of genes of interest without microbe isolation, Classical strain improvement, Mutagenesis, Physical and chemical mutagenesis, Random/rational screening, Stability check, Establishment of phylogeny of mutants, High throughput techniques, Culture preservation, Adaptation, Classical methods, Chemostat operations, Mutant mining, Advantages, Techniques

References

3. S S Purohit, Microbiology Fundamentals and Applications