UNIVERSITY OF CALCUTTA

Notification No. CSR/ 67 /18

It is notified for information of all concerned that the Syndicate in its meeting held on 13.07.2018 (vide Item No.11) approved the Syllabus of M.Sc. Course of Study in Biotechnology under CBCS in the Post-Graduate Departments of the University and in the affiliated Colleges offering Post-Graduate Courses under this University, as laid down in the accompanying pamphlet.

The above shall be effective from the academic session 2018-2019.

SENATE HOUSE
KOLKATA-700073
The 17th August, 2018

(Debabrata Manna)
Deputy Registrar (Acting)

DEPARTMENT OF BIOTECTNOLOGY
AND DR. B. C. GUHA CENTRE FOR GENETIC ENGINEERING AND BIOTECHNOLOGY**UNIVERSITY OF CALCUTTA**

SYLLABUS FOR TWO YEARS M.Sc. COURSE IN BIOTECHNOLOGY

Effective from 2018-19 Academic Year

Orientation of courses in different semesters for M.Sc. in Biotechnology

1st Semester	**MARKS**		
CORE COURSES	**Theo.**	**Prac.**	**Credits(12)**
BTC C11: Biomolecules	25	25	2+2
BTC C12: Cell Biology	25	25	2+2
BTC C13: Molecular Biology	25	-	2+0
BTC C14: Biophysical Chemistry & Instrumentation	25	-	2+0
SUPPORTIVE COURSES			**Credits(8)**
BTC S11: Enzymes & Reaction Kinetics	25	25	2+2
BTC S12: Microbiology	25	25	2+2

2nd Semester			
CORE COURSES			**Credits(14)**
BTC C21: Genetics	25	25	2+2
BTC C22: Biostatistics	25	-	2+0
BTC C23: Metabolism	25	25	2+2
BTC C24: Recombinant DNA Technology	25	25	2+2
SUPPORTIVE COURSES			**Credits(6)**
BTC S21: Diversity of life forms and environmental application	25	-	2+0
BTC S22: Immunology	25	25	2+2

3rd Semester			
CORE COURSES			**Credits(8)**
BTC C31: Genomics	25	25	2+2
BTC C32: Proteomics and Protein Engineering	25	25	2+2
SUPPORTIVE COURSES			**Credits(4)**
BTC S33: Summer Project	-	50	0+4
CHOICE BASED CREDIT COURSES			**Credits(8)**
CBCC-A: Choice Based Credit Course A	50	-	4+0
CBCC-B: Choice Based Credit Course B	50	-	4+0

4th Semester			
CORE COURSES			**Credits(12)**
BTC C41: Medical Biotechnology, IPR, Bio-safety and Bio-ethic	50	-	4+0
BTC C42: Bioprocess Engineering & Microbial Technology	25	-	2+0
BTC C43: Industrial Training	-	25	0+2
BTC C44: Seminar	-	25	0+2
BTC C45: Grand Viva	-	25	0+2
SUPPORTIVE COURSES			**Credits(8)**
BTC S41: Plant Biotechnology	25	25	2+2
BTC S42: Computer Application and Bioinformatics	25	25	2+ 2

Detailed syllabus for first semester M.Sc. Programme in Biotechnology

FIRST SEMESTER

CORE COURSE

BTC C11: Biomolecules:

Concept of Chemical bonding: Forces involved in biological molecules, electrostatic, hydrophobic, H-bonding, van der wal's.

Structure and Functions of Biomolecules and Macromolecules:

Carbohydrates: mono, di- and polysaccharides.

Lipids: classification; structure and function, their role in biological membranes.

Proteins: chemistry of amino acids and peptides, chemical synthesis of peptides, Primary Secondary, Tertiary and Quaternary Structure of proteins; ∝-helix, β-sheet and collagen structure helix-coil transition, Ramachandran plots, amino acid sequences, allosteric interactions, cooperative ligand binding in Oxygen transporters,Hill equation, Protein folding.

Nucleic acids: Watson-Crick model of DNA; sugar puckerings, stacking; B-; A-and Z-DNA ; denaturation kinetics of DNA , Cot curves; structure of tRNA and ribosomes, Supercoiling of DNA and its influence on structure, Nucleosomal structure.

