### B. Sc. - M. Sc. (Integrated) Biotechnology
#### 2016 Admission
#### SYLLABUS AND CREDIT LOAD
#### Semester wise distribution of courses

<table>
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<tr>
<th>Sl. No.</th>
<th>Catalogue No.</th>
<th>Title of the courses</th>
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### Distribution of credits - semester wise

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- Major courses - All Biot courses except optional, seminar, job training and research: 200
- Minor courses - Denoted with ‘**’
- Supporting courses - Denoted with ‘*’
- Non credit course - Denoted with #
**Biot.1101 Fundamentals of cell biology (2+1)**

*Theory*


*Practical*

Preparation of slides of different types of tissues in plants and animals, transverse section of roots, stems, leaves.

**Chem.1101 Fundamentals of chemistry* (3+0)**

*Theory*

Chemical bonding - types, energy changes, Werner’s theory, effective atomic numbers, isomerism, hybridisation and resonance, Valance shell electron repulsion theory, molecular orbital theory, linear combination of atomic orbitals method. Thermochemistry. Reaction kinetics. Determinations of order of simple reactions, equilibrium constant and reaction rates - Lindemann, collision and activated complex theories, complex reactions of first order, characteristics of consecutive, reversible and parallel reactions. Catalysis - theories of catalysis, concepts of promoters, inhibitors and poisoning. Physiosorption, chemisorption. Polymers. Colloids

**Micr. 1101 Fundamentals of microbiology** (2+1)

**Theory**

Practical

Media preparation, sterilization. Culturing methods, pure culture technique- serial dilution, plating, streaking and turbidity measurement. Staining techniques - simple staining, Gram staining, fungal staining. Antibiotic sensitivity test.

**Biot. 1102 Principles of molecular biology (2+0)**

**Theory**


**Stat.1101 Mathematics* (3+0)**

**Theory**

Comp.1101 Introduction to computers* (1+1)

Theory

Introduction to computer fundamentals, organization, low level and high level languages, permanent storage of number systems, flow charts and programming techniques (logic and algorithm) decimal to binary and vice-versa, binary coded decimal number. Database. Windows - Windows application, Word, Excel, Powerpoint and multimedia. Internet, electronic mail, UNIX & C.

Practical

Operating systems - components and selection techniques, file and disk management. Word processing - font, paragraph, page formatting, tables and columns, printing, tables, text boxes, graphics. Spread sheet - spread sheet layout, formatting and customizing data, formulas, functions and named ranges, charts, printing worksheets and charts. Internet browsing and using e-mail.

Biot.1103 Biodiversity (2+1)

Theory


Practical

Taxonomy of plants – representative species belonging to family Malvaceae, Compositae, Leguminosae, Solanaceae, Liliaceae. Developing protocols for molecular characterization of biodiversity. Describing biodiversity in terms of standard descriptors.
Phed.1101 Physical education (0+1)

SEMESTER II

Bich.1201 Biochemistry I** (2+1)

Theory


Practical


Biot.1204 Biophysics (3+0)

Theory

folding - denaturation, effects of temperature and solvent on the thermodynamics of protein folding - unfolding equilibrium. Kinetics of protein folding. Structure of Biological membranes; Lipids in biological membranes; Protein in biological membranes; molecular mechanics and dynamics; Structure of Polysaccharides. Nucleic acids- Structure and Conformation of DNA and RNA. Nucleic acid structure determination; Nucleic acid hybrids; Protein-nucleic acid interactions; Nucleic acid Interactions with ions, and drugs. Radio isotope techniques - nature of radiation sources, Radioactive decay, Units of radiation, Detection and measurements of radioactivity. Radiation damage to proteins, Applications ; LASER and its applications. Physical techniques and their applications in biology - UV - Visible and fluorescent spectroscopy, CD spectroscopy, NMR. spectroscopy; X-ray diffraction, Chromatographic techniques- Electrophoresis. Centrifugation and ultracentrifugation.

**Biot.1205 Cellular and developmental biology (2+1)**

*Theory*

General structure and constituents of plant cells, cell wall organization, synthesis assembly and turn over of cell wall components including membrane components, cell surface related functions, adhesion, cell-cell interactions and other communications, transport, excretion and role in cell division by mitosis and meiosis. Intracellular membranes-endoplasmic reticulum, nuclear envelope, microbodies, golgi apparatus, tonoplast, vacuoles, their molecular structure, synthesis and functions, cytoskeletal element, structure and functions of major organelles, chromosomes, chloroplasts, mitochondria, ribosomes in relation to cell growth and division. Specialized cells in various tissues, pollen biology, cell volume and genome and evolution, development of floral parts, fertilization, embryo and seed development, apomixis.

