DEPARTMENT OF BIOTECHNOLOGY
GAUHATI UNIVERSITY
GUWAHATI-781014

SYLLABUS FOR M.Sc. PROGRAMME
IN
BIOTECHNOLOGY

Effective from August, 2017

M.Sc. Biotechnology Programme (CBCS)

(Total credits:120, Total marks:2100)

Total intake capacity in M.Sc. Biotechnology = **20** seats
Total intake capacity in Open Course (3rd & 4th Sem.) = **25** seats

PROGRAMME STRUCTURE

(L- lecture, T-Tutorial, H- home assignment, P- Practical,

ESE- end semester exam, IA- continuous internal assessment, FW- field work)

:: First Semester ::

Course code	Course name	Credit	Contact hours/Week	Total marks (ESE+IA)	Course Type
BIT-1016	Biochemistry-I	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-1026	Microbiology	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-1036	Cell and Molecular Biology	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-1044	Biochemistry Lab	4	P-8	80	Core (Practical) /Graded
BIT-1054	Microbiology and Cell & Molecular biology Lab	4	P-8	80	Core (Practical) /Graded
BIT1062	Bioinstrumentation	2	L-1, FW-2	32+8=40	Core (Theory) /Graded
	Semester Total:	28	L-16, T-3, P-16, FW-2	500	

‡FW- field work- the contact hours will accrue for a visit to a research hub/facility in the city for demonstration and hands-on training of bioinstruments.

:: Second Semester ::

Course code	Course name	Credit	Contact hours/Week	Total marks (ESE+IA)	Course Type/Nature
BIT-2016	Genetic Engineering	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-2026	Immunology	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-2036	Biochemistry-II	6	L-5, T-1	80+20=100	Core (Theory) /Graded
BIT-2044	Genetic Engineering & Biochemistry-II Lab	4	P-8	80	Core (Practical) /Graded
BIT-2054	Immunology Lab	4	P-7	80	Core (Practical) /Graded
BIT-2062	Bio-statistics and Research Methodology	2	L-2	32+8=40	Core (Theory) /Graded
	Semester Total:	28	L-17, T-3, P-15	500	

:: Third Semester ::

Course code	Course name	Credit	Contact Hours/Week	Total marks (ESE+IA)	Course Type/Nature
BIT-3016	Plant and Animal Biotechnology	6	L-5, T-1	80+20=100	Core (Theory)/Graded
BIT-3026	Bioinformatics	6	L-5, T-1	80+20=100	Core (Theory)/Graded
BIT-3036	Bioresource & Environmental Biotechnology-I	6	L-5, T-1	80+20=100	Elective(Theory) /Graded
BIT-3046	Food Biotechnology & Bioprocessing-I	6	L-5, T-1	80+20=100	Elective(Theory) /Graded
BIT-3054	Plant and Animal Biotechnology & Bioinformatics Lab	4	P-8	80	Core (Practical) /Graded
BIT-3064	Bioresource & Environmental Biotechnology Lab	4	P-8	80	Elective (Practical) /Graded
BIT-3074	Food Biotechnology & Bioprocessing Lab	4	P-8	80	Elective (Practical) /Graded
BIT-3086	Computational Biology	6	L-5, T-1	80+20= 100	Open (Theory)/Graded
	Semester Total:	26+6=32	L-20, T-4, P-16	560	

:: Fourth Semester ::

Course code	Course name	Credit	Contact hours/Week	Total marks (ESE+IA)	Course Type/Nature
BIT-4016	Genomics and Proteomics	6	L-5, T-1	80+20=100	Core (Theory)/Graded
BIT-4026	Bioresource & Environmental Biotechnology-II Lab	6	L-5, T-1	80+20=100	Elective (Theory) /Graded
BIT-4036	Food Biotechnology & Bioprocessing-II Lab	6	L-5, T-1	80+20=100	Elective (Theory) /Graded
BIT-4043	Medical Biotechnology	3	L-3	48+12=60	Core (Project)/Graded
BIT-4059	Dissertation	9	P-18	100˙+20$+30¥ =150	Core (Project)/Graded
BIT-4066	Industrial Biotechnology	6	L-5, T-1	80+20=100	Open (Theory)/Graded
BIT-4072	Advanced lab visit	2	FW‡- 4	30+8=40	Core/Graded
	Semester Total:	26+2=32	L-13, T-3, P-18, FW-4	550	

#Dissertation report evaluation; ˙Quality/Significance of work; $Hands-on training for minimum 7 days/scientific publication in conference, journals, etc./popular science article in leading dailies/attendance of minimum 3 seminars, conferences related to the area of investigation in the dissertation work; Viva-voce¥; ‡FW- field work- the contact hours will accrue for a field visit once in the semester to advanced lab in the country.

Note:

1. 1L- One contact hour, 1T- One contact hour, 1P/FW/H- Two contact hours.
2. Syllabus updation will be done time to time on need basis for meeting the syllabus demands and academic benefits of students.
3. Theory examination will constitute 80 marks for ESE and 20 marks as IA mark to be assessed from 2 internal tests (10 marks), one seminar (4 marks), one assignment (4 marks), and attendance (2 marks). Total marks (Theory) = 100.
4. For BIT-4072, the evaluation will be done based on the report submitted by each student who took part in the academic tour to the faculty members who guided the tour.

COURSE OUTCOMES

BIT1016:Biochemistry-I

Co-01: Generates the ability to describe the fundamentals of structures and functions of biomolecules, such as chemical bonds, acids and bases in living systems.

Co-02: Illustrates the pathways of biosynthesis and breakdown of carbohydrates, lipids and other biomolecules for energy generation in living systems.Interprets thermodynamics of biochemical reactions, and elaborates the role of energy rich compounds as energy currency of cells.

Co-03: Explains the physico-chemical characteristics and biological activity of proteogenic and non-proteogenic amino acids, protein structure, conformations and types. Devisesapproaches to separate and purify proteins.

Co-04: Illustrates lipid biosynthesis and breakdown pathways and other intermediary metabolism.

Co-05: Enumerates the contrasting features of vitamins and co-enzymes, and explain their role in complementing biochemical reactions. Describe about plant and animal hormones, their biosynthesis and biological roles.

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BIT1026: Microbiology

Co-01: Understand the core concepts of the underlining principles in microbial genetics. Solve to understand how they evolve and the basis of their diversity, biochemistry and physiology.

Co-02: Develop a deeper understanding of microbial replication, survival, and interaction with their environment, hosts, and host populations.

Co-03: Illustrate the genetics of metabolic regulation; the principles of growth and microbial nutrition.

Co-04: Building the foundations to generate basic knowledge for subjects like food, environmental and industrial biotechnology.

Co-05: Correlate microbial metabolism with product development/enhancement for global welfare.

BIT1036:Cell and Molecular Biology

Co-01: Illustrates study of the structure, physiology, growth, reproduction and death of cells. Substantiatestructure, function and biosynthesis of cellular membranes, organelles, and the cytoskeleton.

Co-02: Elaborate the exploration on biophysical and molecular regulation leading to changes in cell behaviour, gene expression and protein synthesis or even cell replication. Describe how a cell functions as a unit of life and explain how cells communicate with the external environment to regulate its activities.

Co-03: Correlate the molecular structure and function of extracellular matrices, DNA and RNA, transcription, translation and DNA replication as essential events.interact with each other.
linked to damage in genetic material. Explains how molecular defects in cell cycle regulation can lead to development of cancer. duplication.

Co-04: Explain central dogma, expression of genes and their regulation including post transcriptional and translational modifications, mutation, splicing and repair systems and post translational modifications.

Co-05: Exemplify methods for flow of information from gene to protein and vice versa through various approaches.

BIT1044: Biochemistry-I practical lab

Co-01: Ability to prepare biological buffer solutions, calculate pH of a buffer and determine buffer capacity.
Co-02: Determine the normality of NaOH solution, estimate titration curves of amino acids and determination of their K_a and pK_a.
Co-03: Quantitate glucose, protein, lipids, plant pigments- chlorophylls and carotenoids, vitamin C in plant samples.
Co-04: Demonstrate skill to extract proteins and determine isoelectric point.
Co-05: Acquire quantitative and qualitative data through spectrophotometer, plan, execute, and interpret chromatographic experiments.

BIT1044: Microbiology & Cell and Molecular Biology practical lab

Co-01: Isolate, identify and maintain pure cultures of microorganisms under laboratory conditions, explain the principles of media preparation, plan to prepare enrichment and selective media, isolate free N_2 fixing and hydrocarbon degrading bacteria.
Co-02: Demonstrate staining of bacterial cell walls, observe motility of bacteria, estimate growth curves and determine specific growth rate and cell density of bacteria/ yeasts.
Co-03: Screen for amylase and antimicrobial property displaying bacteria or fungi from natural sources, isolate and identify *E coli* from water/ soil sources.
Co-04: Prepare competent *E coli* cells, transform cells and screen for transformants.
Co-05: Demonstrate isolation of microbial and animal DNA, determine DNA and RNA by conventional biochemical techniques.
Co-06: Demonstrate the procedure and techniques involved in agarose gel electrophoresis of DNA/RNA, generate experiments for polyacrylamide gel electrophoresis of proteins and determination of molecular weights.

