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

Sl. No.	Catalogue No.	Title of the courses	Credit
SEMESTER I			
1	Biot. 1101	Fundamentals of cell biology	2+1
2	Chem.1101	Fundamentals of chemistry*	3+0
3	Micr.1101	Fundamentals of microbiology**	2+1
4	Biot.1102	Principles of molecular biology	2+0
5	Stat.1101	Mathematics *	3+0
6	Comp.1101	Introduction to computers*	1+1
7	Biot.1103	Biodiversity	2+1
8	Phed.1101	Physical education#	0+1
Total			**15+5=20**
SEMESTER II			
1	Bich.1201	Biochemistry I**	2+1
2	Biot.1204	Biophysics	3+0
3	Biot.1205	Cellular and developmental biology	2+1
4	Biot.1206	Bioresources	1+1
5	Biot.1207	Introduction to genomics and proteomics	2+1
6	Pbgn.1201	Fundamentals of genetics**	2+1
7	Comp.1202	Computer applications*	1+1
8	Micr.1202	Applied microbiology**	2+1
Total			**15+7=22**

SEMESTER III			
1	Bich.2102	Biochemistry II**	2+1
2	Biot.2108	Plant biotechnology	2+2
3	Biot.2109	Structural and functional genomics and proteomics	2+1
4	Biot.2110	Food biotechnology	2+1
5	Crps.2101	Plant physiology**	2+1
6	Biot.2111	Basics of virology and oncology	2+1
7	Biot.2112	Biosafety rules and regulations	1+0
Total			**13+7=20**
SEMESTER IV			
1	Biot.2213	Enzymology and enzyme technology	2+2
2	Pbgn.2202	Methods of plant breeding**	1+1
3	Biot.2214	Analytical techniques in biotechnology	2+1
4	Biot.2215	Bioinformatics	1+2
5	Biot.2216	Genetic Engineering I	2+2
6	Path.2201	Molecular diagnostics**	2+1
7	Biot.2217	Nanobiotechnology	2+0
Total			**12+9=21**
SEMESTER V			
1	Biot.3118	Animal biotechnology	2+1
2	Resm.3101	Research methodology*	2+2
3	Biot.3119	Chemical engineering	2+1
4	Biot.3120	Genetic Engineering II	2+2
5	Biot.3121	Immunology	2+1
6	Biot.3122	Stem cell and tissue engineering	2+1
7	Biot.3123	Intellectual Property Rights and Laws	2+0
Total			**14+8=22**

SEMESTER VI			
1	Biot.3224	Job training	0+15
Total			**0+15=15**
SEMESTER VII			
1	Anhs.4101	Animal physiology**	2+1
2	Biot.4125	Bioprocess technology	2+0
3	Biot.4126	Ethics, economics and social implications of biotechnology	2+0
4	Biot.4127	Metabolomics	3+0
5	Biot.4128	Environmental biotechnology	2+1
6	Biot.4129	Biotechnology industry	2+1
7	Biot.4130	Gene therapy	2+0
8	Extn.4101	Professional and personal skill development*	1+2
Total			**16+5=21**
SEMESTER VIII			
1	Biot.4231	Management in biotechnology	2+0
2	Biot.4232	Industrial biotechnology	2+1
3	Stat.4202	Biomathematics and Biostatistics*	2+1
3	Biot.4233	Seminar	0+1
4	Biot.4234 to 4250	Optional courses	10 credits
Total			**19**
SEMESTER IX			
1	Biot.5151	Research	0+22
Total			**0+22=22**
SEMESTER X			
1	Biot.5252	Research	0+18
Total			**0+18=18**

	* Non Credit Course **Optional courses**		
1	Biot.4234	Advanced agricultural biotechnology	2+1
2	Biot.4235	Advanced food biotechnology	1+1
3	Biot.4236	Agrobiotechnology, industry and infrastructure	2+1
4	Biot4237	Soil biotechnology	2+1
5	Biot.4238	Transport properties of biological membrane	2+0
6	Biot.4239	Molecular drug designing and targeting	2+1
7	Biot.4240	Molecular medicine and diagnostics	2+1
8	Biot.4241	Advanced clinical biotechnology	1+1
9	Biot.4242	Drug metabolism	2+0
10	Biot.4243	Fermentation technology for animal and plant products	2+1
11	Biot.4244	Advanced carbohydrate and lipid technology	2+0
12	Biot.4245	Advanced modeling and simulation in bioprocess	2+1
13	Micr. 4203	Advanced industrial biotechnology	1+1
14	Biot.4246	Downstream processing	2+1
15	Biot.4247	Microbial processing engineering	2+1
16	Biot.4248	Computational modeling in biology	2+1
17	Biot.4249	Vaccines	2+1
18	Biot.4250	Pharmacological screening and assays	2+1