Separation and purification of biomolecules and macromolecules: ionexchange, gel filtration, affinity chromatography, TLC, HPLC, GC, electrophoresis, electrofocusing.

Practicals:

Titration of amino acids, Quantitation of sugars, Estimation of proteins by different methods, SDS-PAGE, Analysis of oils-iodine number, saponification value, acid number.

BTC C12: Cell Biology

Membrane : membrane constituents- phospholipids, glycolipids, cholesterol, membrane proteins; receptors and phospholipases; Phospholipid bilayer- structure, asymmetry, fluid mozaic model of random diffusion of membrane components, domains in membrane-natural and artificial membranes passive movements of solutes; membrane cytoskeleton.

Transport: membrane transport of small molecules, carrier proteins and active membrane transport; ion channels; intracellular compartments and protein sorting; compartmentalization of cells;.transport of proteins into mitochondria and chloroplasts; peroxisomes; the endoplasmic reticulum. membrane anchorage of proteins. Vescicular traffic in the secretary and endocytic pathway; transport from the ER through the Golgi apparatus; transport from the Trans Golgi Network; Transport from Plasma membrane via Endosomes; endocytosis;transcytosis; transport from the Trans Golgi Network to the

cell surface; Exocytosis; the molecular mechanisms of vesicular transport and maintenance of compartmental diversity.

Cell signaling: signaling via G-protein-linked cell surface receptors; signaling via Enzyme-linked cell surface.

Cytoskeleton: The nature of cytoskeleton; Intermediate Filaments; Microtubules; Cilia and Centrioles.

Cell cycle and cell division- general strategies of the cell cycle; yeast and molecular genetics of cell- cycle control; cell-division control in multicellular animals .

Methods of studying the cell surface: re-constitutional studies; fluorescence assisted methods e.g. flow cytometry; membrane active peptides;

Practicals

Subcellular fractionations of tissue by centrifugation, Microscopy: Bright field, Phase Contrast & Fluorescence. animal tissue culture, cell counting, cell viability, cell cycle by flow cytometer, immnuofluroscence by florescence microscope and confocal microscope.

BTC C13: Molecular Biology

DNA synthesis and their processing: General features and enzymology; detailed mechanisms of initiation, elongation and termination; experiments underlying each step and role of individual factors; telomerases: mechanism of replication, maintenance of integrity and role in cancer,

DNA repair and recombination: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways, recombination and transposition, models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition).

RNA synthesis and their processing: RNA polymerase subunits, different sigma factors- related to stress, viral infections etc., initiation, elongation and termination (rho-dependent and independent) of RNA synthesis; anti-termination, attenuation and other influences of transnational apparatus on the process of transcription; eukaryotic promoters, enhancers, transcription factors, RNA polymerases; various protein motifs involved in DNA-protein interactions during transcription.

Protein synthesis and their processing: formation of initiation complex, initiation factors and regulation, elongation and elongation factors, termination, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins.

BTC C14: Biophysical Chemistry and Instrumentation

Thermodynamics: extensive and intensive variables; mathematical description of a system with two or more variables, exact and partial differential; first law of thermodynamics, isothermal process, entropy and second law of thermodynamics,

reversible and irreversible process, free energy and chemical potential; Gibb's free energy; Application of thermodynamics in biological systems.

Spectroscopy Techniques: Principles and application following spectroscopy in biological systems: Absorption Spectroscopy (UV-visible), Fluorescence and Phosphorescence, Circular Dichroism (CD), Infrared spectroscopy (IR), Resonance Raman spectroscopy; Electron spin resonance (ESR),

Instrumentation: Liquid Scintillation counter; pH meter; Ultracentrifuges, optical microscopy; phase, ultraviolet and interference microscope-their applications in cell biology; fluorescence microscope, confocal microscope, fluorescence activated cell sorter (FACS). Electron microscopy, scanning electron microscop, application of electron microscopy in cell and molecular biology; embedding and section cutting.

SUPPORTIVE COURSE

BTC S11: Enzymes and Reaction Kinetics

Introduction: Nomenclature, classification, general properties isoenzyme, active site, substrate, coenzyme, cofactor.