BIT1062: Bioinstrumentation

Co-01: Acquaint to general analytical equipment's, maintenance and handling of equipment's, operation and safety measures in laboratory instruments.
Co-02: Understand basic principles in chormatographic techniques including some high end ultrasensitive chromatographic systems.
Co-03: Comprehend basic principles, techniques and applications of different spectroscopic methods and understand basics of spectroflorimetry and mass spectrometry.
Co-04: Analyze the basic understanding of electrophoretic techniques, isoelectric focussing and immunoelectrophoresis.
Co-05: Distinguish the principles of light, dark, phase contrast, fluorescence microscopy and understand the application of high end imaging techniques like electron and confocal microscopy.

BIT2016:Genetic Engineering

Co-01: Understand the basic and advanced concepts of molecular biology and cloning and acquire a deeper understanding of genetic engineering.
Co-02: Elaborate the basics of recombinant DNA technology and define/explain advanced concepts of their applications.
Co-03: Acquire working knowledge of molecular biology protocols, including PCR, genetic mapping, gene isolation and cloning, DNA sequencing during practical sessions.
Co-04: Describe the application of biotechnology in the manipulation of plants, animals and microbes for human benefit.
Co-05: Understand the necessity and principle of genetic manipulation processes in industries for production of pharmaceuticals and useful products.
Co-06: Justify the knowledge through hypothesis generation and designing experiments to solve problems in medicine, agriculture and pharmaceutical industry.

BIT2026:Immunology

Co-01: Imbibeall aspects of the immune system in multicellular organisms including humoral and cell mediated responses.

Co-02: Justify applications to other core fields like microbiology, molecular biology, physiology and biochemistry.
Co-03: Analyze the development and function of the immune system and disease, as well as techniques used in research and conventional diagnostic immunological laboratories.
Co-04: Correlate its applications to the development and clinical use of new immune-based therapies for cancer and infectious diseases, prevention of transplantation responses as well as allergies and autoimmune diseases.
Co-05: Engender critical questions on immunotherapeutics, development of vaccines, drugs and assay kits to determine host pathogen interaction, autoimmune responses, generation of antibody diversity, role of antigen presenting cells, major histocompatibility issues, complement systems, transplantation immunology and elicitor molecules in hypersensitivity.

BIT2036:Biochemistry-II

Co-01: Illustrate the principles of glycoconjugate biology, glycomics and glycome and specify their precise structures and functions. Elaborate the extensive role of proteoglycan structures in vertebrate anatomy.
Co-02: Explain the biosynthesis of cholesterol and its fundamental role in the synthesis of hormones, esters, lipoproteins and eicosanoids as the precursor molecule and also understand the role of eicosanoids in physiological processes.
Co-04: Comprehend the pathways for biosynthesis of amino acids and nucleotides and theirregulationduring cancer and carcinogenesis.
Co-05: Enumerate the importance of enzymes and understand the kinetics of enzyme action, role played in biochemical reactions, classification, structure and functions, controlling factors of enzyme activity and inhibition, allosteric and covalent modifications.
Co-06: Interpret the importance of enzymes as potent biosensors, development of semi-synthetic enzymes through enzyme engineering, immobilization of enzymes and their uses, abzymes and ribozymes in biological applications.
Co-07: Evaluate the significance of electron transport chain in mitochondria and chloroplasts, critique the intricate assemblies involved in transfer of electrons inside living organisms and appraise about the molecular mechanisms involved during energy generation in cells.
Co-08: Apprehend the sources of natural products from indigenous, ethnic plants, animals and microbes and explore their usefulness to humans, analyze the processes of extraction, purification and characterization of natural products through established protocols and process optimizations.

BIT2044:Genetic Engineering & Biochemistry-II practical lab

Co-01: Demonstrate the principles of isolation and quantification of plant DNA, perform agarose gel electrophoresis of plant DNA, perform a PCR reaction and amplify DNA using standard primers.
Co-02: Isolate plasmid DNA from microbial cells, construct a restriction map from the plasmid DNA, clone DNA fragments into plasmid vectors and screen for transformants by colony hybridization.
Co-03: Extract and purify enzymes, assay and investigate their kinetics of catalysis (K_M and V_{max} at different pH, temperature), perform inhibition experiments through spectrophotometer. Demonstrate skills to plan and execute SDS-PAGE experiment for separation of proteins. Perform experiments on immobilization of proteins.
Co-04: Extract, separate and quantify lipids, and cholesterol from biological samples. Perform separation of lipids by TLC.perform SDS-PAGE of enzymes, estimate cholesterol in biological samples, assay the activity of clinically important enzymes like SGPT/SGOT.

BIT2054: Immunology practical lab

Co-01: Prepare an antigen and perform an antigen-antibody reaction.
Co-02: Demonstrate the route of immunization, process of bleeding, separation and collection of serum from rat/mice blood and their preservation for subsequent tests.
Co-03: Perform serological tests for SGOT-PT, demonstrate agglutination reactions, conduct immunoelectrophoresis, ELISA, immunoperoxidase and immunofluorescence experiments.
Co-04: Isolate lymphoid cells from mouse spleen and determine their cell viability.
Co-05: Separate mononuclear cells from blood by density gradient technique, perform Rosette assay for human T cell lymphocytes.

Co-06: Perform DTH skin tests in mice, and conduct leucocyte/macrophage migration inhibition tests in mice.

BIT2062: Biostatistics and Research Methodology

Co-01: Appraise about the importance of statistics in biology, categorize statistics in terms of their application in biotechnological research, data types and graphical representation of data.
Co-02: Recognize population parameters, sampling attributes, sampling types,sampling fundamentals, sampling size and errors during sampling.
Co-03: Devise a hypothesis,test a hypothesis, different types of parametric and non-parametric tests, correlation and regression of data forinterpretation.
Co-04: Identify a research problem, formulate research question, generate and design a hypothesis, null and alternate hypothesis, explain the concept of measurement in research.
Co-05: Explain a research design, concept of dependent and independent variables, measures of central tendency, probabilities, distribution of data, symmetry and kurtosis.
Co-06: Elucidate data preparation in statistics, interpret data and design a thesis layout, use library and e-resources, browse online databases, interpret ethical issues in publishing and justify plagiarism.

BIT3016: Plant and Animal Biotechnology

Co-01: Appraise laboratory requirements for plant tissue culture techniques and explainthe procedures of isolation of single cells from plants, generation of suspension cultures and production of secondary metabolites from plants for human benefit.
Co-02: Describe the principles and techniques of plant micropropagation, production of synthetic seeds, virus free plants and haploids, illustrate the processes of somaclonal and gametoclonal variation and their benefits.
Co-03: Interpret the principles of protoplast technology, protoplast culture, regeneration of plants and decipher somaclonal variation.
Co-04: Describe direct and indirect gene transfer methods in plants, elucidate vectors used in plant transformation, review the role of Agrobacterium tumefasciens in plant genetic engineering and elaborate marker genes used in selection and scoring during plant transformation events.
Co-05: Explain the principles behind generation of herbicide resistant, insect pest resistant, disease resistant, abiotic stress tolerant plants through engineering approaches, elaborate the role of antisense RNA technology in enhancing shelf life of plants and restoration of nutritional quality.
Co-06: Describe the techniques of molecular pharming in plants and animals to produce edible vaccines, biopharmaceuticals and industrial enzymes, critique in-vitro fertilization principles in human and livestock to generate transgenic animals of economic importance.
Co-07: Illustrate the principles of animal cell culture techniques, culture procedures, generation and maintenance of primary cultures, cell lines and cell clones, define importance, function, origin and types of stem cells, therapeutic cloning of embryonic stem cells and ethical issues in stem cell research.

BIT3026: Bioinformatics

Co-01: Develop an overview of applications of *in silico* methods available to deal with solving problems in biology.
Co-02: Explain availability and utility of biological databases. Generate detailed information on sequence, structure and organism specific biological databases that instruct information on data retrieval.
Co-03: Inculcate knowledge development towards applications of tools, modules and software for analysis of genome and proteome.
Co-04: Evaluate developing knowledge on protein structure prediction, homology modelling and modelling protein-protein interactions which have practical applications in industries.
Co-05: Generate basic understanding on computational algorithms, their utility and involvement in tools used for bioinformatics analysis.
Co-06: Describe *hands-on* knowledge on sequence based analysis which include sequence retrieval, multiple and pairwise homology search, annotation of newly obtained sequences, phylogenetic analysis and homology modelling which have profound practical utility in *in silico* drug designing approaches.