*Practical*

Examination of cell structure, organelle, floral parts, embryo sac and seeds of crop plants. Examination of chromosomes of crops. Mitosis and meiosis in crop plants. Isolation of nucleic acids-total DNA, RNA, organelle DNA, detection of Cot value. Isolation and quantification of proteins.
Biot.1206 Bioresources (1+1)

Theory


Practical

Identifying plants, animals and microbes based on utility. Field work for studying and documenting local biodiversity / bioresources. Comparison of past and present distribution of species, analysis of factors responsible for the decline of biodiversity. Study of agricultural biodiversity through visits to farms and meetings with farmer communities. Study of forest / wetland / arid zone, marine biodiversity through field visits/nature camps. Visits to institutions of relevance.
Biot.1207 Introduction to genomics and proteomics (2+1)

Theory


Practical

DNA sequencing methods, genetic map construction, DNA library construction and maintenance, map base cloning, gene expression analysis, microarray technology and analysis.

Pbgn.1201 Fundamentals of genetics** (2+1)

Theory

Practical


**Comp.1202 Computer applications** (1+1)


Networking of computer, NICNET, INFLIB NET. E - discussion forums, web designing, E - agriculture, Computer models in biology, Statistical, weather analysis and crop simulation models, Smart phone mobile apps in biology. Decision support systems, concepts, components and applications. Expert system and other information systems.

Practical


**Micr.1202 Applied Microbiology** (2+1)

Theory

Microbial genetics - transduction, transformation, conjugation and Hfr mapping, genetic recombination. Food microbiology - important microorganisms in food. Factors affecting microbial growth - pH, moisture, oxidation - reduction potential,

**Practical**

Analysis of spoiled food for microbes, quantitative analysis of milk by MBRT, preparation of fermented food, isolation and cultivation of *Rhizobium* from legumes, isolation of phosphate solubilizers from soil, assessment of VAM colonization, laboratory diagnosis of *E. coli*, antibiotic sensitivity assay, assessment of minimal inhibitory assay.

**SEMESTER III**

**Bich.2102 Biochemistry II***(2+1)**

**Theory**

Practical


**Biot.2108 Plant biotechnology (2+2)**

Theory


Practical

Plant tissue culture - micropropagation, embryo culture, haploid culture. Protoplast isolation and fusion, in vitro mutagenesis. Genetic transformation.

**Biot.2109 Structural and functional genomics and proteomics (2+1)**

Theory

Organisation of transcriptional units, mechanism of transcription in prokaryotes and eukaryotes, types of transcribed RNAs. RNA processing - methyl capping - poly adenylation, splicing sRNAs, ribozyme, structure of mRNA, synthesis and processing of rRNA and tRNA, mRNA editing. Ribosome structure and function. Nature of genetic code, deciphering genetic code, Wobble hypothesis, universalities and exceptions. Operon principle - negative and positive regulation of operon. Lac operon and trp

Practical

Gene expression and regulation in prokaryotes. DNA sequencing. Alignment of sequences, Dot plots, BLAST, FASTA, global sequence alignments, multiple sequence alignments, amino acid alignments - amino acid searches, gene prediction.

**Biot.2110 Food biotechnology (2+1)**

Theory

Practical

Method of plant cell culture, Preparation of starter culture, Preparation of beer, wine, tempeh, yoghurt, vinegar. Production of amylase, pectinase, proteases, flavour, colour by fermentation. Immobilization of enzymes.

**Crps.2101 Plant physiology** (2+1)

Theory


Practical


Biot.2111 Basics of Virology and Oncology (2+1)

Theory


Practical

Electron microscopic observations of ultrastructure of viruses. Plaque/focus formation assay of animal / plant viruses and / or animal / plant cell transfection by viruses. Microtitration - haemagglutination technique, immunodiffusion, immunoelectrophoresis, ELISA.

Biot.2112 Biosafety rules and regulations (1+0)

Theory

Convention on biological diversity, Cartagena protocol on biosafety, The Indian environment (protection) act. Ministry of environment and forests notification, Rules for the manufacture, use / import / export and storage of hazardous microorganisms / genetically engineered organisms or cells. Biosafety - general

**SEMESTER IV**

**Biot.2213 Enzymology and enzyme technology (2+2)**

*Theory*


*Practical*

Assay of enzyme activity, isolation and purification of urease, time course of enzymatic reaction, influence of substrate concentration on the rate of enzymatic reaction, effect of pH and temperature on the rate of enzyme reaction, specificity of enzyme action, inhibition of enzyme activity. Determination of $K_i$ values, molecular weight determination of enzyme by gel filtration, isozyme detection, immobilization, preparation of urease entrapped in alginate beads and determination of percent entrapment, study of the kinetics of the rate of urea hydrolysis by urease entrapped alginate beads, study of reusability and storage stability of urease entrapped alginate beads, immobilization of urease by covalent attachment to solid support.