Enzyme kinetics: single and two substrate kinetics, deviation from linear kinetics; ligand binding studies; rapid kinetics; association and dissociation constants; use of isotopes in enzyme kinetics mechanism analysis; effect of pH, temperature and isotopically labeled substrates on enzyme activity;

Enzyme regulation: allosteric model, substrate induced conformational change in enzyme.

Enzyme inhibitors: competitive, un-competitive and non-competitive inhibitors.

Practicals

Enzyme kinetics, effects of pH and temperature on enzyme activity, use of inhibitors for active site determination, Michaelis-Menten equation: determination K_M and V_{max}

BTC S12: Microbiology

Microbial world: Discovery and importance of microorganism in Biotechnology Role of microorganisms in transformation of organic matter and in the causation of diseases. Distribution and classification of bacteria, fungi, anaerobes, cyan bacteria and protozoa. Cultivation, propagation and preservation of microorganisms, sterilization and disinfectants.

Methods in Microbiology: Pure culture techniques; Theory and practice of sterilization, principles of Microbial nutrition: Construction of culture media. Maintenance of microbial cultures of biotechnological importance. Causes of culture degeneration.

Microbial Growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; continuous culture; growth as affected environmental factors.

Bacterial cell structure and fine structure: Structure-function Cell walls of eubacteria (peptidoglycan) and related molecules, Outer-membrane of Gramnegative bactreria, Cell

wall and cell membrane synthesis, Flagella and motility, Cell inclusions like endospores capsules, slime layer pili. Quorum sensing and biofilm formation.

Microbial Taxonomy: New approach to bacterial taxonomy and classification including ribotyping and rRNA sequencing.

Host-Parasite Relationships: Normal micro flora of skin: oral cavity, gastrointestinal tract. Entry of pathogens into the host; Colonization and factors predisposing to infections, Types of toxic (Exo-Endo-Entero-) and their structure, Mode of actions.

Chemotherapeutic Antibiotics: Antimicrobial agents Sulfa drugs. Antibiotics Penicillin and cephalosporins. Board-spectrum antibiotics, mode of action of important antibiotics. Resistance to antibiotics.

Practicals

Preparation of liquid and solid media for growth of microorganism, isolation and maintenance of organism by plating, streaking and serial dilution methods, slant and stab cultures, storage of microorganism. Isolation of pure cultures, Growth curve, microscopic examination of bacteria, yeast and molds, Gram stain, Assay of Antibiotics, Microbiological analysis of drinking water.

SECOND SEMESTER

CORE COURSE

BTC C21:Genetics

Mendelian principles : Dominance, segregation, independent assortment. Mendel's experiments, monohybrid and dihybrid cross; sexual vis-a-vis sexual reproduction; applications of chi square test; deviation from Mendelian segregation; linkage

Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests

Extensions of Mendelian principles : Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

DNA polymorphism in mapping; structure and function; polygenic inheritance.

Extra chromosomal inheritance : Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

Microbial genetics : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Human genetics : Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders, DNA polymorphism in mapping; structure and function; polygenic inheritance.

Quantitative genetics : Polygenic inheritance, heritability and its measurements, QTL mapping.

Mutation : Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

Structural and numerical alterations of chromosomes : Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Techniques of studying Bacteriophages-virulent phage(T4) and Temperate phage(phage lambda). Important aspects of life cycles; phage genome and gene mapping; host parasite relationship, immunity and repression; site specific recombination (lambda and PI), Transposable phage(Phage Mu), genetic organization and transposition , Mu as a genetic tool.

Practicals:

Conjugation, Transaction, Transposome.

BTC C22: Biostatistics

Probability and statistics; population, variables, collection, tabulation and graphical representation of data, frequency distribution, central tendency and skewness, binomial, Poisson and Gaussian distributions, additive and multiplicative laws of probability,

concept and correlation; regression; methods of least squares; chi-square tests, random number generation- testing and use; probability density and cumulative distribution function; systematic and random sampling.