BIT3036: Bioresource and Environmental Biotechnology

Co-01: Explain the concept of biodiversity and define hot spots, levels of biodiversity and techniques for the measurement of biodiversity.

Co-02: Elaborate causes and concern of biodiversity loss and procedures for biodiversity conservation, compare and contrast in-situ and ex-situ conservation, explain endemism and techniques to conserve endangered species of plants and animals.

Co-03: Justify conventions on biological diversity, laws and bills that protect biodiversity, biotechnological tools to conserve plant resources and molecular approaches to access plant diversity through germplasm characterization.

Co-04: Define concepts and techniques of bioprospecting, enumerate biotransformation reactions and free radical biology in plants and microbes, substantiate production of secondary metabolites in plants and microbial cells and explain the role of bioreactors to facilitate mass culture of secondary metabolites.

Co-05: Describe biochemical pathways in microorganisms that degrade complex hydrocarbons, pesticides, polyaromatic hydrocarbons, polychlorinated biphenyls and are used for toxicity studies in biological materials, elaborate about microbes that produce biopolymers, biosurfactants and extracellular polysaccharides of industrial use.

Co-06: Explain the principles, techniques, protocols, methodologies, advantages and disadvantages of cryopreservation, ameliorate strategies for long term cryogenic storage and post cryopreservation recovery of plant, animal and microbial cells.

Co-07: Illustrate scope and application of sericigenous insects in developing seri-biotechnology in northeast India, describe about biotechnological tools to enhance silk quality, productivity and improvement of silkworms and their host plants, emphasize on developing techniques to enhance production of endemic muga silkworm and strategies to overcome endemic diseases inflicting muga silkworm populations through the application of biotechnology.

Co-08: Justify Intellectual Property Rights of India, compare and contrast IPR of different nations, discuss patent issues and national patent laws.

BIT-3046: Food Biotechnology and Bioprocessing-I

Co-01: Ability to differentiate chemical and biological processing of foods, techniques and challenges of food preservation, describe the microbiology and biochemistry of different traditional fermented foods and their health benefits. Elaborate knowledge of ways and means to apply traditional fermentation for industrial scale production of fermented foodstuffs by using food fermenting microorganisms (bacteria, yeasts and moulds); Lactic acid bacteria (LAB).

Co-02: Describe symbiosis between the beneficial microorganisms and body, critique the nutrient and other growth requirements of such microorganisms in the body. Compare probiotic, prebiotic, symbiotic and nutraceuticals.

Co-03: Describe enzymes applicable in food industry, production of such enzymes in immobilised form including exemplars of their applications.

Co-04: State the various products of industrial fermentation and describe genetic interventions for quality and quantity improvement.

Co-05: Evaluate the various food laws needed for quality control of industrially and traditionally fermented foods for safety as laid down by CODEX, FSSAI, EFSA, FDA, etc.

BIT3054: Plant & Animal Biotechnology practical lab

Co-01: Learn techniques for sterilization of equipment's and media preparation for plant tissue culture. Demonstrate micropropagation, culture of embryo and preparation of artificial seeds in plant nodal explants.

Co-02: Characterize heat shock proteins in bacteria/yeasts subjected to stress and demonstrate techniques for isolation of *Agrobacterium tumefasciens* from crown gall infected plants.

Co-03: Perform animal cell culture experiments, isolate DNA, RNA from animal cells and execute PCR/RT-PCR reactions of specific gene sequences.

Co-04: Retrieve gene and protein sequences from online sequence/ structural databases and conduct property analysis, perform practical work of simple statistical programmes.

Co-05: Demonstrate datamining procedures for active site analysis of enzymes/ proteins, study protein-ligand binding characteristics and perform organizationalstudy of DNA/protein.

Co-06: Learn techniques for sequence similarity search via BLAST, Clustal-W and generate dendogram for phylogenetic relationships. Derive conserved domains in protein motifs from PROSITE and relevant databases.

BIT3064: Bioresource and Environmental Biotechnology practical lab

Co-01: Demonstrate in-vitro clonal propagation of selective endemic plant species through tissue culture, cryopreservation/ lyophilisation of plant/microbial cells or tissues.

Co-02: Detect coliform bacteria in potable water, determine total dissolved solids, sulphates, COD, BOD in wastewater.

Co-03: Screen bacteria/fungi for in-vitro biosurfactant production, characterize extracellular polysaccharides from bacteria/ yeasts and demonstrate degradation of hydrocarbons by biosurfactant producing bacteria/ yeasts.

Co-04: Isolate PAH/ PCB degrading bacteria from environmental sources by selective enrichment method, extract DNA, perform PCR of 16SrDNA sequences and determine their phylogenetic status.

Co-05: Characterize bioactive components from a selective medicinal plant and demonstrate lab-scale production of biofertilizers, vermicompost and biodiesel using bacteria, annelids and algae.

BIT3074: Food Biotechnology & Bioprocessing practical lab

Co-01: Determine food quality by assessing microbial load of selected fermented and non-fermented foods, such as milk, curd, bamboo shoot.

Co-02: Generate various traditional fermented food items, such as sauerkraut, wine. Demonstrate the use fermentable microorganisms for bioconversion of food substrates.

Co-03: Culture microorganisms for enzyme extraction or biomass production for food applications. Determine biochemical and microbiological parameters of commercial immobilised yeast and prepare immobilised yeast.

Co-04: Critique growth kinetics of microbes and determine tolerance to fermentation products such as alcohol, acetic acid, antibiotic, etc.

Co-05: Screen and produce enzymes of commercial importance from microorganisms.
Plan and execute solid-state fermentation.

BIT3086: Computational Biology

Co-01: Acquire knowledge of hardware and software components of a computer system and use of Windows/Unix/Linux operating systems in biological computational process. Learn the different types ofprimary and secondary biological databases and different types of biological data file formats.

Co-02: Understand the application of scoring matrices PAM and BLOSUM series for sequence analysis and prediction. Learn to perform **s**equence-based database searches using BLAST and FASTA algorithms and Pairwise and Multiple sequence alignment methods. Learn the Method of construction of Phylogenetic trees for **P**hylogenetic analysis.

Co-03: Learn structural organization of DNA, mechanism of DNA replication and process of transcription and translation in prokaryote and eukaryote.

Co-04: Gain knowledge of genome sequencing projects and techniques involved in DNA sequences analysis and high throughput data analysis and acquire knowledge of 2D Gel electrophoresis, Chromatography and Spectroscopy techniques.

Co-05: Understand the basic building blocks of proteins, different structural organization of proteins and different methods applied for prediction of secondary and tertiary structure of proteins, engineering and design of protein structures.

Co-06: Learn the techniques of determination of protein structures by X-ray and NMR methods. Acquire knowledge of structural genomics and various existing structural databases.

Co-07: Learn the application of algorithms in computational biology for DNA computing, molecular computing, RNA secondary structure prediction, Artificial Neural Network and the basics of PERL, Python and C^{++} programming and use of programs in analysis of biological data.

BIT4016: Genomics and Proteomics

Co-01: Understand theorganization of prokaryotic and eukaryotic genomes. Learn strategies for systematic sequencing of complex genomes, sequence analysis, annotation and gene prediction. Gain knowledge of physical and genetic mapping techniques.

Co-02: Learn the process of accessing and retrieving genome project information of different species from the web. Gain knowledge of methods applied in comparative genomics for identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.
Co-03: Acquire knowledge for measurement of concentration, determination of amino acid composition and sequence in a protein.
Co-04: Learn to identify proteins and modified proteins by 2-D electrophoresis and peptide fingerprinting by mass spectrometry. Learn the techniques for study of differential level of transcription,translation and protein-protein interactions.
Co-05: Learn the technique for isolation of high molecular weight DNA and separation of chromosomes by PFGE. Gain knowledge of cloning systems used in genomics, chromosome walking and map-based cloning, contig assembly.
Co-06: Learn high throughput screening methods for identification of functional genes in the genome, gene tagging strategies and identification of gene targets for drug development and the methods employed for differential gene and protein profiling.

BIT4026: Bioresource and Environmental Biotechnology

Co-01: Explain the concept of environmental biotechnology and the role of biotechnology in environment protection in the context of current status with respect to climate change and pollution.
Co-02: Explicate types of environmental pollution, biological indicators and accumulators and application of biosensors in determining the levels of pollution in nature.
Co-03: Elaborate treatment of wastewater and industrial effluents by biotechnological means, air pollution abatement and odour control through deodorization processes and principles cum application of solid waste management.
Co-04: Define the concept of bioremediation involving both naturally occurring and genetically engineered microbes.Elucidate definition and methods of phytoremediation employing both naturally occurring and genetically engineered plants.
Co-05: Describe reforestation approaches using plants to restore degraded lands. Explain the principles and techniques involved in formulation of biopesticides and biofertilizers.
Co-06: Interpret the role of fossil fuels in pollution enhancement with non-conventional sources of bioenergy. Describe global environmental problems on climate change, ozone depletion, green-house effect, acid rain and formulate biotechnological approaches for the management of such problems.