Distribution of credits - semester wise

Year	Semester	Credits		Supporting	Physical education (NC)	Optional	Job Training	Research	Seminar	Total
		Major	Minor							
I	I	6+2=8	2+1=3	7+1=8	1					20
	II	8+3=11	6+3=9	1+1=2	-	-	-	-		22
II	III	9+5=14	4+2=6	-	-	-	-	-		20
	IV	9+7=16	3+2=5	-	-	-	-	-		21
III	V	12+6=18	-	2+2=4	-	-	-	-		22
	VI	-	-	-	-	-	15	-		15
IV	VII	13+2=15	2+1=3	1+2=3	-	-	-	-		21
	VIII	4+1=5	-	2+1=3	-	10	-	-	1	19
V	IX	-	-	-	-	-	-	0 +22	-	22
	X	-	-	-	-	-	-	0 +18	-	18
Total		**87**	**26**	**20**	**1**	**10**	**15**	**40**	**1**	**200**

- 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 #

DETAILED SYLLABUS

SEMESTER I

Biot.1101 Fundamentals of cell biology (2+1)

Theory

Origin of life - theories. Varieties of life - classification.Cell - concept, structure and function of prokaryotic and eukaryotic cells. Histology - meristems and their function, simple tissues, complex tissues, tissue systems, primary and secondary growth. Animal tissues - types and functions. Autotrophic nutrition - pigment systems, chloroplast, light absorption by chlorophyll and transfer of energy, photosynthetic unit, phosphorylation and electron transport system, Calvin - Benson Cycle, Hatch Slack Pathway, Crassulacean Acid Metabolism, mineral nutrition in plants. Heterotrophic nutrition - forms of heterotrophic nutrition, Energy utilization - respiration - structure of mitochondria, cellular respiration, relationship of carbohydrate metabolism to other compounds, electron transport system and oxidative phosphorylation, ATP. Cellular reproduction-regulation of cell cycle-mitosis and meiosis.

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

- colloidal state, classification of colloidal solution, true solution, colloidal solution and suspensions, preparation of sol, purification of colloidal solutions, General properties and optical properties, stability, coagulation of lymphobic sols, electrical properties of sols, kinetic properties of colloids - Brownian movement, size of colloidal particle, emulsions, gels, colloidal electrolytes and applications of colloids. IUPAC nomenclature of organic compounds. Principles of stereochemistry, conformational analysis, isomerism and chirality. Principles and applications of organic photochemistry. Free radical reactions. Reactions involving nucleophotic carbon intermediates. Oxidation and reduction of functional groups. Physical characterization of organic compounds by IR, UV, MS and NMR.

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

Theory

History and scope of microbiology. Microscopy and staining- principles and applications, bright field, dark field, phase contrast, fluorescence, SEM and TEM, specimen preparation for electron microscopy, freeze etching, stains and staining reactions, types of staining - simple, differential (Gram's, spore, AFB), capsule staining, nuclear and flagellar staining. Principles and methods of sterilization and disinfection, physical - dry heat, moist heat, filtration, membrane & HEPA, radiation, chemical sterilization - chemical agents and mode of action. Ultra structure of bacteria, fungi, algae, protozoa and viruses.Culture techniques-media preparation, solid and liquid. Types of media- crude, semi-synthetic, synthetic, enriched, enrichment, selective, differential and special purpose media, anaerobic culture technique - Wrights tube, Roll tube, McIntoshFildes jar method. Pure culture technique - tube dilution, pour, spread, streak and micro manipulator. Maintenance and preservation, short term- slant, slab, mineral oil over lay, long term- lyophilization, cryopreservation and storage in sterile soil, storage in silica gel. Nutrition- nutritional requirements of microorganisms- autotrophs, heterotrophs, photoautotrophs, chemoautotrophs, copiotrophs, oligotriophs, endospore formation in bacteria.

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

Nucleic acids - structure, forms, properties.History and development of molecular biology.Genome organization and structure - viral, prokaryotic, eukaryotic, organelle genomes (mitochondrial and chloroplast). Fine structure of gene and modern gene concept. DNA replication - prokaryotic, eukaryotic, RNA viruses. Control of DNA replication - enzymes, inhibitors. Transcription in prokaryotes and eukaryotes. Regulatory elements: promoters, enhancers, terminators, factors and inhibitors. Post transcriptional modifications. Translation in prokaryotes and eukaryotes, post translational processes.

Stat.1101 Mathematics* (3+0)

Theory

Matrices – definition, types-Determinant of square matrix, Evaluation of determinants, matrices manipulation, Inverse of square matrix, solution of systems of linear equations using inverse of matrices and Crammer's rule. Solutions to quadratic and cubic equations. Co-ordinate geometry – Area of triangle and quadrilateral, equation of straight line – in slpoe form, intercept form and perpendicular form. Trigonometric ratios and their interrelations. Linear programming- common applications. Numerical methods – polynomial fitting and interpolations. Calculus – Derivative and its physical significance, derivative of a function, implicit function, basic rules for differentiation, maxima and minima – their applications in biology, exact and inexact differentiation with specific emphasis on thermodynamic properties, partial differentiation, curve sketching. Integration of functions, basic rules for integration, definite and indefinite integrals, geometric meaning of integration, applications in finding area under curves. Differential equations, homogenous equations, variable separable form. Applications of integration and differential equations in chemistry and biology.