BTC C23: Metabolism

Carbon cycle, bioenergetics and metabolism. Carbohydrate metabolism: glycolysis, the citric acid cycle, the glyoxylate cycle, electron transport, oxidative phosphorylation and regulation of ATP production, the Cori Cycle, gluconeogenesis, glycogen metabolism and metabolism of different sugars. Membranes –its structure and role in ATP generation oxidative degradation of fatty acids and amino acids in animal tissues correlation between carbohydrate, amino acids and fatty and degradation, Metabolism of nitrogen compounds protein turnover, metabolic regulation of enzymes, nitrogen fixation - mechanisms and control he nitrogen cycle as the source of cellular biosynthetic intermediates.

Practicals:

Estimation of cholesterol from blood, Estimation of glucose from blood serum, alkaline phosphatase assay from blood serum, Estimation of liver function test enzyme assay enzyme (SGPT & SGOT).

BTC C24: Recombinant DNA Technology

Principles and methods of recombinant DNA technology- hybridization, cloning, sequencing, polymerase chain reaction, genome projects; gene manipulations; cloning in *E.coli*, plasmids, bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in *E. coli*, products made in *E. coli* by genetic engineering;

Cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2m plasmid, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector; features of yeast promoter and expression of cloned genes; yeast 2-hybrid system; plasmid shuffling to explore interactive domains of multimeric proteins; the cassette model for mating type switches and silencing of genes.

Genetic engineering of plants: transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, *Agrobacterium tumefaciens*; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells- binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

P**racticals**

Isolation of plasmid DNA, transformation, restriction enzyme digestion, ligation , Southern blotting, Northern blotting, Overexpression of proteins, PCR analysis, protein-DNA interactions.

SUPPORTIVE COURSE

BTC S 21 Diversity of life forms and environmental applications

Evolution of environment and Origin of life, Diversification of life and speciation; Classifying organisms: Concepts of phenetics and cladistics; Principles of ecological organization; Basics of structural & functional ecology; Concept of Population genetics; Basic approach to evolutionary biology and behavioural ecology; Evolutionary principles and stable strategies; types of selections.

Biodiversity- levels of biodiversity, alpha, beta and gamma diversity, Values and ethics of biodiversity; Global patterns of biodiversity, hotspots of biodiversity and megadiversity country; Biogeographic zones in India; factors influencing local and regional biodiversity, Biodiversity **documentation**

Threat to species diversity, Extinction vortex, Causes of extinction; Population viability analysis; Red Data Book, Biodiversity conservation approaches: Local, National and International, Insitu and exsitu conservation, Concept of protected area network, Selecting protected areas, criteria for measuring conservation value of areas, Sanctuary, National Park and Biosphere reserves; Design and management of protected areas; Threats to wildlife conservation and wildlife trade; Tools for wildlife research, Wildlife threat, Use of Radiotelemetry and Remote sensing in wildlife research

Perception on Bioresource; Legal binding of biological materials- concept of Biopatents

Environmental biotechnology: Understanding biotechnology, Concept and outlines of various applications- GM crops and GMO: Environmental implications;; Biodegradation, Phytoremediation: types and applications Bio-fuel production, Bio fertilizer, Bio pesticides; Integrated Pest Management,

Microorganisms and environmental pollutants: Overall process of biodegradation, Environmental biomonitoring and indicator microorganisms, biodegradation of organic pollutants, anaerobic biodegradation, in-situ and ex-situ bioremediation, case studies of microbial remediation, lagoon and Vadose zone bioremediation, surface bioremediation of soils and sludge, Applied bioremediation and industrial applications, developing bioremediation technologies, Concept of Fermentation technology and Bioreactor, microorganisms and metal pollutants, metal – microbial interaction and metal remediation; Microbial transformation of pesticides.

Waste treatment – modern wastewater treatment, traditional methods, wetlands and aqua-culture systems, Surface Bioremediation of soil and sludge

BTC S22: Immunology

Blood & Blood cells, Bone Marrow, Reticulo-Endothelial system & ABO Blood groups. Tissue fluid, Lymph, Lymphatics, Lymph nodes and Spleen. Cardiovascular System (Heart, ECG, Blood Pressure, Sino - Aortic mechanism, Regional & Capillary circulation.