Practical


Analytical techniques in biotechnology (2+1)


Practical

Preparation of solutions, buffers and dyes. Familiarization of different experimental techniques –microscopy, centrifugation - separation of macromolecules, chromatography, electrophoresis, spectrophotometry, ELISA, PCR, RAPD, AFLP RFLP etc.
Biot.2215 Bioinformatics (1+2)

Theory


Practical


Biot.2216 Genetic engineering I (2+2)

Theory


Practical

Isolation of nucleic acids, sequencing, experiments with cloning vectors, extraction and purification of plasmid DNA. Restriction, methylation and ligation reactions. Preparation and transformation of competent *E. coli*. Identification of recombinants.
Path.2201 Molecular diagnostics** (2+1)

Theory

G-banded chromosomal preparations for detection of autosomes of autosomal/sex chromosomal disorders. FISH for detections of translocations, inversions, PCR based diagnosis, Southern blot-based diagnosis, PCR-SSCP to detect mutations. SNP analysis for known SNPs. PAGE - band detection of enzyme variants. Immunodiagnostics. Production of monoclonal antibodies. Immunogenetics of mice-fusion of myeloma cells. Selection of hybrid-use of MoAb in diagnostics of TB. Avidin biotin technique in immunocytochemical staining. Immunofluorescence technique. Immunoblot analysis of antigens and allergens. ELISA for detection of Salmonella in food, antibodies to AIDS viruses.

Practical


Biot.2217 Nanobiotechnology (2+0)

Theory

Nanotechnology - definition, significance, properties (surface area, surface energy), characterization (TEM, SEM, AFM, XRD, DLS), Nanofabrication - top-down approaches (milling, FIB, photolithography, DPN, EBL, Nano contact printing), bottom approaches (Thermodynamic approach like sol - gel processing and reduction, kinetic approaches such as aerosol synthesis, spray pyrolysis), Nanobiotechnology and applications - diagnostic and therapeutic applications, supramolecular biochemistry (self assembly) bacterial S-layers, peptide nanotubes, nucleic acid templates for nano wires, biological motors, nano devices (F1-ATPase hybrid nano devices), MEMS and its biomedical applications (Biosensors). Case study: Biomimetic interfaces for a
multifunctional biosensor array, Quondam dots and tumour imaging, drug delivery, nano drug delivery systems (Nanoparticles as drug carriers, concept of theragnostics), application of nanotechnology in the food industry, agriculture, water technology and cosmetics.

**SEMESTER V**

**Biot.3118 Animal biotechnology (2+1)**

*Theory*


*Practical*

Preparation of media preparation of primary culture, maintenance of secondary culture, evaluation of culture dynamics. Cell synchronization - preservation and revival of cells. Use of animal viral vectors, expression vectors. Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Production of useful proteins.

**Resm.3101 Research methodology* (2+2)**

*Theory*

Research - definition, need for research, objectives, science vs technology. Chance discoveries, exploitation of chance opportunities, hypothesis, productive thinking, role of reasoning. Philosophy of science. Qualities, duties and responsibilities of a research worker. Categories of research - fundamental, basic,

Practical

Use of audio visual aids, photography, computer aided literature search, preparation of project proposals, research paper writing and formalities for submission, thesis writing, poster presentation, oral presentation, preparation of reports, popular articles, pamphlets, brochures. Communicative English - Listening - listen to a talk or conversation and understand the topic and main points. Speaking - narrate incidents and events (real or imaginary) in a logical sequence, present oral reports or summaries and make announcements clearly and confidently. Writing - Paragraph, letter, writing, resume etc. Expand notes into a piece of writing. Summarize or make notes from a given text.

Biot.3119 Chemical engineering (2+1)

Theory

transfer in biological reactions, determination of mass transfer co-efficient. Scale-up principles and criteria, different methods of scale-up. Instrumentation and control of bioprocesses.

Practical

Chemical kinetics: Determination of the rate law, orders of chemical reactions, determining rate constants for different types of chemical reactions, study of effect of change in concentration on the rate constant and reaction rate, determination of activation energy. Microbial kinetics: Determination of microbial growth rate, Doubling time and CFU’s for each growth stage. Fermentation Kinetics: Study of batch culture fermentation, Study of the effect of different parameters such as substrate type, substrate concentration, temperature and pH on the rate of fermentation.