BIT4036: Food Biotechnology and Bioprocessing

Co-01: Explain engineering designs and requirements of bioreactors, its components and kinetics for various cell cultivation methods involving plant, animal and microbes. Devise methods to troubleshoot during the fermentation process.
Co-02: Explicate media formulations and explain the tools and techniques of sterilisation of each media component.
Co-03: Compare and identify the contrasting features of upstream and downstream processing methods with suitable examples.
Co-04: Describe the application of nanotechnology in foods.
Co-05: Generate skills to design and preserve improved microbial strains for special processing and applications in industry.

BIT4043: Medical Biotechnology

Co-01: Explore insights into the understanding of the molecular basis of evolving diseases and their management.
Co-02: Get exposed to information ignited by a variety of technological advancesfuelled by the rapid progress of the human genome project.
Co-03: Describe the paradigm shift of molecular biology and its application in teaching and practice of medicine.
Co-04: Target challenges in the integration of rapidly advancing field into our understanding and treatment of disease.
Co-05: Interprets the understanding of normal body functioning and disease pathogenesis at the molecular level enabling researchers to design specific molecular tools for disease diagnosis, treatment, prognosis, and prevention.

Empowers to pursue a career in biomedical sciences as well as undertake futuristic cutting edge research in relevant areas.

BIT4059: Dissertation

Co-01: Enhance capability to plan and execute a research work starting from identifying a research problem, formulation of a hypothesis and testing the hypothesis through a sequence of experiments followed by data interpretation.
Co-02: Develop skills to acquire analytical data, tabulate and process the data, collate it and describe the observations to formulate a scientific thesis.
Co-03: Empower to gain confidence to communicate scientific work in peer reviewed journals, popular articles in magazines, newspapers, etc.
Co-04: Develop exposure to participate in scientific events like seminars, workshops, trainingsetcthat will act like a primer for a successful completion of research training.
Co-05: Enhance quality and preparedness for direct job and research opportunities in relevant sectors of biotechnology.

BIT4066:Industrial Biotechnology

Co-01: Contrast between conventional and industrial biotechnology, elaborate biotechnological innovations and success stories of products developed for commercial use. Discuss about bioremediation approaches and sustainable management of industrial wastes.
Co-02: Define the role of microorganisms in industrial applications, describe processes to screen industrially important microbes. Design strategies for strain improvement in industries including the probable role of synthetic biology.
Co-03: Elaborate the principles of fermentation, types of fermentation, design and working principle of a bioreactor. Differentiate between liquid and solid state fermentation, process, control and optimizing fermentation parameters, determining efficiency of growth, biomass yield, reactor kinetics and large scale production.
Co-04: Interpret downstream processing techniques in relevance with solid liquid separation, release of intracellular products, concentration, chromatographic purification and formulation of raw metabolites.
Co-05: Explain the use of microroganisms in industries with reference to bakery, confectionary, fermented food, single cell proteins, beverages, wine and products from mushrooms.

BIT4072: Advanced Lab Visit

Co-01: Gain exposure to the industrial environment and a practical perspective of working in industrial units.
Co-02: Undertake opportunity to learn practically the working methods and employment practices through interaction which will enable them to understand the factors influencing decisions in biotechnological companies.
Co-03: Generate practical information about the key functioning of various industries andgain knowledge of process development and application at an industrial scale for product recoveryincluding innovative measures applicable in biotechnology sectorsto translate scientific ideas into commercial products.
Co-04: Acquire knowledge of quality control measurement employed in the development of marketable products in industries.
Co-05: Inculcate an intention to generate industry-academia partnerships and produce job opportunities in both public and private funded industrial sectors like food and pharmaceuticals, agriculture and milk, cosmetics and nutraceuticals and the like.

Syllabus for MSc Biotechnology Programme

SEMESTER-I

BIT-1016 Biochemistry-I (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture//Tutorial outlines
1.	Chemical foundations of Biochemistry: Biomolecules and their three dimensional configuration and conformation. Types of bonds - covalent, ionic, coordinate and hydrogen bonds; Vander-walls forces, peptide bonds, hydrophobic and hydrophilic interactions.
2.	pH, pK, pI, buffers and acid-base balance, ionization of water, week acids and weak bases, Henderson hasselbach equation.
3.	Carbohydrates: classification and general properties of monosaccharides, disaccharides and polysaccharides; Glycolysis, Kreb cycle, gluconeogenesis and glycogenolysis. Pentose phosphate pathway.
4.	Amino acids: classification, properties and chemical reactions; acid base chemistry of amino acids, optical activity and stereochemistry; spectroscopic properties.
5.	Proteins: Structural and functional diversity of peptides and polypeptides; determination of primary structure of a polypeptide (amino acid composition, N & C terminal determination) ; conformational properties of a dipeptide; Ramchandran plot; globular and fibrous proteins.
6.	Separation and purification of proteins.
7.	Classification and properties, biosynthesis of triacylglycerol and phospholipids, fatty acids, α and β oxidation of fatty acids, ketone bodies, glyoxylate cycle.
8.	Bioenergetics: Principles of bioenergetics and laws of thermodynamics; biological oxidation-reduction reactions; Concept of free energy; phosphoryl group transfers and ATP; biological energy transducers and their importance; energy rich compounds in cells.
9.	Vitamins and coenzymes: sources; biological and biochemical functions. Steroids and isoprenoid derivations from vitamins.
10.	Basic concept of Plant and animal hormones.

Suggested readings

1. Lehninger Principles of Biochemistry, D. L. Nelson & M. M. Cox, 6th Edn (2012). W. H. Freeman.
2. Oxford dictionary of Biochemistry and Molecular Biology, Editor: Richard Cammack. 2nd Edn (2006) or later/revised editions. Oxford University Press.
3. Harper's Illustrated Biochemistry- Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 26th Edn (2003) or later editions. McGraw-Hill.
4. Biochemistry- D. Voet and J.G. Voet. 2010. 4 Unbound edition. J. Wiley and Sons.
5. Tools of Biochemistry- T.G. Cooper, Revised Edition, 2011. Wiley India Pvt Ltd.
6. Biochemistry, R. H. Garrett and C. M. Grisham. 2012. 5 edition. Cengage Learning.
7. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Trevor Palmer, Philip Bonner. 2008, 2nd Edn. East West.
8. Molecular and Cellular Enzymology. Jeannine Yon-Kahn, Guy Herve. 2010. Volume I. Springer-Verlag.

BIT-1026 Microbiology (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Brief historical background, developments in 20th century, overview of application of microbiology in different fields
2.	Structure and organization of prokaryotic and eukaryotic cells, Archaebacteria, eukaryotic protists, cell wall of eubacteria-organization and gram reaction, flagella and motility. *E.Coli* as an indicator organism, coliforms; methods for isolation and characterization of *E.Coli*; pathogenic *E.Coli* and its virulence factors.
3.	Pure culture techniques - theory and practice of sterilization, culture media, enrichment culture techniques for isolation of chemoautotrophs and chemoheterotrophs; preservation and maintenance of culture.
4.	Classification- Kingdom Prokaryote; new approaches to bacterial taxonomy including ribotyping based on Bergy's manual of determinative bacteriology.
5.	Viruses- Bacterial, plant, animal and tumor viruses; T-phages - structure and replication, lysogenic and lytic cycle; DNA and RNA viruses with special emphasis on HIV and HBV viruses. Viriods and Prions.
6.	Bacterial Genetics- Transformation, conjugation, transduction, recombination; Ames test for mutagenesis, auxotrophic mutants; plasmids and its role.
7.	Antibiotic resistance in pathogenic bacteria (Enterobacteriaceae) and its mechanism; β-lactamase and ESBL.
8.	Overview of basic metabolic pathways; Primary and secondary metabolic products of commercial importance.
9.	Nutrition and microbial growth - Nutritional groups; carbon, nitrogen, sulphur, and phosphorus requirements; growth factors; role of physical factors on growth.
10.	Definition of growth and growth curve, measurement of growth and growth yields, synchronous growth; batch and continuous culture.

Suggested readings

1. General Microbiology, Stainer, RY, Ingraham JL, Wheelis ML and Painter PR. Macmillan Press Ltd.
2. Microbiology, Pelczar, M.J.Jr., Chan, E.C., S. and kreig, N.R., Tata McGraw Hill.
3. Microbial Genetics, Maloy, S.R., Cronan, J.E. Jr. and Freifelder, D. Jones, Bartlett Publishers.
4. Microbiology-a Laboratory Manual, Cappuccino, J.G. and Sherman, N.Addison Wesley.
5. Fundamental Principles of Bacteriology-A.J. Salle, Tata McGrow Hill.
6. Microbiology-Prescott, Hesley and Klein.
7. Bergeys Manual of Systemic Bacteriology, Williams & Wilkings, Baltimore, London.