Immunoglobins, organization and expressions of Ig genes; B cell maturation, activation and differentiation; MHC/ HLA; antigen processing and presentation; T-cells, T-cell receptors, T-cell maturation, activation and differentiation; cytokines; cell mediated and

humoral effector responses, auto immunity, immunodeficiency diseases, transplantation immunology, cancer and immune system. Monoclonal and polyclonal antibodies, monoclonal antibody technique.

Practicals

Blood film preparation and identification of cells, determination of blood groups, Immunoelectrophoresis , Western Blotting (Immuno-blotting), Immunostaining/Immunofluorescence, ELISA, Immunodiagnostics (using commercial kits).

THIRD SEMESTER

CORE COURSE

BTC C31 GENOMICS

Genomics: genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdisection, molecular markers in genome analysis; RAPD and AFLP analysis, molecular markers linked to disease resistant genes, application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal etc. Genome sequencing: genome sizes, organelle genomes, genomic libraries, strategies for genome sequencing, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. Pharmacogenetics, genetics of globin triplet repeat disorders, cancer genetics; immunogenetics; mapping of human genome; somatic cell genetics; DNA polymorphism in mapping; structure and function; biochemical genetics; polygenic inheritance, Microarray.

Practicals

(i) analyse assembly of sequences

(ii) analysis of sequences from already sequenced genomes to annotate promoter, ORF, analyse putative promoters

(iii) show them yeast two hybrid screen

(iv) arrangement with established facility to learn the process of sequencing and annotation

BTC C32: PROTEOMICS & PROTEIN ENGINEERING

Proteomics: Sample preparation, Gel-based proteomics - two-dimensional gel electrophoresis (2-DGE), two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining methods, PF-2D, Tandem FPLC, Mass spectroscopy: basic principle, ionization sources, mass analyzers, different types of mass spectrometers (MALDI-TOF Q-TOF, LC-MS) Multidimensional proteomics: SELDI-TOF. Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Label-free proteomics.,

Nuclear magnetic resonance spectroscopy (NMR), basic principles, chemical shift, spin-spin interaction, NOE, 2D-NMR, NOESY,COSEY.

X-ray Crystallography: Principle of X-ray diffraction, scattering vector, structure factor, phase problem, reciprocal lattice and Ewald sphere, Miller indices, Zone axes, crystal lattice, Lane Equations, Bragg's law, special properties of protein crystals, model building, refinement and R-factor.

Protein Engineering: Protein sources, Industrial and medical application of proteins, different expression of proteins for large scale purifications, protein engineering strategy, rational and random mutagenesis. Applications of protein engineering protein in

Chemical and Medical Industries: Generation of heat stable, pH stable engymes, application in vaccine development, drug development, sensor development.

Practicals

, Protein electrophoresis-1D+2D, HPLC, FPLC, MALDI-TOF & LC-MS

SUPPORTIVE COURSE

BTC C33: Summer Project

Eight weeks research project in a renewed National/International Institute/University.

CHOICE BASED CREDIT COURSE (DETAILS IN ANNEXURE-I)

CBCC-A: Choice Based Credit Course A ~ 50 marks; 4 credits, 40 lecture hours

CBCC-B: Choice Based Credit Course B ~ 50 marks; 4 credits, 40 lecture hours

FOURTH SEMESTER

CORE COURSE

BTC C41: Medical Biotechnology, IPR, Bio-safety and Bio-ethics

Disease diagnosis-probe: PCR,LCR immunologicalassay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides, Gene therapy, Types of gene therapy, somatic virus germline gene therapy, mechanism of gene therapy, Immunotherapy, Detection of mutations in neoplastic diseases MCC, SSCP, DGGE, PTTC.

Animal Biotechnology: Development Biology; fertilization and organogenesis, Stem cells; potency and differentiation, different signaling for development, Morphogenesis in different model systems, Cloning; Transgenic and knockout systems. Animal cell Culture methods.

Virology: Classification and modes of propagation; bacterial, plant and animal viruses: morphology and ultrastructure; assay of viral particles, cell culture;viral enzymes, nucliec acids, DNA viruses: Herpes, Hepatitis B, Adeno virus; RNA viruses: Polio, VSV, Influenza, Retroviruses: Structure, life cycle, transformation; TMV, Baculoviruses,; Response to viral infections: slow and persistent infections, Antiviral agents, Interferons.