Biot.3120 Genetic engineering II (2+2)

Theory


Practical

Biot.3121 Immunology (2+1)

Theory


Practical


Biot.3122 Stem cell and tissue engineering (2+1)

Theory

Stem cells - basic concepts and definitions, biology of stem cells and regenerative medicine, stem cells and niche (microenvironment), key regulatory mechanisms in maintenance of

Practical

Aseptic techniques, principles of cell culturing, cell line maintenance, Immunocytochemistry, ELISA - based assays for the endocytic pathways, Signal transduction or cell signaling using flow cytometry or western blotting, Conventional and real-time PCR.

Biot.3123 Intellectual Property Rights and Laws (2+0)

Theory


**SEMESTER VI**

**Biot.3224 Job Training (0+15)**

In this semester, the students will be attached to public or private research institute/industry involved in biotechnology activities. They will take part in the ongoing activities of the institute. At the end of the training, they have to submit a report. Grade point will be calculated based on the evaluation made by the institute and KAU.

Evaluation criteria:

- Research aptitude : 20 marks
- Involvement in training : 20 marks
- Capacity for data analysis and interpretation : 20 marks
- Maintenance of records : 10 marks
- Submission of Report : 20 marks
- Viva voce : 10 marks

**SEMESTER VII**

**Anhs.4101 Animal physiology** (2+1)

*Theory*

Homeostasis and membranes, cell function, respiration and gas exchange, cell permeability, blood and circulation, blood pressure, heart rate, osmoregulation, thermal physiology, energetics, metabolic rate, muscle physiology, nervous system, neuronal control and integration, neurophysiology, endocrine system, water and solutes, digestion, nutrition.
**Practical**

Erythrocyte Experiment - Spirometry and Respiratory Dynamics - Skeletal Muscle - Locomotion and Thermoregulation - Renal Function - Digestion.

**Biot.4125 Bioprocess technology (2+0)**

*Theory*


**Biot.4126 Ethics, economics and social implications of biotechnology (2+0)**

*Theory*

Biot.4127 Metabolomics (3+0)

Theory


Biot.4128 Environmental biotechnology (2+1)

Theory


Practical


Biot.4129 Biotechnology industry (2+1)

Theory

Technology development, drug related technology development. Toxicological studies, bioequivalence, clinical trials - Phase I, Phase II and Phase III, approved bodies and agencies. Scale - up, semi - commercialization and commercialization - practical aspects and problems. Significance of transfer of technology. Managing technology transfer - guidelines. TOT agencies in India - APCTT, NRDC, TIFAC, BCIL, TBSE/SIDBI. TOT related documentation - confidentiality agreements, licensing, MOUs, legal issues. Compulsory licensing, access to medicine issues, DOHA declaration, POST WTO product patent regime from 2005, challenges for Indian Pharma industry in the context of globalization of IP, Drug registration and licensing issues - national and global, drug master file submissions, SOPS, related registration and marketing issues. Antiretroviral drugs. Preparation of a project report, financial appraisal, business models. GOI schemes and
incentives, NRDC - TePP, HGT, TDB schemes, PATSER venture capitalists, banks. Incubator concept - IIT, CCMB, IMTECH, NIPER. Documentation and related aspects.

Practical

Visits to various biotechnology industries and laboratories

**Biot.4130 Gene therapy (2+0)**

*Theory*

Disease prevention by vaccines (DNA vaccines), disease diagnosis probes, monoclonal antibodies, disease treatment products from recombinant organisms, interferons, antisense nucleotides as therapeutic agents, drug delivery (Viral delivery and therapeutic strategies, nonviral delivery, gene delivery to skin, use of liposomes as drug delivery system), disease targets, augmentation therapy, gene therapy in cancer treatment in HIV infection.

**Ext.4101 Professional and personal skill development* (1+2)**

*Theory*

Personal Communications, organizing learning process, Mind mapping, body language, presentation skills and personal delivery, writing skills, verbal communications, group working, behavioral skills - personal, interpersonal, organizational, managing stress, handling conflict, time management, personal creativity, leadership qualities, management skills, customer service skills, human resource management, professional ethics. Event management.

*Practical*

Presentations, quiz, group discussions, debates, interviews. Event management, organizing seminars and discussions. Procedures for establishing and maintaining biotechnological facilities. Project preparations.
SEMESTER VIII

Biot.4231 Management in biotechnology (2+0)

Theory


Biot.4232 Industrial biotechnology (2+1)

Theory


Practical

Assessment of pesticide residues in fruits, vegetables and fodder. Different analytical techniques. Biodegradation of cellulose, lignin, starch, protein and lipid substrates; Biodegradation of synthetic products. Fermentation - use of different types of microorganisms.