BIT-1036 Cell & Molecular Biology (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Structure of prokaryotic and eukaryotic cell.
2.	Cell signaling - Components of signal transduction pathway, Mechanism of signal transduction.
3.	The central dogma, Identification and properties of genetic materials.
4.	Physico-chemical structure of DNA in virus, prokaryotes and eukaryotes.
5.	DNA replication in prokaryotic and eukaryotic systems; Mechanism of replication, enzymes and accessory proteins involved in replications.
6.	DNA repair, DNA methylation.
7.	Transcription: Classes of RNA molecules, RNA polymerases in prokaryotes and eukaryotes; RNA processing in eukaryotes - capping and polyadenylation, Splicing of RNA, Alternative splicing; RNA editing.
8.	Translation: Outline of prokaryotic and eukaryotic translation; Translation machinery - Physical and chemical structure of prokaryotic and eukaryotic ribosome; tRNA and its role; Genetic code and its characteristics; Mechanism of initiation, elongation and termination of polypeptide chains; the role of GTP; Post-translational modification.
9.	Regulation of prokaryotic gene expression: inducible and repressible operon systems: *lac, Ara* and *trp* operon. Concept of regulatory strategies in eukaryotes –levels of regulation, regulation of RNA processing, regulation of transcription, regulation of translation; Regulatory elements of Eukaryotic genes. RNA interference - its role in gene expression.
10.	Homologous recombination - Holiday junction; Gene targeting; FLP/FRT and Cre/Lox recombination; Rec-A recombinases.
11.	Transposable elements: Characteristics, types and application.

Suggested readings:

1. Cell and Molecular Biology-de Robertis and de Robertis.
2. Genes - IX, B. Lewin, Oxford University Press.
3. Genetics-P.K. Gupta.
4. Methods in Plant Molecular Biology-Mary J. Schullar and R.E. Zielinsky.
5. Molecular Biology of Gene (4th edition) Waston *et al*.
6. Molecular Biology of the Cell. Watson *et al*. Pearson education.
7. Plant Molecular Biology-(2nd edition) D. Grieson and S.N. Covey

BIT-1044 Biochemistry-I Lab (Core Practical)

Credits: 4

ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1.	Preparation of biological buffer solutions, calculation of pH of a buffer, and determination of buffer capacity.
2.	Determination of titration curves of amino acids and determination of their K_a and pK_a.
3.	Determination of strength of NaOH solution in normality by titrating against N/10 oxalic acid.
4.	Quantitative estimation of plant pigments-chlorophylls and carotenoids.
5.	Extraction of casein from milk.
6.	Verification of Beer-Lamberts law.
7.	Quantitative estimation of glucose by Anthrone method.
8.	Chromatographic separation of amino acids and sugars by PC and TLC.
9.	Colorimetric estimation of Vitamin-C from various plant sources.
11.	Quantitative estimation of proteins by Folin-Lowry method.
12.	Determination of isoelectric point of proteins.

BIT-1054 Microbiology and Cell & Molecular Biology Lab

(Core Practical) Credits: 4

ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1.	Isolation and maintenance of pure culture of micro-organisms- (a) Preparation of media, (b) Pure culture techniques, (c) Maintenance of culture.
2.	Enrichment and selective isolation of micro-organisms – (a) Isolation of free living/symbiotic N-fixing bacteria, (b) Isolation of hydrocarbon utilizing bacteria.
3.	Gram's staining and observation of motility of bacteria.
4.	Growth curve of bacteria / yeasts. Determination of specific growth rate in a batch culture. Determination of cell density.
5.	Screening of amylase/antibiotic producing fungi/bacteria from soil.
6.	Isolation and identification of *E.Coli* and MPN count.
7.	Competent cell preparation, transformation and Isolation of microbial plasmid from *E.Coli*.
8.	Microbial DNA isolation.
9.	Spectrophotometric quantification of DNA using Diphenylamine method.
10.	Spectrophotometric quantification of RNA using Orcinol method.
11.	Isolation of mitochondria and plastids from different plant species.
12.	Isolation and quantification of DNA from bacteria, plant and animal.
13.	Agarose Gel Electrophoresis.
14.	Protein analysis by vertical slab gel electrophoresis and characterization by standard protein marker.

BIT-1062 Bioinstrumentation (Core Theory)

Credits: 2

ESE- 32, IA- 8, Total marks- 40 Contact hours/week- 2 (L-1, FW- 2)

Unit	Lecture outlines
1	General introduction to analytical equipment's. Maintenance, operation and safety measures in laboratory instruments.
2	Chromatographic techniques: basic principles and applications of adsorption, absorption, partition, ion exchange, gel filtration, affinity and hydrophobic interaction chromatography. Chromatographic methods (paper, TLC, GC, LC, HPLC, FPLC and their applications).
3	Spectrometry: Basic principles and applications of UV-VIS, IR and AAS spectroscopy. Basics of spectroflorimetry and mass spectroscopy.
4	Centrifugation techniques: Basic principles and applications. Ultracentrifugation and density gradient centrifugation.
5	Electrophoretic techniques: Basic principles, applications and types of vertical and horizontal electrophoresis. Techniques involved in agarose, PAGE, PFGE, 2D, field inversion, capillary, submerged, Isoelectric focusing and immunoelectrophoresis.
6	Microscopic techniques: Basic principles of light, dark, filed, phase contrast and florescence microscopy. Principles and applications of SEM, TEM, confocal, atomic force microscope and EM tomography.

* Field work: The practicals will primarily include visits of students to State Biotech Parks/ Biotech Institutes of eminence for demonstration of florescence and confocal microscopy and to IASST, Guwahati for demonstration of SEM and AFM.

Suggested readings:

1. Ackerman 1962. Biophysical Science Prentice Hall, Inc.

2. Daniel, M.1989. Basic Biophysics, Agro Botanical Publishers Bikner.

3. Boyer, R. F. 1986. Modern Experimental Biochemistry. The Benjamin/Cummings Publishing Co. Inc. New York

5. Srivastava, P.K. 2005. Elementary Biophysics, Narosa Publishing House, New Delhi.

6. Piramal, V. 2005. Biophysics. Dominant Publishers and Distributors, New Delhi.

7. Jeyaraman, J. 1981. Laboratory Manual in biochemistry. Wiley Eastern Ltd. Mumbai.

8. Plummer, D.T. 1979. An introduction to practical biochemistry Tata McGraw Hill Co.

9. Keith Wilson and John Walker 1995. Practical Biochemistry University of Cambridge. New York.

SEMESTER-II

BIT-2016 Genetic Engineering (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T- 1)

Unit	Lecture/Tutorial outlines
1.	Basic concepts – Restriction Enzymes; DNA Ligase, Klenow enzymes, T4DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing.
2.	Lambda genome - Molecular mechanism of lysogeny and lytic cycle; M-13 genome. Basic plasmid biology.
3.	Labeling of DNA; Nick translation, Random priming, Radioactive and non-radioactive probes; Hybridization techniques – Northern, Southern and colony hybridization. Fluorescence in situ hybridization.
4.	Cloning vectors – Plasmid; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors; Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Plant based vectors, Ti and Ri vectors; Yeast vectors; Shuttle vectors.
5.	Cloning methodologies – Insertion of Foreign DNA into host cells; Transformation; Construction and screening of Geneomic and cDNA libraries; Expression cloning. Restriction digestion and restriction mapping of cloned genes.
6.	PCR and its application – Basic PCR; Primer design; Types of PCR – multiplex, nested, reverse transcriptase, Real time PCR, touchdown PCR, hot-start PCR, colony PCR; Application of PCR.
7.	DNA sequencing - Maxam and Gilbert's Chemical degradation method; Sanger's Chain termination method; Fluorescence labeled chain termination method.
8.	Antisense RNA - Principles and application. RNA interference (RNAi), Mechanism of RNAi, RNAi as a tool. Ribozymes - Structure, types and functions.
9.	DNA fingerprinting methods; RFLP, RAPD, AFLP and EST techniques.
10.	Basics of gene fusion. Expression and expression analysis using standard reporter genes – lacZ and maltose binding protein. Cleavage of fused protein.

Suggested readings:

1. Plant Genetic Engineering - D.Grieson.
2. DNA Inserting Elements- Plasmids and Episomes. Bukhari Shapiro and Adhya.
3. Elements of Biotechnology - P.K. Gupta.
4. Genetic Engineering - S. Mitra.