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

Evolution and classification of archaea, eubacteria, algae, fungi, plants, animals. Evolution of vertebrates, fishes, amphibians, reptiles, birds and mammals. Adaptations. Historical and geographical causes for diversity, genetic diversity. Biodiversity - concept, value and types of biodiversity. Analyzing and documenting biodiversity. Morphological and molecular characterization of biodiversity. Quantifying biodiversity. Maintenance of ecological biodiversity. Centres of origins of plants. Biodiversity hot spots in India. India as a mega diversity nation and economic potential of biodiversity. Ecological role and species interdependence.

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

Cell - biochemical organization. Concept of pH and buffer, properties of water. Structure and functions - cell membrane, carbohydrates, lipids, amino acids and proteins, nucleic acids. Enzymes - nomenclature, classification, functions, kinetics and mechanisms of action. Vitamins and coenzymes. Metabolic pathways of carbohydrates - glycolysis, pentose phosphate pathway, gluconeogenesis. Citric acid cycle. Electron transport and oxidative phosphorylation. Amino acid degradation. Biosynthesis of amino acids. Biosynthesis and degradation of nucleotides. Lipids - fatty acids, glycerols, waxes, phospholipids, sphingolipids, sterols lipoproteins, fatty acid oxidation. Ketone bodies. Biosynthesis of fatty acids.

Practical

Quantitative tests for carbohydrates, fats and oils, proteins and amino acids. Quantitative estimation of reducing sugars, total sugars, starch, proteins, organic acids. Enzyme kinetics.

Biot.1204 Biophysics (3+0)

Theory

Scope and methods of Biophysics. Levels of molecular organization, Interactions in biological systems-strong and weak. Intra and intermolecular forces, Chemical bonds, effect of bonding on reactivity, bond length, bond angle, dipole moment electrostatic interactions Hydrogen bonding interactions. Vanderwaals forces and hydrophobic interactions. Disulphide bridges. Role of water and weak interactions - pH and Buffer concept. Protein structure - Amino acids - peptide bonds. Conformational properties of poly peptides - Primary, secondary - helix and sheet structures; tertiary and quarternary structures, Ramachandran plot. Secondary and tertiary structure prediction of protein conformation. Protein

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

Plant, animal and microbes - uses. Conservation and sustainable management of biodiversity and bioresources- current practices, social movements, biodiversity laws, environmental education, natural balance, mankind sustenance, resource limitations, environmental managements, legal provisions and approaches of environmental management, sustainable development and consumption need, challenges, support base and skilled manpower for sustainable development. *In situ* and *ex situ* conservation-biosphere reserves and national parks, wildlife sanctuaries, high value biodiversity areas, Ramsar Sites and important bird areas. National polices and instruments for the protection of the wild/ domesticated flora and fauna and habitats. Ramsar Convention, Wildlife (Protection) Act 1972, Forest Conservation Act 1980, Convention on the Conservation of the migratory species of wild animals – (Migratory species convention) 1983. Need for wild relatives of cultivated plants/animals/microbes. Centres of origin of cultivated plants and domesticated animals. Loss of biodiversity - habitat destruction, over exploitation, biological invasion, over hunting, collection for zoos and research, deforestation, control of pests and predators. Red data books. Uses and values of biodiversity. Remote sensing and GIS application. International policies and instruments. Biotechnology and intellectual property rights. WHO, GATT, TRIPS, CBD, sovereignty rights, Indian *sui-generis* system for plant variety and farmer's rights protection act. Bioprospecting and IKS, biopiracy, rights of farmers, breeders and indigenous people, biodiversity/ bioresources data bases.

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

Historical development and significance - genome size and sequence components-prokaryotic genome sequence and structural components. Eukaryotic genome sequence and structural components. DNAsequencing. Characteristics of cloning vectors, Enzymes of molecular cloning, Preparation of Genomic and cDNA libraries, Genomeprojects. The structure, function and evolution of the human genome. Strategies for large-scale sequencing projects. Scope and applications. Genome mapping. Genetic map to physical map - DNA contigs - cosmids, YAC, BAC, MAC, PAC libraries. Chromosome walking and jumping, applications of genomic technologies -microarray technology. Bioinformatics for the analysis of sequence data, Approaches for determining gene expression patterns and functions.

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

Mendelian Genetics - principles, the concept of gene, dominance, multiple allelic systems, gene interaction, mutations, linkage, ploidy, mutations, deletions. Changes in gene frequency by mutation and selection against recessive allele. Quantitative inheritance. Population genetics - Hardy-Weinberg law. Principles of plant/ animal breeding, inbreeding and heterosis, plant improvement, hybridization. Chromosome alteration and sister chromatid exchanges. Lethals, detection of genotoxicity, assays using cytogenetic analysis in mammalian cells. *In vitro* and *in vivo*, host mediated assay. Molecular Genetics - gene mapping in phages, bacteria. Point mutations, isolation of auxotrophs, conditional lethals and suppressor mutations. Genetics of biosynthetic pathways. Transposons in prokaryotes and eukaryotes. Mutagenesis - mutagenic agents, mechanisms of mutagenesis, expression of mutations, gene mutation, detection of DNA damage at molecular level, Ames test.