Stat.4202 Biomathematics and Biostatistics* (2+1)

Theory

Introduction - statistical data, Frequency distributions, diagrammatic and graphical representation. Averages - definition, characteristics, central tendency, arithmetic mean, harmonic mean, median, mode, geometric mean. Mean of grouped and ungrouped data. Comparison and selection of appropriate average, properties, weighted arithmetic mean. Measures of dispersion - definition, characteristics, range, quartile deviation, mean deviation and standard deviation. Relative measures of dispersion. Skewness and kurtosis. Correlation, scatter diagram regression, correlation vs. regression. Elementary ideas on probability, probability distributions - Binomial, Poisson and normal. Sampling - census vs. sampling, sample from a population, random sampling, sampling designs. Test of significance - test for proportion, mean and standard deviation. F anf t - test. Chi square, test for goodness of fit. Test associated to correlation and linear regression. Analysis of variance for one and two way classification, design of experiments, randomization, replication, local control. Completely randomized and randomized block design, factorial experiments, layout of main effect plans. Nonparametric tests - tests equivalent to two sample comparison, one way and two way analysis.
Practicals

Diagrams, graphs, measures of averages and location, measures of dispersion, probability, binomial, Poisson and normal distribution, normal deviation and student’s t-test, chi-square test, correlation analysis, and regression analysis. Analysis of variance and non-parametric tests.

Biot.4233 Seminar (0+1)

SEMESTER IX

Biot.5151 Research (0+22)

SEMESTER X

Biot.5252 Research (0+18)

OPTIONAL COURSES

Biot.4234 Advanced agricultural biotechnology (2+1)

Theory

Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for imparting tolerance to abiotic stress conditions like drought, flood, salinity, alkalinity, mineral / metal toxicity; Genetic engineering for imparting tolerance to biotic stress due to Insects, fungi, bacteria, viruses and weeds; Genetic engineering for quality improvement with respect to proteins, lipids, carbohydrates, vitamins and mineral nutrients. molecular Marker aided Breeding, constructing molecular maps; Molecular markers, RFLP, RAPD, STS, SCAR, SSCP, AFLP. Molecular tagging of genes / traits; molecular marker - assisted selection of qualitative and quantitative traits, map based cloning; micropropagation for virus - free plants, somaclonal variation, somatic hybridization, haploids in plant breeding; micropropagation: commercial applications; homozygous plant production through ovule, anther & pollen culture; embryo rescue & embryo culture; endosperm culture & production of seedless plants; apomixis& experimental polyembryony; AFLP
variety identification & fingerprinting; molecular farming; use of organogenesis & embryogenesis for commercial utilization; commercial production of plant secondary metabolites; increase in production using suitable media supplements (elicitors, growth factors, stress factors, precursors, antimetabolites, defense proteins etc.); Protoplast culture & somatic / parasexual hybridization for overcoming incompatibility barriers - somatic hybrids, cybrids; transgenic plants, single gene transfer to plant cells: concepts; methods of gene transfer: direct & indirect; stabilities & instabilities in transgene expression; present status of transgenic crops; case studies; organelle transformation; gene silencing; use of bioreactors in plant production; secondary metabolite production.

Practical

Micropropagation of banana, spices, ornamentals, medicinal plants; protoplast isolation & culture; Agrobacterium mediated transformation of dicots.

**Biot.4235 Advanced food biotechnology (1+1)**

*Theory*

Recombinant Proteins - production and applications in food; diagnostic systems in food; cell culture and food - brewing, dairy biotechnology, food additives, microbial products used in food; industrial cell culture - downstream processing; preservation technology - spoilage of food, microbiology of water, meat, milk, vegetables, technology - canning, dehydration, ultrafiltration, sterilization, irradiation. Food Production technology: Single cell protein, fermentative production of food, pickling and alcoholic beverages; enzymes in bakery and cereal products; enzymes in fat / oil industries, protease in cheese making and beverage production, utilization of food waste for production of valuables; food quality and control - analysis of food, major ingredients present in different products; food additives colour, flavour, vitamins; microbial safety of food products; chemical safety of food products; biochemical engineering for flavor and food production, cryopreservation, irradiated foods; dairy products, non - beverage plant products, beverages and related products of baking; quality control; food spoilage & food borne diseases; ethics and safety of food biotechnology products; regulations of food biotechnology.
Practical

Preparation of starter culture, preparation of wine, youghurt, vinegar; production of amylase, pectinase, proteases, flavour, colour by fermentation; immobilization of enzymes.

**Biot.4236 Agrobiotechnology, industry and infrastructure (2+1)**

**Theory**

Homozygous plant production through ovule, anther and pollen culture; embryo rescue and embryo culture; endosperm culture and production of seedless plants; apomixis and experimental polyembryony; AFLP – variety identification and fingerprinting; molecular farming; marker assisted technology; use of bioreactors in plant production and scale-up; metabolic engineering; biotic and abiotic stress; secondary metabolites; edible vaccines; diagnostic kits and virus indexing. Laboratory infrastructure development; bioethics; IPR; regulatory practices; quality control/quality assurance.