BIT-2026 Immunology (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T- 1)

Unit	Lecture/Tutorial outlines
1.	Concept of Immunology: Immunity—innate and acquired, humoral and CMI
2.	Cells and organs of the Immune System and their role.
3.	Antigens and its types, hapten; immunogenecity; Adjuvant—types and use.
4.	Major Histocompatibility Complex: Structure, types and immune response. Concept of HLA.
5.	Immunoglobulins: Molecular structure and classes, B cell receptors, Isotypes, Allotypes and idiotypes. Immunoglobulin superfamily.
6.	Hybridoma technology and Monoclonal antibodies.
7.	Complement system: Activation pathways—classical and alternate.
8.	Cytokines: Types, properties and functions.
9.	Humoral Immune Response: Activation and differentiation of B cells in response to antigenic stimulation. Primary and secondary immune response.
10.	Cell mediated immune response.
11.	Antigen—antibody interactions: Antibody affinity and avidity, agglutination tests, precipitation tests, complement fixation test, ELISA, Radioimmunoassay.
12.	Hypersensitivity reactions: Introduction to autoimmunity, tumour immunology and transplantation immunology.

Suggested readings:

1. Essentials of Immunology- Roitt, I.M. (1980)
2. Immunology– Nandini Sethi.
3. Monoclonal antibodies- Principle and Practice, J.W. Goding (1983)
4. Immunology- Janis Kuby (3rd edition) Freemen.

BIT-2036 Biochemistry-II (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T- 1)

Unit	Lecture/Tutorial outlines
1.	Glycoconjugates: proteoglycans, glycoproteins and glycolipids - structure and function.
2.	Cancer and carcinogenesis (basic concept).
3.	Biosynthesis of cholesterol, cholesterol esters, lipoproteins, eicosanoids.
4.	Biosynthesis of amino acids and nucleotides.
5.	Enzymes - classification, mechanism of enzyme action, enzyme kinetics, Michaelis-Menten equation, control of enzyme activity, enzyme inhibition. Regulatory enzymes -allosteric and covalent modification.
6.	Ribozyme and catalytic antibodies. Isozymes.
7.	Enzymes as biosensors; Enzyme engineering, semi synthetic enzymes.
8.	Immobilized enzymes - methods of immobilization of enzymes. Introduction to kinetics of immobilized enzymes.
9.	Electron transport chain on mitochondria and chloroplast. Mechanism of oxidative phosphorylation and photophosphorylation, Redox potential.
10.	Extraction, purification and characterization of bioactive principles of natural products.

Suggested readings:

1. Lehninger Principles of Biochemistry, D. L. Nelson & M. M. Cox, 6th Edn (2012). W. H. Freeman.
2. Oxford dictionary of Biochemistry and Molecular Biology, Editor: Richard Cammack. 2nd Edn (2006) or later/revised editions. Oxford University Press.
3. Harper's Illustrated Biochemistry- Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell, 26th Edn (2003) or later editions. McGraw-Hill.
4. Biochemistry- D. Voet and J.G. Voet. 2010. 4th Unbound edition. J. Wiley and Sons.
5. Biochemistry, R. H. Garrett and C. M. Grisham. 2012. 5 edition. Cengage Learning.
6. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Trevor Palmer, Philip Bonner. 2008, 2nd Edn. East West.
7. Molecular and Cellular Enzymology. Jeannine Yon-Kahn, Guy Herve. 2010. Volume I. Springer-Verlag.
8. Protein –Structure and Molecular Properties; T. E. Creighton. 1993, 2nd Edn or later editions. WH Freeman and Company.
9. Genes – IX. B. Lewin. 2008. Oxford University Press.
10. Physical Chemistry of Macromolecules, Gary Patterson. 2007. CRC Press.
11. Protein Structure. Max F. Perutz. 1992 or later editions. W. H. Freeman.
12. Enzyme Biotechnology. G. Tripathi. 2009. ABD Publisher.
13. Plant Biochemistry. Edited by P. M. Dey and J. B. Harborne. 1997 or revised editions. Academic Press.
14. Protein Engineering. Stefan Lutz and U. T. Bornscheuer. 2009, Vol. I & II. Wiley-VCH Verlag.

BIT-2044 Genetic Engineering and Biochemistry-II Lab (Core Practical)

Credits: 4
ESE- 80, Total marks- 100 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1.	Isolation and quantification of Plant genomic DNA
2.	Isolation of plasmid DNA
3.	Agarose gel electrophoresis of DNA
4.	Setting up a PCR and amplification of DNA using standard primers.
5.	Construction of restriction map of plasmid DNA
6.	Cloning of small DNA fragments in plasmid vectors.
7.	Screening of libraries using probe by colony hybridization
8.	Extraction and purification of enzymes.
9.	Study of the effect substrate (starch) on amylase activity and determination of Km and Vmax of the reaction.
10.	Effect of pH and temperature on enzyme activity.
11.	Extraction of lipids from egg yolk and their separation by TLC.
12.	Immobilization of enzymes and whole cells (entrapment) in/on sodium alginate or glass or polystyrene beads.
13.	Determination of KI for an enzyme inhibition.
14.	Titrimetric /colorimetric/spectrophotometric assay of enzyme activity.
15.	Polyacrylamide Gel Electrophoresis of enzymes/Protein
16.	Assay of enzyme of clinical significance such as SGOT/SGPT
17.	Estimation of cholesterol in biological samples.

BIT-2054 Immunology Lab (Core Practical)

Credits: 4
ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1.	Preparation of antigen.
2.	Route of Immunization; Process of bleeding; Collection of serum and preservation.
3.	Serological tests– SGOT-PT, Immunoelectrophoresis; Agglutination. ELISA, Immuno-peroxidase test, Immunoflurescence test.
4.	Isolation of lymphoid cells from mouse, spleen and determination of cell-viability.
5.	Separation of mononuclear cell by density gradient technique.
6.	Rosette assay - E rosette for human T cells.
7.	Assay of CMI: DTH skin test, Leukocyte/Macrophage migration inhibition test.

BIT-2062 Biostatistics and Research Methodology

(Core Theory) Credits: 2

ESE- 32, IA- 8, Total marks- 40 Contact hours/week- 2 (L-2)

Unit	Lecture outlines
1	Biostatistics: importance of statistics in biology, data types, descriptive and inferential statistics, graphical representation of data (line graph, bar graph, histograms, dot and scatter plots), box plots, standard deviation and error.
2	Population parameters: sampling types and sampling attributes, random and discrete sampling, sampling fundamentals, characteristics of good sample, simple, random, stratified, systematic and multi-stage sampling, determination of sample size and sample error.
3	Tests for hypotheses: Terms of hypothesis testing, parametric and non-parametric tests, analysis of categorical data and goodness of fit, sign test, chi square test, one-way ANOVA, two-way ANOVA, the *F* statistic, Tukey's test, Correlation (Pearson and Spearman) and regression (simple and multiple linear).
4	Research process: problem identification and formulation, research question. Designing a hypothesis, measurement issues and hypothesis generation, qualities of good hypothesis, null and alternate hypothesis, qualitative and quantitative research, concept of measurement.
5	Designing experiments: exploratory and descriptive research, concept of dependent and independent variables, measures of central tendency, measures of dispersion and variability, probabilities, distribution of data, symmetry and kurtosis
6	Data analysis: data preparation and statistics, interpretation of data, layout of thesis, dissertation, report and paper, presentation and publishing a paper, library and e-resources, academic databases, referencing, softwares for referencing and formatting. Ethical issues, plagiarism and self plagiarism.

Suggested Readings

1. Biostatistical Analysis, 5ht edition- Zar JK, Prentice Hall International, INC, Englewoods Cliffs, New Jersy, 2005.

2. Biostatistics, 8th edition- Daniel WW, John Wiley & Sons Publishers, 2005.

3. Research methodology: methods and techniques, 2nd edition- Kothari CR, New Age International (P) Ltd Publishers, New Delhi, 2004.

4. Text Book of Biostatistics I- Sharma, Discovery Pub, New Delhi, 2005.

5. Fundamentals of Biostatistics- Raastogi VB, Ane's Books, New Delhi,2006.

SEMESTER-III

BIT-3016 Plant and animal Biotechnology (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1	Plant cell and tissue culture - laboratory requirements; culture media preparation; sterilization techniques.
2	Plant Cell culture - isolation of single cells; suspension cultures; application of plant cell culture. Production of secondary metabolites in plants.
3	Micropropagation - principles and techniques; production of synthetic seeds; somaclonal and gametoclonal variation; anther culture and production of double haploids; production of haploids.