Practical

Cell division-mitosis and meiosis. Permanent slides - polytene chromosomes, grass hopper spermatids and chromosomes. Use of Drosophila as a model system in genetics. Estimating gene frequencies in human population, estimation of heterozygotes frequencies, pedegree analysis, analysis of human karyotes, chromosomal aberrations. Isolation and identification of auxotroph mutants in bacteria, recombination in bacteria. Micronucleus test for detecting genotoxins. AME's test for screening genotoxins.

Comp.1202 Computer applications* (1+1)

Application of computers in Biostatistical problems. Database creation and management - basic SQL prompts, retrieval, sorting, indexing and merging. Computers in biology - sequence databases, sequence analysis of proteins and nucleic acids, Structure prediction, simple molecular modeling, computer aided drug designing, Genomics and proteomics.

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

MS - EXCEL - analysis of scientific data, handling macros. MS - ACCESS: creating database, prepare Queries and reports. Introduction of programming languages Visual basic, C++, simulation models. Computer aided learning. Practise on preparation of decision support system.

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,

nutrient content and inhibitory substances and biological structure. Principles of food preservation, spoilage of food - egg and milk. Fermented food - alcoholic beverages, bread and cheese. Food borne diseases - food poisoning and food infections. Microbial association in soil- symbiotic proto - cooperation, ammensalism, commensalism, syntrophism, parasitism and predation. Agricultural microbiology - symbiotic and non - symbiotic nitrogen fixers. Biofertilizers in agriculture - Rhizobium and phosphate solubilizers, mycorrhizal association. *Agrobacterium tumaefaciens*. Medical microbiology- morphology, pathogenicity and laboratory diagnosis of *Bacillus anthracis, Escherichia coli, Treponemapallidum.* Mycology, superficial infections - dermatophytes - Microsporum, Trichophyton, Epidermophyton - Madura mycosis, opportunistic fungal infections - *Candida albicans*, Aspergillus, Mucor, parasitic diseases - Giardia. Antibiotics and chemotherapeutic agents - mechanism of actions, drug resistance, antimicrobial susceptibility testing - disc diffusion - Kirby Bauer.

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

Biological membranes and transport, prostaglandins, leukotrienes, thrombaxanes.Interferons and interleukins, antibiotics, alkaloids. Animal pigments. Cytoskeletal organisation, Chemical synthesis of peptides and oligosaccharides. Vitamins, minerals and hormones, Integration and hormonal regulation of mammalian metabolism. Biosynthetic pathways - photosynthesis, biosynthetic pigments, energy transduction in photosynthesis. Integration of intermediary metabolism. Nitrogen and sulphur cycles. Secondary metabolites - structure, function and metabolism.

Practical

Estimation of vitamins and hormones. Estimation of secondary metabolites. Measurement of photosynthetic rate. Chromatographic techniques. Determination of fat contents.

Biot.2108 Plant biotechnology (2+2)

Theory

Plant tissue culture principles, historical background, general applications. Plant tissue culture media - methods of preparation of media, culture conditions, Stages of *in vitro* propagation, Tissue culture methods, production of artificial seeds. Planting out and related problems. Handling methods - structures, potting media. Commercial micropropagation. Single cell culture. *In vitro* production of secondary metabolites. Micropropagation - advantages, disadvantages, prospects. Problems of *in vitro* propagation. Production of virus free plants. Somaclonal variation, Protoplast culture, somatic hybridisation, haploid culture, Gene transfer techniques, importance, tissue culture as a tool in genetic engineering. GM crops - adoption, status, prospects

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.9+ 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

operon, attenuation. Gene regulation in eukaryotes, transcriptional, post transcriptional and translational events in gene regulation. Regulation of lactate dehydrogenase gene. Organisation of immunoglobulin genes, signal transduction. Organisation of plant genome, modern gene concept. Regulation at transcriptional and translational levels, post translational modifications, transposable elements, controlling elements. Heat shock genes. Genome Editing. Web based information systems, bioinformatics - sequence alignment tools, pair wise and multiple alignments, programming / modeling, languages. Computational analysis tools - genome annotation - automated pipelines, manual, genome comparison, RNA secondary structure. Transcriptome analysis - DNA array technologies, SAGE, RNA sequencing, EST.

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

Importance. Microbial Synthesis and Production - flavors, vitamins.Impact of Biotechnology on Nutritional Quality of Food Plants. Biochemistry and molecular biology of fruit ripening. Metabolic pathway engineering and applications in food industry. Enzymes in food processing - isolation and purification of enzymes. Enzyme immobilization and applications. Use of amylase, invertase, protease, pectinase and cellulase in food industries. Biotechnology applied to fats and oils. Nutritional Value, flavor. Lipid modifications. Biochemistry and molecular biology of food preservation and processing. Principles of plant tissue culture-sterilization techniques. Bioreactors. Single - Cell Proteins. Starter Cultures. Potential Impact of Biotechnology on food Industries, downstream processing techniques. Regulatory and social aspects of biotechnology of foods, application of enzymes in food industry, production of food flavour, colour, enzymes.