Economics, Biosafety. Patent rights and Special Topics Biotechnology R & D and industry: Business aspects of biotechnology, research and market place, Finance and human resources: Intellectual property right: patents, R & D partnership, license agreement and joint venture

Innovation Management: Technology transfer tools, Industry-Academia collaborations, Bio-incubators, Bio-accelerators, Finishing schools.; Bioethics: Role of bioethics in research. Prevention and management of plagiarism, fabrication/manipulation of data, conflict of interest, socio-cultural and behavioral conflicts during the conduct of research. Authorship & patenting/commercial rights and conflicts. Bioethical norms governing research related to animals and humans.

Biosafety: Prevention and management of chemical and biological hazards associated with research. Evaluation and interpretation of data sheets, labels etc. for pre-assessment of biological and chemical hazards.

BTC C42: Bioprocess Engineering & Microbial Technology

Introduction to Bioprocess Engineering: Bioreactors and membrane Bioreactors and Membrane Bioreactors, Isolation Preservation and Maintenance of Industrial Microorganisms, Kinetics of microbial growth and death, Media and medial sterilization for Industrial Fermentation, Air quality Management and Air sterilization, Types of fermentation processes. Analysis of batch, Fedbatch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed fluidized, photobioreactors etc). Fermentation kinetic and monitoring, Measurement and control of bioprocess parameters.

Downstream processing: Introduction, Removal of microbial cells and solid matter, foam reparation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, membrane process. Drying and crystallization, Effluent treatment D.O.C. and C.O.D. treatment and disposal of effluents. Whole cell Immobilization and their Industrial Applications, Immobilized enzymes in aqueous and non-aqueous media, bioconversion and Biotransformation. Industrial Production of chemicals: Alcohol (ethanol). Acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanon), Antibiotics (penicillin, streptomycinl, tetracy6cline), microlodes, anticancer antibiotic, Amino acids (lysine, glutamic acid), Single Cell Protein, single Cell Lipids. Use of microbes in mineral beneficiation and oil recovery. Introduction to Food technology elementary idea of canning and packin-Fat-Based Edible products, Sterilization and Pasteurization of food Products. Fast-based Nutraceuticals Technology of Typical Food/ food products (bread, cheese, idli, Agro-products (oilseeds) Food preservation, Food colors, Flavors, and Antioxidants. Introduction to Bioprocesses Technology, Hydrogenation, Oxidation, Esterification, Polymerization, Introduction of Microbial Biotechnology-Fine Chemicals (e.g. Biosurfactants, Spirulina, Yeast), oleo chemicals (Fatty acids, Glycerol, Methol-petrochemicals-perfumery chemicals Drugs and pharmaceuticals.

Biology of Industrial Microorganisms: (Saccharomyces, Aspergillus, penicillia, spore forming bacteria etc); Idea of Fermentation, Cell growth, Regulation of Metabolism, Substrate Assimilation/Product Secretion.; Different fermentative system; Batch and Continuous Process, Fermentor Design, Surface and submerged liquid substrate fermentation; Solid Substrate Fermentations, Fermentation raw materials, Downstream processing, Bio-mass production (alcohol, lactic acid, cheese making, bread making, soya based foods, meat fermentation, vinegar, industrial chemical, bio-polymer, bioinsecticides, food additive (amino acids, nucleosides, vitamins, fats and oils), health care products (antibiotics, steroids, vaccines), Production of Industrial solvents (alcohol, acetone, butanol etc.); Industrial Enzymes (amylase, proteases, lipases), concepts of immobilized enzymes.

BTC C 43: INDUSTRIAL TRANING:

Four weeks training in a Biotechnology Industry.

BTC C 44: SEMINAR:

A Recent Peer-reviewed Journal paper will be presented (with Power Point slides) in front of Examiners.

BTC C45 GRAND VIVA

A panel of examiners, comprising of both internal and external examiners, shall conduct the Grand Viva voce examination.