Unit	Lecture/Tutorial outlines
1.	Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics, Problems and Applications of Bioinformatics.
2.	Biological databases - Sequence & structural databases, e.g. NCBI, PDB, SwissProt, KEGG and EBI.
3.	Sequence analysis and comparison - (Identity, similarity and homology between sequences; Sequence alignment - pairwise and multiple sequence alignment), e.g. BLAST, FASTA, Clustal W, Phylogenetic relationship and EMBOSS.
4.	Structural organization of digital computer. Different Operating system (DOS and Linux).
5.	Introduction to the language of different levels, flowchart, basic characters, constant variables, I/O statements, relational and logical statements, subscripted variable (arrays).
6.	Introduction to PERL
7.	Systems Biology-an introduction
8.	Needleman-Wunch and Smith-Waterman algorithm
9.	Drug design and development - History of drug design, Analog design, *in silico* drug design.

ed readings:

1. Fundamentals of Biotechnology, By P.Prave, V. Paunt, W. Sitting and D.A. Sukatesh(Ed.) 1987.
2. Animal cell culture Techniques, Ed. Martin Cynes, Springer.
3. Plant Tissue Culture, - MK Razdan, Oxford & IBH Pub. Co.Pvt.Ltd.
4. Elements of Biotechnology – P.K. Gupta

BIT-3026 Bioinformatics (Core Theory) Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Suggested readings:

1. Bioinformatics Basics: Applications in Biological Science and Medicine- H. Rashidi & L. K. Buehler
2. Biological Sequence Analysis – R. Durbin, S. Eddy, A. Krogh, G. Mitchisen
3. Bioinformatics: Sequence & Genome Analysis, By D.W. Mount,
4. Dictionary of Bioinformatics – K. Manikandakumar
5. Plant Genome Analysis – Peter M. Gresshoff (ed)
6. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins – Andreas D. Baxevanis (ed)

7. Introduction to Bioinformatics - Stephen A. Krawetz, David D. Womble
8. Bioinformatics: Concepts, Skills & Applications. Rastogi, S.C., Mendiratta, N. and Rastogi, CBS Publishers & Distributors, New Delhi.
9. Statistical Methods in Bioinformatics: An Introduction. Evens, W.J. and Grant, G.R.

BIT-3036 Bioresource and Environmental Biotechnology (Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorials outlines
1	Biodiversity-concept and definition; hot spots; types and levels of biodiversity; measurement of biodiversity.
2	Biodiversity conservation- causes and concern for loss and degradation of biodiversity; *in-situ* and *ex-situ* conservation; conservation of threatened and endangered species; endemism.
3	Conventions on biological diversity. Biodiversity Bill in India
4	Biotechnological techniques for conservation of plant biodiversity. Plant tissue culture technology.
5	Molecular approaches to access plant diversity- molecular markers in germplasm characterization; Molecular taxonomy.
6	Bioprospecting- concept and techniques; *in vitro* production of secondary metabolites in plant and microbial cells. Biotransformation-reactions and free radical biology. Bioreactors for mass cell culture.
7	Biochemical pathways- breakdown of complex hydrocarbons, pesticides and xenobiotics. Microbial polymers, biosurfactants, microbial plastics and toxicity testing using biological materials.
8	Cryopreservation- principles and techniques; freezing and long term cryogenic storage; post-cryopreservation recovery; advantages and disadvantages of cryopreservation. Cryopreservation protocols for animal, plant and microbial cells.
9	Seri-biotechnology- application of biotechnological tools for increasing silk productivity; enhancing silk quality and improvement of host plants. Characterization of silk proteins and approaches to overcome silkworm diseases.
10	Intellectual property rights (IPR); patenting of biological materials; patent issues and national patent laws.

Suggested readings:

1. Biodiversity and sustainable conservation - HG Kumar, Oxford and IBH Publication.
2. Micropropagation Technology and application - PC Debergle (1991) Kluwer Acad. Publ. Dardrecht.
3. Plant cell, tissue and organ culture: Fundamental methods - OL Gamborg and GC Philips, Narosa.
4. Plant Tissue Culture, - MK Razdan, Oxford & IBH Pub. Co.Pvt.Ltd.

BIT-3046 Food Biotechnology and Bioprocessing

(Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Introduction: Biotechnology and its application in the food processing industries.
2.	Food microbiology and preservation: Food spoilage and food fermenting microorganism; Control of microorganism for food preservation; Methods of preservation - physical, chemical and biological; Radiation preservation; Safety aspects of preservation methods.
3.	Food and beverage biotechnology: Fermented foods and beverages (FFB) – diversity; Diversity of food fermenting microorganisms (bacteria, yeasts and moulds); Lactic acid bacteria (LAB).
4.	Probiotics, Prebiotics, Synbiotic and Nutraceuticals: Characteristics, types, effect on human health and application.
5.	Technology and bioprocessing of traditional fermented foods from soybeans, vegetables (sauerkaraut, bamboo shoots), cereals (rice beer), milk (cheese, yoghurt, kefir) meat and fish. Nutritional qualities of fermented food products and safety. Common Indian Traditional foods & beverages.
6.	Enzymes in food industries: Application and value addition of food products and beverages. Engineering of food enzymes. Rennet production through genetically modified microorganisms. Use of enzymes in HFCS production.
7.	Immobilized enzymes and cells: Application in food industries.
8.	Microbial protein (SCP) as food and feed. Types of substrates and microbes for SCP production. Production of SCP from *Spirulina,* mushrooms and yeasts. Genetic improvement of SCP microorganisms.
9.	Regulatory programmers in food plant sanitation –HACCP and GMP. Food laws and regulations in India.

Suggested readings:

1. Basic Food Microbiology – G.J. Banwart
2. Food Microbiology – W.C. Frazier & D.C. Westhoff

3. Food Microbiology – M.R. Adams & M.O.Moss
4. Biotechnology : Food Fermentation- V.K. Joshi & A. Pandey
5. Enzyme Biotechnology – G. Tripathi
6. Food Biotechnology – Ed. Dietrich Knorr, Marcell Dekker Inc.
7. Microbial Ecology of Foods ,Vol. 1& 2, ICMSF, Academic Press.
8. Industrial Microbiology – Patel
9. Enzymes Biotechnology by N Gray, M Calvin, SC Bhatia

BIT-3054 Plant and animal Biotechnology & Bioinformatics (Core Practical)

Credits: 4

ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1	Media preparation, sterilization and storage in plant tissue culture
2	Micropropagation of selected plants using nodal explants
3	Culture of plant embryo
4	Preparation of artificial seeds
5	Characterization of heat shock proteins in bacteria/ yeasts subjected to stress
6	Animal Cell culture
7	Isolation of DNA from animal tissues and PCR of specific gene sequences
8	Isolation of RNA from animal tissues
9	Practical work of simple statistical programs.
10	Online sequence and structural data bases (retrieving of gene and protein sequence and structure and property analysis of protein sequences and structure)
11	Datamining- Sequence analysis for DNA and Protein, Structural analysis of protein (active site analysis, protein-ligand binding)
12	Sequence similarity search BLAST, Clustal W and generation of dendogram for Phylogenetic analysis, identification of similar motifs and conserved domains of proteins sequences.
13	To be designed as per theory

BIT-3064 Bioresource and Environmental Biotechnology Lab (Core Practical)

Credits: 4

ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1	Media preparation, sterilization and storage in plant tissue culture
2	*In-vitro* clonal propagation of selected plant species through tissue culture
3	Cryopreservation techniques/ lyophillization
4	Screening bacteria/ fungi for *in-vitro* biosurfactant production
5	Screening and characterizing extracellular polysaccharides from bacteria/ yeasts
6	Characterization of bioactive principles from plants
7	Isolation of DNA from environmental microbes, PCR of 16S rDNA and ribotyping
8	Estimating soil enzyme activities—phosphatase/ dehydrogenase/ catalase/ amidase
9	Detection of coliforms for determination of the purity to potable water.
10	Determination of total dissolved solids of waste water.
11	Determination of chemical oxygen demand (COD) of waste water.
12	Determination of biological oxygen demand (BOD) of waste water.
13	Determination of sulphate in waste water.
14	Isolation of Xenobiotic degrading bacteria by selective enrichment technique.
15	Test for the degradation of aromatic hydrocarbons by bacteria.
16	Lab-scale production of biofertilizers, biopesticides, vermicompost and biodiesel.