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

Photosynthesis - Electron transport, ATP synthesis, Carbon fixation, photorespiration, C4 and CAM photosynthesis, ecological considerations. Water properties - water potential, water transport, transpiration stream. Mineral nutrition - essential elements, mineral uptake, solute transport, mycorrhizae, nitrogen assimilation, nitrogen fixation. Phloem transport. Carbon allocation / yield. Stress physiology - chilling and freezing. Plant growth and development - hormones and signal transduction, phytochrome, flowering, circadian rhythms.

Practical

Preparation of solutions, Plasmolysis, water potential, imbibition, osmosis in living plant cells, unequal transpiration in leaves, measurement of transpiration rate.Photosynthesis. Extraction and estimation of chlorophyll pigments. Quantification of growth hormones.

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

Theory

Bacteriophages - Classification, morphology, structure and reproduction. Phage - μ, T3, T4, lambda, single stranded DNA phages - M13 and RNA phages. Lytic and lysogenic cycles, transduction. Cyanophage and actinophage. Fungal and algal viruses. Plant viruses - classification, morphology, structure, composition and reproduction. Transmission of viruses. Diseases caused by plant viruses and their control - TMV, CaMV, Rice blight virus, Banana bunchy top virus, BSV. Animal viruses - classification, morphology, structure, composition and reproduction. Cytocidal

infection, cytopathic effects and cell damage. Small RNA viruses - Rous sarcoma viruses, negative strand RNA viruses, double stranded RNA viruses, Rheoviruses, Retro viruses - AIDS. Foot and mouth disease virus. Viroids and prions. Viral genome structure. Viral replication - DNA viruses, RNA viruses. Techniques used in virology - quantification, enumeration of viruses. One step growth curve. Viral cultivation - egg and tissue culture cultivation. Applied virology and diagnostics - immuno and molecular diagnostics. Control of viral diseases - vaccine production. Types of vaccines - Live, attenuated vaccine, inactivated vaccine, vaccination programme. Antivirals - anti-metabolites as control agents. Response to viral infections, interferons. Role of viruses in biological control measures. Viral vectors - gene delivery, viral vaccines. RNA interference - antiviral effects and viral modulation of RNAi. Molecular biology of cancer - genetic basis of cancer, benign and malignant tumor - kinetics of tumor cell growth, host factors affecting tumor cell growth, in vitro tumor cell growth, karyotypic changes in tumors. Metastasis. Carcinogenic agents and their cellular interactions - chemical, radiation, viral. Oncogenes and cancer - product of proto-oncogenes and their functions, activation of proto - oncogene, cancer suppressor genes. Host tumor interactions. Hormones in cancer, Telomerases and their role in cancer.

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

guidelines, guidelines for rDNA research activity, containment facilities and biosafety practices, guidelines for research in transgenesis. Drugs and cosmetics rules. Guidelines for generating preclinical and clinical data for rDNA vaccines, diagnostics and other biologicals. Drug policy. Seed Policy. Plant quarantine order.

SEMESTER IV

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

Theory

Enzyme nomenclature and classification. General properties of enzymes. Extraction, assay and purification of enzymes, steady state kinetics, Michaelis - Menten, Lineweaver - Burke, Eadie - Hofstee and Hanes - Woolf equations and Km value. Enzyme inhibitors. Fast kinetics to elucidate the intermediates and rate limiting steps, enzyme specificity, nucleophilic and electrophilic attack, role of metal ions in enzyme catalysis. Mechanism of enzyme action. Zymogens and enzyme activation, Allosteric interactions and product inhibition, complex kinetics and analysis. Membrane bound enzymes - extraction, assay, lipid - protein interaction and effect of fluidity on enzyme activity. Coenzymes. clinical and industrial applications of enzymes, immobilisation of enzymes and their applications, ribozymes and their applications, enzyme engineering.

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.

Pbgn.2202 Methods of plant breeding** (1+1)

Theory

Methods of plant breeding - introduction and acclimatization. Selection, mass selection, Johannson's pure line theory, genetic basis, pure line selection. Hybridisation - aims and objectives, type of hybridizations. Methods of handling of segregating generations - pedigree method, bulk method, back cross method and various modified methods. Incompatibility and male sterility - utilization in crop improvement. Heterosis - inbreeding depression, theories of heterosis, exploitation of hybrid vigour, development of inbred lines. Single cross and double cross hybrids. Recurrent selection, synthetics and composites. Methods of breeding for vegetatively propagated crops, clonal selection, mutation breeding, ploidy breeding, wide hybridization.

Practical

Botanical description and floral biology in self and cross pollinating species. Study of megasporogenesis and microsporogenesis. Plant breeders' kit. Selfing, emasculation and crossing techniques in major crops. Selection methods in segregating populations.