**Practical**

Ovule, embryo and endosperm culture. AFLP analysis for varietal identification and fingerprinting of a horticultural plant.

**Biot.4237 Soil biotechnology (2+1)**

**Theory**

Beneficial soil organisms and mode of action; bacterial suspensions / inoculants as bio-fertilizers and bio-control agents to fight insect pests, weeds or diseases in plants; atmospheric nitrogen fixing soil bacteria (*Rhizobium, Azotobacter, Acetibacter*) and cyanobacteria; mechanism of soil bacteria and cyanobacteria for enhanced nitrogen fixation; role of Azola as biofertilizers; advantage of biofertilizers over chemical fertilizers; activity to control insect pests; free living and symbiotic nitrogen fixers; endophyticdiazotrophs; NIF gene transfer; nodulation by *Rhizobium*; *Rhizobium* management; Rhizo-sphere engineering. Microbes as biocontrol agents, *Pseudomonas, Trichoderma, Glomus*; microbe derived inhibitors, preparation of different types of inoculants; nitrogen fixers, phosphate solubilizers,
plant growth promoting rhizobacteria; composting; anaerobic and aerobic composting, xenobiotics, degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons; wetland management, membrane based waste water treatment processes; use of microbes in environmental applications, bioremediation, bio-augmentation, Bio-emulsifiers, bio-surfactants, leaching of ores, microbial fuels.

Practical

Isolation and characterization of Nitrogen fixers; isolation and characterization of phosphate solubilizers; preparation of inoculants; enrichment culture for hydrocarbon degradation; production and characterization of emulsifiers by microbes

Biot.4238 Transport properties of biological membrane (2+0)

Theory


Biot.4239 Molecular drug designing and targeting (2+1)

Theory

Basic concepts which determine the design and discovery of drugs; bioorganic, medicinal and physico-chemical principles behind the rational designing and mechanism of drugs; computer based approaches - structure activity relationship with bioactive compounds; key features of molecular interactions; introduction to rational drug design and its history; molecular mechanics; structure
and conformation of small molecules; overlay and identification of active conformer, molecular properties, descriptors; molecular interactions - protein-drug, protein-protein, protein - DNA; virtual screening - structure based designing and ligand based designing; targeting methods for drug delivery; case studies; principles of target identification to compound synthesis.

Practical

Molecular modeling; synthesis of a complex drug and analysis of intermediate and final products using various analytical methods; drug docking; structure based de novo ligand design.

Biot.4240 Molecular medicine and diagnostics (2+1)

Theory

Human genetics diseases; genetic and molecular epidemiology; pharmacogenetics; molecular biology of neurological diseases; pathophysiology of dementia; functional MRI and its application; infectious diseases-parasite and virus infections; molecular biology of cardiovascular diseases; translational bioinformatics; calcium channels and diseases; the immune systems; PCR - based mutation detection: single-stranded conformational polymorphism analysis, heteroduplex analysis, DNA chips, automation, gene therapy; applications in diagnosis of genetic disorders.

Practical

Analytical techniques such as polymerase chain reaction (PCR), quantitative real time PCR (qRT-PCR), microarray analysis, and DNA bioinformatic tools.

Biot.4241 Advanced clinical biotechnology (1+1)

Theory

Introduction to clinical study and design of clinical studies; drug design and synthesis - synthesis of compounds in accordance with the molecular structure and biological activity concept; analgesics, neuromuscular blocking agents; anti-fertility drugs and bactericidal & bacteriostatic agents; study of therapeutic proteins and related case studies - blood and blood products; clotting
factors, anticoagulants, thrombolytic agents, tissue plasminogen activator and streptokinase; safety guidelines in blood transfusion; therapeutic proteins - antibodies, enzymes, hormones, growth factors (erythropoietin), vaccines (HIV and Cancer), interferon and interleukins; cancer biology and modes of treatment - radiotherapy, chemotherapy, surgery, biological therapy, immunotherapy and gene therapy; clinical toxicology - basic concept in toxicology; types and mechanism of toxin action - epoxidation & drug toxicity, n-oxidation & drug toxicity and sulphur xenobiotics; hepatotoxicity and nephrotoxicity; biotransformation of toxins; inactivation and removal from the body.

Practical

Nucleic acid - based methods like hybridization, amplification, and sequencing; non-nucleic acid methods like HPLC, GLC, and protein analysis; serological testing methodologies; developing clinical database.

Biot.4242 Drug metabolism (2+0)

Theory

Chemical changes associated with metabolic transformations; major classes of drug metabolizing enzymes and their pharmacogenetics; role of transporters in affecting drug metabolism and drug; techniques used to study drug metabolism and drug disposition - chromatography, mass spectrometry, NMR spectroscopy, radioisotope studies; clinical implications of drug metabolism, including metabolic detoxification and activation as well as metabolism - based drug interactions; implications of metabolism in the design and development of safe and efficacious therapeutic agents.