SUPPORTIVE COURSE

BTC S41: Plant Biotechnology

Plant cell tissue and organ cultures: Introduction to cell and tissue culture techniques; tot potency ; Morphogenesis *in vitro*; Organogenesis and somatic embryogenesis; Micropropagation and clonal propagation. Synthetic seeds; Germplasm preservation *in vitro*; Production of haploids and triploids (anther, microspore and endosperm culture); Protoplast culture and somatic hybridization; nuclear and cytoplasmic hybrids. Somaclonal variation in plant cell culture and regenerated plants; Cryopreservation and germplasm conservation

Transgenic plant technology: Gene transfer (vertical) by classical methods; horizontal gene transfer; methods of genetic transformation in plants; methods of nuclear transformation; Organelle transformation; advantages; Direct transformation of plant systems using physical methods; *Agrobacterium* mediated plant transformation; manipulating gene expression in plants, selectable markers and reporter genes, *Agrobacterium tumefaciens*; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells-binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes.

Application of plant transformation for productivity and performance: Herbicide resistance; Insect resistance; Bt genes; long shelf life of fruits and flowers; molecular farming, benefits and risks; Transgene stability and gene silencing; Strategies to avoid gene silencing and improve gene expression in transgenic plants; ethics and plant genetic engineering; metabolic engineering and industrial products; plant secondary metabolites, control mechanisms and manipulations of phenylpropanoid pathway; alkaloids etc.

Practicals

Basic techniques in plant cell, tissue and organ culture**;** Excised embryo culture**;** Organogenesis and somatic embryogenesis; Stages of micropropagation ; Callus and cell suspension culture; isolation and culture of protoplasts; basic techniques in genetic transformation in plants; transformation with wild type and disarmed strains of *Agrobacterium*.

BTC S42: Computer Application and Bioinformatics

Computer Application

Basic idea to work on Linux platform – basic concept of OS. simple shell commands

Bioinformatics

Concept of homology, paralogy, orthology, analogy and xenology

Comparison of sequences of biological macromolecules – Pairwise alignment: local and global alignment; Concept of indel, affine gap penalty; Database search algorithm, significance of hits, Karlin Altschul equation; Multiple sequence alignment, concept of consensus, interpretation with regular expression, concept of protein profile and PSSM, algorithm of PSI-BLAST

Concept of tree, reading and interpreting phylogenetic trees, distance-based and character-based methods for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree.

Kyte-Doolittle plot and Hopp-Woods plot- prediction of localization of a protein, prediction of TMD

Secondary, tertiary and quaternary structure prediction –concept of propensity in Chou-Fasman method; Homology modeling, threading and ab initio method; Docking – rigid and flexible, protein-protein and protein-ligand.

Practicals

Pairwise alignment- local and global alignment using Smith-Waterman and Needleman-Wunsch algorithm respectively. Comparison of the results with reference to percentage identity, percentage gaps.

Comparison of the different BLOSUM matrices.

Cross dot plot to identify regions of similarity/identity and self dot plot to identify repeats.

Two BLAST searches - one using a house keeping protein and another using a rare protein and comparison of the results.

Study of the CATH and SCOP database to write a report followed by classification of a given protein.

Hydropathy plot of a globular and a membrane protein followed by a comparison of the two plots

Identification of consensus sequence through multiple sequence alignment

Using the multiple sequence alignment for the construction of phylogenetic tree

CBCC offered by Dept. of Biotechnology

Biotechniques and Instrumentations

Molecular Biology and Recombinant DNA methods:

Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial vectors. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis,. DNA sequencing methods.

Spectroscopic Methods:

Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, and surface plasma resonance methods.

Proteomics and Mass spectroscopy: Gel-based proteomics - two-dimensional gel electrophoresis (2-DGE), two-dimensional fluorescence difference in-gel electrophoresis (DIGE), Staining methods, PF-2D, Tandem FPLC. Multidimensional proteomics: SELDI-TOF. Quantitative proteomics - stable isotope labeling by amino acids in cell culture (SILAC), isotope-coded affinity tag (ICAT), isobaric tagging for relative and absolute quantitation (iTRAQ); Label-free proteomics. Different types of mass spectrometry and applications in biology.

Modern Genomics Techniques:

DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, western blot, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques.

Gene mapping methods : Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants. Pedigree analysis, lod score for linkage testing. QTL mapping.