Biot.2214 Analytical techniques in biotechnology (2+1)

Theory

Electrophoresis - principles, agarose gel electrophoresis, PAGE, denaturing gradient PAGE, detection of nucleic acids on gels, staining techniques, isolation of DNA from gel. Blotting methods. Chromatography - column, paper, thin layer. Spectrophotometry - Applications in quantification of nucleic acids & determining cell density. Microscopy - different types. Centrifugation. Use of radio isotopes-labelling, autoradiography. Radio immuno assay. ELISA. Polymerase Chain Reaction. Molecular Markers - RFLP, RAPD, AFLP.

Practical

Preparation of solutions, buffers and dyes. Familiarization of different experimental techniques –microscopy, centrifugation - separation of macromolecules, chromatography, electrophoresis, spectophotometry, ELISA, PCR, RAPD, AFLP RFLP etc.

Biot.2215 Bioinformatics (1+2)

Theory

Bioinformatics as a tool for biotechnology, databases, dynamic programming sequence analysis using different programmes, BLAST, FASTA, ClustalW, applications of bioinformatics, dendrograms, phylogenetic trees, DNA chips. Molecular mechanics and dyanamics, molecular simulation. Prediction of molecular structure using neural network, hidden Markow model etc. Structure of protein and nucleic acid. Structure prediction methods. Application of bioinformatics - database management, computer aided drug design - limitations and advantages.

Practical

Sequence analysis by BLAST-FASTA-ClustalW-primer designing prediction of 3D structure of proteins - construction of dendrograms-phylogenetic trees. Molecular visualization using Molmol, Rasmol, 3D structure. Docking, homology modeling.

Biot.2216 Genetic engineering I (2+2)

Theory

Genetic engineering-principles and methods. Identification and isolation of genes. DNA cloning strategies. Characteristics of vectors - plasmids, phages and cosmids as cloning vehicles, PCR techniques for cloning. Separation and isolation of nucleic acids and proteins, sequencing. Enzymes of molecular cloning - exo and endo nucleases, restriction enzymes, classes of restriction enzymes, mode of action. Methylation. ligases. DNA polymerases. preparation and screening of genomic and cDNA libraries. cDNA cloning. Structural and regulatory genes. Antisense RNA-ribozymes.

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

Use of molecular techniques for identification and characterization of plant and animal pathogens – PCR, RAPD, AFLP, microsatellite. Southern, Northern and Western blotting and hybridization. Autoradiography, labeling of nucleic acid probes, preparation of antibody, agglutination, precipitation, titre estimation. ELISA. Bioassay of pathogens.

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

multifuctional 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

Transformation of animal cells, immortalization, cell lines. biology of viral vectors - SV40, adeno virus, retro virus, vaccinia virus, herpes virus, baculo virus. Construction of animal viral vectors for gene transfer.Production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.Gene therapy - prospects and problems. Biotechnological applications for HIV diagnostics and therapy. Oncogenes and antioncogenes. Phage display technology. Signal transduction. Transgenic animal production and application in, expression of therapeutic proteins. Gene knock out and mice model for human genetic disorder. Baculovirus for biocontrol, expression of foreign genes. Nucleic acid based detection of human disease genes.

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. Catogories of research - fundamental, basic,

applied, adaptive, operational, action research. Level of research. Collaborative research. Participatory research. Identification of research problems. Formulation of research project proposals. Literature search. Planning of experiments. Technical programme. Design and lay out of experiments. Recording observations. Tabulation, analysis and interpretation of data. Project records. Reporting. Thesis, research papers, popular articles. Presentation of data. Monitoring and evaluation.

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

Principles of chemical reactor analysis and design. Experimental determination of rate equations, design of batch and continuous reactors, optimization of selectivity in multiple reactions, consideration of thermal effects and residence time distribution. Introduction to multi - phase reactors. Kinetics of microbial growth, structured and unstructured model of growth, equations for substrate utilization and product formation. Agitation- different types, effect of agitation on aeration, flow behavior. Sterilization of air and medium - different methods of sterilization. Kinetics of sterilization, batch and continuous sterilization, advantages and disadvantages. Mass Transfer - mass and energy balance in microbial processes, resistances encountered in fermentation medium by the oxygen molecule, role of dissolved oxygen concentration in mass transfer. Dimensional analysis, heat transfer in bioreactors, mass

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

Eukaryotic vectors. Gene regulation. Post - translational modifications. Comparison of transcription in Prokaryotes, Eukaryotes and Archaea. Introduction of recombinant DNA technology. Attenuation and anti termination mechanisms in Bacteria. Enzymes used in recombinant technology. Bacterial plasmids, bacteriophage lambda-I structure & assay. Plasmids - replication and copy number control. Bacteriophage lambda-II life cycle and gene regulation. Plasmid and cosmid vectors. Restriction modification systems in bacteria. F factor and conjugation. Transformation. Viruses - Generalized and Specialized transduction. Bacteriophage lambda vectors, M-13 based vector. Transposable elements, Yeast vectors, *E.coli* expression systems, Cloning Strategies. Strategies for screening DNA libraries. Analysis of recombinants. Gene Therapy Molecular genetics in clinical practice, genetic counselling.

Practical

Genetic transformation – biolistic and *Agrobacterium* mediated. Screening of recombinants, regeneration of transformants. Modification of vectors.Confirmation of transformation using PCR and nucleic acid hybridization.