Biot.4243 Fermentation technology for animal and plant products (2+1)

Theory

Fermentation processes; biomass, enzymes and metabolites; process components; batch, continuous and fed-batch cultures; fermenting media formulation; carbon and nitrogen sources; oxygen requirements; anti-foams; bioreactors - functions; design, aeration
and agitation; sterilization; instrumentation and control; production of industrial starters; isolation, maintenance and development of microorganisms; starter utilization; immobilization of biocatalysts - kinetics effects; inactivation kinetics; biocatalysis in non-conventional media (biphasic; organic; ionic liquids; supercritical fluids).

**Practical**

Development of cultivations systems for aerobes and anaerobes; applications of cells in bioprocesses (lactic acid bacteria, yeasts, mixed cultures, plant and animal cells).

**Bich.4244 Advanced carbohydrate and lipid technology (2+0)**

**Theory**

Carbohydrate diversity and carbohydrate - active enzymes (CAZymes); carbohydrate - based biotech applications; carbohydrate structure, configuration, conformation, linkage and diversity; nucleotide sugar enzymology; common sugars in plant and microbial cell walls; structural glycans in animals; UDP - activated sugars as oligo & polysaccharide precursors; UDP sugar interconversion; glycosyltransferases; enzymatic synthesis of glycosides / enzymatic cleavage of glycosides I; carbohydrate - active enzymes; CAZy database; GTs; GHs; CBMs; enzymatic cleavage of glycosides II; PLs; CEs; CAZyme structure/ function relationships; glycoproteins I; glycoproteins II; glycolipids; lignin-carbohydrate complexes; applications of hydrolases in fiber processing; other enzymes in fiber processing & analysis; enzymes in food production; enzymes in (bio) fuel production; medical applications. Physicochemical and nutritional characteristics of fats and oils, and their processing and utilization; sources and utilization of animal, vegetable and marine fats / oils; role of edible fats and oils in human nutrition and health; sources and classification of commercial edible fats and oils - innovations in the production and processing of oils and fats from different sources; non-conventional fats / oils for edible purpose; advances in refining of oils and fats; modification of fats and oils. applications of fats and oils; technology of cooking oils, salad oils and oil based dressings; frying process and systems; changes in fats and oils during frying. fat replacers; technologies for production of plasticisers, emulsifiers and protective coatings.
Biot.4245 Advanced modeling and simulation in bioprocess (2+1)

Theory

Concepts of modeling and simulation - modeling - introduction, metabolic structure, balance equations, mass balances, stoichiometric relations. simulation - introduction, continuous processes, parameter estimation, model verification, decomposition, model discrimination; optimization - static, dynamic modeling and simulation in biological reaction engineering - mathematical models, digital simulation - examples; unstructured growth model with bottle - neck kinetics; modeling of waste treatment system - neural networks - introduction, theory; use of neural networks in the analysis and prediction of activated sludge process; biofilm and anaerobic reactors; modeling of bioprocess system; bioreactor analysis and bioprocess modeling; modeling of upstream and downstream processing; structured model applications; enzyme reaction kinetics in aqueous and non - aqueous phases and yields.

Practical

Formulating and solving mathematical models to simulate processing systems.

Micr.4203 Advanced industrial biotechnology (1+1)

Theory

Introduction to industrial biotechnology; technology and its components; sustainable industry, production and marketing; need of R&D and compatible management; current global scenario; fermentation technology - fermentor operation, downstream processing, pilot scale production; environmental biotechnology; biosensors, pollution control, phytoremediation, modern applications; genetically modified organisms and products; GM Foods and current global situation; pharmaceuticals, biopharming; regulatory issues, patent issues, trade; IT applications in high - tech industry; management of biotech related industries; compatible management and financial issues; industrial safety - rules and regulations; potential biotech industries for India, current status and future.
Practical

Use of fermentors for production of microbial and plant products, estimation of products, factors influencing scaling up.

**Biot.4246 Downstream processing (2+1)**

*Theory*

Role and importance of downstream processing in biotechnological processes; problems and requirements of bioproduct purification; economics of downstream processing in biotechnology, cost - cutting strategies, characteristics of biological mixtures; process design criteria for various classes of bioproducts; physico - chemical basis of bio - separation processes; cell disruption methods for intracellular products; removal of insoluble, biomass; flocculation and sedimentation, centrifugation and filtration methods; membrane - based separations; enrichment operations; precipitation methods; *in situ* product removal, integrated bioprocessing; electrophoresis - electrophoresis of proteins and nucleic acids, 1D-2D Gels; types of electrophoretic techniques; product resolution / fractionation; Chromatographic techniques - paper, TLC, adsorption, ion exchange, gel filtration, affinity chromatographic separation processes, GC, HPLC, FPLC; chromatome focusing electrophoretic separations; dialysis, crystallization.

*Practical*

Cell disruption techniques; solid separation methods - filtration, sedimentation, centrifugation, product enrichment operations, precipitation, ultra filtration, two - phase aqueous extraction, high - resolution purification, preparative liquid chromatographic techniques, product crystallization and drying.

**Biot.4247 Microbial processing engineering (2+1)**

*Theory*

Microbial process development; bioreactor systems including utilities; fluid flow and mixing - flow behavior, mixing, power consumption and shear properties of rushton turbine, helical, anchor, bubble column, external loop, airlift; heat transfer - different
modes of heat transfer; mass transfer in microbial processes, enzyme kinetics - determination of rate parameters and reaction kinetics, bioreactor analysis - ideal and non-ideal reactors; modes of culture - batch, fed batch, continuous, recycle; fluidized bed bioreactors and immobilized bioreactors; scale up of microbial processes with case studies related applications in various biotech and biopharma industries; reactor engineering: bioreactor configurations; practical considerations for bioreactor construction; monitoring and control of bioreactors; ideal reactor operations; batch operation of a mixed reactor; case study of penicillin production.

Practical

Isolation of useful microorganisms from natural samples; growth of microorganisms, estimation of Monod parameters; temperature effect on growth - estimation of energy of activation and Arrhenius Constant for microorganisms. Batch, fed batch and continuous cultures; Production of secondary metabolites in synthetic and complex industrial media.

Biot.4248 Computational modeling in biology (2+1)

Theory

Modeling single populations with difference equations; Malthusian model, nonlinear models; analyzing non-linear models; introduction to scientific computing, properties of floating point arithmetic, numerical differentiation and integration; applying the computational techniques to model specific problems in population regulation; linear models of structured populations, Leslie model and Usher model; numerical methods for matrix algebra; multi-population models; predator-prey models, linearization and stability, positive and negative interactions, computational techniques related with these models and their applications; modeling genetics of families.

Practical

Modeling stochastic processes - introduction to Monte-Carlo Technique, ising model; Markov chains, deterministic models, stochastic models, modeling of simple epidemic in continuous time, interacting groups, homogeneous populations, stratified populations.
**Biot.4249 Vaccines (2+1)**

*Theory*

History of vaccine development; definition of vaccine; evolution of vaccines; process development for vaccines; manufacturing of vaccines; various aspects of vaccines, process development and manufacturing; clinical development of vaccines; clinical end-point: evolution of vaccines; general specifications and pharmaceutical release criteria for the existing vaccines, cold chain management of vaccines; new technologies for vaccine development such as DNA vaccines, recombinant mucosal vaccines, dendritic cells for antigen delivery, novel adjuvants, and methods to increase vaccine stability; delivery systems for vaccines - traditional and new methodologies; underlying biological role of the innate and adaptive immune systems.

*Practical*

Egg based vaccine production, cell based vaccine production and visits to commercial vaccine production centre.

**Biot.4250 Pharmacological screening and assays (2+1)**

*Theory*

Regulations for Laboratory Animals care and Ethical Requirements Guidelines and regulatory agencies - CPCSEA, OECD, USFDA, ICH, FHSA, WHO; laboratory animals - commonly used laboratory, transgenic and other genetically prone animal models; techniques of blood collection, anesthesia and euthanasia of experimental animals; various routes of drug administration; maintenance and breeding of laboratory animals; principles of biological standardization - statistical treatment of model problems in evaluation of drugs; methods of biological assay, principles of biological assays; development of new bioassay methods; organization of screening for the Pharmacological activity of new substances with emphasis on evaluation using in vivo, in vitro, ex vivo, in situ, in silico and other possible animal alternative models; general principles and safety pharmacology procedures; screening for pharmacological activity; analgesics, anti-inflammatory and...
antipyretic agents; gastrointestinal drugs anti-ulcer, anti-emetic, anti-diarrhoeal and laxatives; anti-cancer agents; drugs for metabolic disorders like anti-diabetic, anti-hyperlipidemic, anti-obesity, and hepatoprotective agents; anti-oxidants and anti-fertility agents.

Practical

Effect of drugs on rats; genotoxic effect of unknown drug; demonstration of nerve conduction velocity in rats; effect of antidepressant on tail suspension test, antinflammatory activity of unknown compounds; measurement of cholesterol and TGs in rats, effect of cyclophosphamide on neutrophil counts; blood cell counting and histopathological studies.