Biot.3121 Immunology (2+1)

Theory

History and scope of immunology. Types of immunity - innate, acquired, passive and active. Physiology of immune response - MI and CMI specificity and memory. Antigen-antibody reactions.Antigens - types, hapten, Immunoglobulins - structure, distribution and function. Molecular biology of Ig synthesis. Lymphoid tissues - Ontogeny and physiology of immune system - origin and development, differentiation of lymphocytes. Lymphocyte sub - populations of mouse and man. Structure and functions of class I and II molecules. Antigen distribution in population - HLA in human health and diseases. Transplantation immunity - Organ transplantation and HLA tissue typing. Effector mechanisms in immunity - macrophage activation. Cell-mediated cytotoxicity. Hypersensitivity reactions. Cellular interactions in immune response. Antigen recognition. T, B-cell receptors, MHC restriction. Lymphocyte activation, clonal proliferation, differentiation. Interleukins and their role. Complement systems - mode of activation, classical and alternate pathway, biological functions. Immunoregulation - helper and suppressor cells, specific factors, idiotype network. Immune response genes. Immunological tolerance - immunosuppression. Introduction to tumor immunology, autoimmune disorders and immunology of infectious diseases.

Practical

Identification of blood groups. Total and differential white cell counts. Separation of blood leucocytes. Determination of white cell viability. Demonstration of phagocytosis by neutrophils. Determination of ESR. ELISA, preparation of antigen, methods of bleeding, preparation of serum, antigen antibody reaction, precipitation tests, immunodiffusion, immunoelectrophoresis, western blotting.

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

self renewal and differentiation. Biology and techniques involved in derivation, culture and maintenance of pluripotency of embryonic stem cell lines derived from both mouse and human preimplantation embryos. Adult and foetal stem cell types including haematopoietic, mesenchymal, neural and cord blood cells, basic biology, clinical applications of stem cells and their derivatives. Ethical, economic, and social issues. Use of engineered scaffolds for optimal stem cell culture and tissue growth - 2D versus 3D culture, 3D culture in bioreactor system. Rationale for scaffolds, enhance nutrient/waste transport, phenotype, cell migration, temporary structure. Cell chemotaxis, cell flux equations. Bone as a tissue. Bone and material science / tissue engineering. Structure of hair follicle. Primary culture of epithelial cells, concept of feeder layer. Bone formation and mineralization. Concepts of bone differentiation analysis. Tissue engineering. Connective Tissues - structure and function. Skin, organogenesis, tissue healing, inflammatory responses. Mechanical loading systems - cell stretching devices - strain fields and concomitant effects. Functional tissue engineering of articular cartilage, vascular mechanics, functional tissue engineering of blood vessels. Advances in tissue engineering - autologous versus allogeneic transplants, animal models and correlation with humans, engineering transplants and prosthetic devices.

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

Intellectual property - concepts, Intellectual property protection, and Intellectual property rights. Economic importance, mechanisms for protection of IP - patents, copyright, trademark. Trade related aspects of IPR. Intellectual property and international trade - WTO, WIPO, GATT, TRIPS. Protection of plant and animal genetic resources, biological materials, gene patenting, biotechnology / drug related IPR issues - status. Types of patents.

Indian Patent Act 1970. WTO and modifications under TRIPS. Filing of a patent application, types of patent applications. International patenting. Financial assistance for patenting, publication of patents. Patent annuity. Patent attorneys. Patent infringement. Patenting by research students, lecturers and scientists - University / organizational rules in India and abroad.

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

Industrially important microbial metabolites - process technology for the production of primary metabolites. Production of secondary metabolites. Enzyme Technology - source of enzymes, production, isolation and purification of enzymes, applications of enzymes in pharmaceutical industry, in therapeutics and in clinical analysis. Production and use of glucoseisomerase, amylase, cellulase, penicillin acylase, lipase, protease, hydantoinase, nitrilase for the production of different types of drugs and drugs intermediates, future directions. Biomass production from agro - residues - biofertilizers and biopesticides. Immobilized enzyme engineering - different techniques of immobilization of enzymes, kinetics of immobilized enzymes, design and operation of immobilized enzyme reactors, multi step immobilized enzyme systems, application and future of enzyme engineering.

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

Theory

Ethical principles supporting research policies - basic ethical principles and their justifications, analyzing ethical arguments and making decisions. Policies regulating research. Mentoring, under - represented minorities and women in research. Use of humans in research, use of animals in research. Research misconduct. Authorship. Conflicts of interest and commitment. Collaborative research. IP and ethics - positive and negative aspects of IPP, societal responsibility. Avoiding unethical practices. Eco - responsibility - economic, social and environmental benefits of modern biotechnology. Voluntary adoption of pollution control strategies.

Biot.4127 Metabolomics (3+0)

Theory

Energetics - free energy, steady state, Enzyme kinetics. Overview of pathway regulation, mechanisms and strategies. Implications of pathway structure for effective methods of regulation. Central metabolism - types of metabolic pathways and typical reactions of specific types of pathways. Metabolomic data from glycolysis / fermentation, regulatory analysis on cancer cell metabolism. Metabolomic data from the citric acid cycle and related pathways. *Schistosoma* mouse model metabolism. Photosynthesis beta oxidation of fatty acids with electron transport and oxidative phosphorylation. Fatty acid anabolism, connections to central metabolism. Synthesis of cholesterol and steroid hormones, connections to central metabolism. Central metabolism of carbohydrates. Nitrogenous compound-related biochemical pathways. Amino acid biosynthesis and catabolism. Nucleotide biosynthesis and catabolism. Metabolomics and regulation of amino acid and nucleotide pathways, genetic diseases affecting amino acid and nucleotide metabolism and their regulatory implications. Anabolism of polynucleotides, Catabolism of polynucleotides, Anabolism of proteins, Catabolism of proteins. Macromolecular anabolic and catabolic regulation - Global regulation of nucleotide and protein synthesis, regulation of turnover, genetic diseases and antibiotics affecting anabolism or catabolism of macromolecules.

Biot.4128 Environmental biotechnology (2+1)

Theory

Environment - basic concept and issues. Environment pollution - types of pollution, methods of measurement of pollution, pollution control measures and their limitations. Air pollution and its control. Water pollution and its control - measurement of water pollution, waste water collection, waste water treatment - physical, chemical and biological treatment processes, microbiology of waste water treatments. Treatment scheme for waste water of dairy, distillery, tannery sugar, antibiotic industries. Microbiology

of degradation of xenobiotics - ecological considerations, decay behavior and degradative plasmids, oil pollution, surfactants, pestisides.Bioremediation of contaminated soil and waste land. Bio - pesticides and biocontrol agents in integrated pest management. Solid wastes - sources and management. Global environmental problems - zone depletion, green house effect, acid rain.

Practical

Isolation of microbes from natural habitats. Isolation of antibiotic resistant organisms from hospital effluents and study of their characteristics. Determination of biological and chemical oxygen demand (BOD, COD) of different water samples. Determination of bacterial load from different environmental samples. Isolation of lactose fermenting bacteria. Maintenance of stock cultures. Fermentations. Immobilization.

Biot.4129 Biotechnology industry (2+1)

Theory

Technology development, drug related technology development. Toxicological studies, bioequivalence, clinical trials-Phase 1, 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.

Extn.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

Principles of management, management process, functions of organization. Functions of mangers - delegation, decentralization and leadership. Motivation - management control, MIS process of design and management. Use of flow sheets in the design of a process. Entrepreneurship development - theory of entrepreneurship. Process techniques, raw material preparation, product recovery and purification, formulation packaging and quality control. Economic considerations - cost estimation, total product cost, capital investment and profitability. Manufacturing cost estimates, capital investment and resources, cost benefit analysis. Legal and ethical issues, biosafety legal issues concerning genetic engineering, biological containment, ethical and professional problems, risk assessment and prevention. Patents and exploitation of inventions. Intellectual Property Rights (IPR), Farmer's/ breeder's rights, geographic appalletation. Bio industry and prospects - recent trends in the development of bioindustry, selection, transfer and adaptation of technologies. Training of qualified personnel, new relationship between industries and universities. International cooperation. Scope and status of biotechnology industry in India.

Biot.4232 Industrial biotechnology (2+1)

Theory

Products of biotechnology and their living resources. Fermentation process- Fermentors, types, design, auxillary instrumentation of bioreactors, microprocessor controlled fermentation, detection and assay of fermentation products. Immobilization of cells and enzymes.Significance of molecular cloning and genetic engineering, applications in food and pharmaceutical industry. Other high value products - interferons, somatostatin. Microbial degradation of waste products. Biomining - mineral recovery. Types and extend of pollution, health hazard. Principles of biodegradation, techniques to study biodegradation.

Biodegradation of cellulose, lignin, starch, protein, lipid substrates, hydrocarbons pesticides, synthetic products. Role of recombinant technology and mutants in utilizing cellulosic wastes, Biodegradation of Microbial leaching. Aerobic and anaerobic waste treatment process. Solid waste treatment - sludge sanitisation and utilization. Bioremediation - recent advances.

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 micro organisms.

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

Membrane Lipids: chemical composition and differences among eukaryotes, bacteria, and archaea. Transbilayer and in-plane heterogeneity; Membrane Proteins: mechanisms of synthesis, trafficking, and topogenesis. The secretory pathway and molecular mechanisms of endo - and exocytosis. Membrane Receptors: ligand - gated ion channels, G-protein coupled receptors, and catalytic receptors. Signalling cascades. Membrane receptors as allosteric proteins. Soluble receptors. Transport of ions across biological membranes: ion channels, ion pumps, transporters, cotransporters, exchangers, and the underlying physicochemical principles; transport of water and the regulation of cell volume. Cellular responses to acute and chronic osmotic challenges. Trans epithelial transport of solutes and water: transcellular and paracellular pathways. Fundamentals of epithelial electrophysiology.

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 sulphurxenobiotics; 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 - elecrtrophoresis 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; chromate 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.