BIT-3074 Food Biotechnology and Bioprocessing Lab

(Core Practical) Credits: 4

ESE- 80, Total marks- 80 Contact hours/week- 4 (P-8)

Sl. No.	Description of practical demonstration
1.	Microbial load and relative densities (RD) of different microbes in food.
2.	Determination of microbial quality of milk by MBRT and reasazurin reduction method.
3.	Coliform and total bacterial count in food and water.
4.	Isolation and identification *E. coli* LAB, yeasts and moulds from fermented foods.
5.	Study of microbial profile during fermentation of bamboo shoot/mustard seed/soyabean .
6.	Fermentation of grapes using *Saccaharomyces cerevisiae;* ginger wine preparation; estimation of alcohol in the mature product.
7.	Determination of quality of commercial yeasts cake-cell viability (Living-dead cell ratio), dough raising capacity (DRC) determination.
8.	Immobilization of yeasts and fungal cells using Na-alginate.
9.	Determination of alcohol tolerance of two isolates of *Saccharomyces cerevisiar.*
10.	Bioconversion of starch and pectin using immobilized cells by determining substrate depletion rate and end product determination.
11.	Screening of amylase, lipase, pectinase and cellulose producing bacteria and fungi.
12.	Production of edible fungal biomass (SCP) using *Pleurotus sajor-caju.*
13.	(a) Determination of growth curve of a microorganisms and computer specific growth rate (m), generation time (g) growth yield (Y); from the above screening of bacteria/moulds for specific products (alcohol/acid/enzyme etc.)
14.	Effect of different inoculum concentrations on the rate of growth of a bacterium.
15.	Comparative studies of ethanol production using different substrates.

16.	Solid-state fermentation using a fungus (*Rhizepus /Aspergillus*) and detection of enzyme activity (amylase/protease)
17.	Effect of aeration/shaking and pH on the growth/biomass production in bacteria/fungi.
18.	Determination of k_La.
19.	Production and estimation of alkaline phosphatase /protease/ amylase/cellulose/ pectinase.
20.	Antibiotic resistance screening of food-brone E.coli strains.
21.	Sauerkraut formation and estimation of microbial profile during fermentation.

BIT-3086 Computational Biology (Open Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1	**Basic Computers and Analysis tools**
	Introduction to Computational Biology. **O**verview of a computer system, storage, devices, memory. Introduction to Windows/Unix/Linux. **I**ntroduction to primary and secondary Databases. File formats. Genbank, fasta, gcg, msf, nbrf-pir file formats. Sequence patterns and profiles. Sequence Analysis and prediction. **B**asic concepts of sequence similarity, identity and homology. Definition of homologues, orthologues, paralogues. Scoring matrices: basic concept, PAM and BLOSUM series. **S**equence-based Database Searches: definition, BLAST and FASTA algorithms. Pairwise and Multiple sequence alignments. **P**hylogenetic analysis: Definition, description and types of phylogenetic trees, Method of construction of Phylogenetic trees [UPGMA, Maximum Parsimony and Maximum Likelihood method].
2	**Basic Molecular Biology and Bio-techniques**
	Introduction to Life forms. DNA Structure, Replication, Transcription, Translation. High throughput DNA sequences, Genome sequencing projects. Sequence assembly, alignment and annotation. High throughput data analysis. 2D Gel electrophoresis, Column chromatography, Spectroscopy techniques, Mass-Spectroscopy.
3	**Introduction to Structural Biology & Cheminformatics**
	Basic structural principles, building blocks of proteins, motifs of protein structures, alpha domain structures, alpha/beta structures. Macromolecular crystallography-concepts, Folding and flexibility, Prediction, engineering and design of protein structures. Methods to identify secondary structural elements, Determination of protein structures by X-ray and NMR methods. Prediction of secondary structure- PHD and PSI-PRED methods. Tertiary Structure: homology modeling, fold recognition and ab-initio approaches. Structural genomics - concepts and significance. Structural databases.
4	**Algorithms in Computational Biology**
	DNA Computing: DNA Structure, and Processing, Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length. Beginnings of Molecular Computing - Adelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm. Design of covariance models. Application of RNA folds. Combinatorial Pattern Matching. Hidden Markov Model: Support Vector Machines, Artificial Neural Network.

5	**Programming** Simple C++ programs, Introduction to PERL and Python. Procedural concept – decision making, functions and structures, Pointers and file handling.

Suggested readings:

1. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
2. D. Higgins and W. Taylor (Eds), Bioinformatics- Sequence, structure and databanks, Oxford University Press, New Delhi, 2000.
3. Introduction to protein architexcture Arthur M.Lesk., Oxford University Press. 2001.
4. Introduction to Protein Structure, Branden, Carl and Tooze. John Garland, Publication Inc. 1991 S.R. Pennington & M.J. Dunn, Proteomics – from protein sequence to function, BIOS Scientific Publishers, 2002.
5. Data Structures and Algorithm Analysis in C++, 2nd Edition, Mark Allen Weiss, Pearson Education.
6. Introduction to Algorithms, 2nd Edition, T.H.Cormen, C.E.Leiserson, R.L.Rivest, and C.Stein, PHI Pvt.Ltd./ Pearson Education.
7. Object Oriented Programming using C++ (4th Ed.) by Lafore, R. Sams Publishers. 2002.
8. Principles of Gene Manipulation- An Introduction to Genetic Engineering By S.B. Primrose, university of California Press.

SEMESTER-IV

BIT-4016 Genomics and Proteomics (Core Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Introduction: Prokaryotic and Eukaryotic genome organization; Organelle genome-mitochondrial, chloroplast; Sequencing and analyzing genome - Sequencing strategies for the systematic sequencing of complex genomes, sequence analysis, annotation and gene prediction; Physical and genetic mapping - (restriction hybridization analysis, FISH and related techniques, Chromosome painting and microdissection, Long range physical mapping).
2.	Genome sequencing projects: Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers- 16S rRNA typing/sequencing, ESTs and SNPs.
3.	Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectricfocusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.
4.	Pharmacogenetics: High throughput screening in genome for drug discovery- identification of gene targets, Pharmacogenetics and drug development.
5.	Functional genomics and proteomics: Cloning systems used in genomics-Cosmids, P1 bacteriophage, BAC and YAC cloning vectors, Isolation of High molecular weight DNA and separation of chromosomes by PFGE, Contig assembly, Chromosome walking and map-based cloning; Mining functional genes in the genome, Gene tagging strategies and application. ESTs and its utility in genomics, Differential gene profiling methods, DNA chips/Microarrays; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Structural proteomics.

Suggested readings:

1. Fundamentals of Biochemistry, 2nd Edition. Voet D, Voet JG & Pratt CW, Wiley 2006
2. Genomes, 3rd Edition. Brown TA, Garland Science 2006
3. Discovering Genomics, Proteomics and Bioinformatics, 2nd Ed. Campbell AM & Heyer LJ, Benjamin Cummings 2007
4. Principles of Gene Manipulation and Genomics, 7th Ed. Primrose S & Twyman R, Blackwell.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
6. Plant Functional Genomics, Grotewold E, Humana Press 2003
7. The Handbook of Plant Functional Genomics: Concepts and Protocols, Kahl G & Meksem K, Wiley 2008
8. Plant Proteomics: Technologies, Strategies, and Applications, Agrawal GK & Rakwal R, Wiley 2009
9. Gene Expression Studies Using Affymetrix Microarrays, Gohlmann & Talloen W, CRC Press 2009

BIT-4026 Bioresource and Environmental Biotechnology

(Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Environment: Basic concepts and issues. Role of Biotechnology in Environment protection: Concept and definition of Environmental Biotechnology; Current status of biotechnology in environment protection.
2.	Environmental pollution, types of pollution, Biological indicators and accumulators: Application of Protein biomarkers, Biosensors and biochips.
3.	Biotechnology for waste treatment: Biological processes for industrial effluent treatment; biological treatment of waste water - aerobic and anaerobic processes.
4.	Biotechnology for air pollution abatement and odor control: deodorization process, applications; solid waste management.
5.	Bioremediation: Concept and definition; bioremediation using naturally occurring and genetically engineered microorganisms.
6.	Phytoremediation: Definition and methods; Naturally occurring plants for phytoremediation; Transgenic plants for phytoremediation.
7.	Restoration of degraded lands: Reforestation approaches.
8.	Biofertilizers and biopesticides in integrated pest management.
9.	Environment and energy: Fossil fuels and non-conventional sources of bioenergy.
10.	Global environmental problems: ozone depletion, green house effect and acid rain - their impact and biotechnological approaches for management GEP.

Suggested readings:

1. Biodiversity and Sustainable Conservation; H.D. Kumar, Oxford and IBH Publication, New Delhi.
2. Biofertilizers in Agriculture; N.S. Subba Rao, (Ed.) oxford & IBH Publication.

3. Introduction to Biodeterioration; D. Aasopp and K.J. Seal, ELBS/Edward Arnold.

BIT-4036 Food Biotechnology and Bioprocessing

(Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

Unit	Lecture/Tutorial outlines
1.	Introduction: Bioprocesses and Bioprocess engineering.
2.	Bioreactors: Overview of fermentation processes: Production of biomass, microbial enzymes and metabolites, recombinant products and biotransformation; types of bioreactors for microbial fermentation. Structure and design. Bioreactors for animal cell culture-design requirements.
3.	Oxygen and heat transfer in a bioreactor. Mechanism of oxygen transfer; oxygen transfer barriers; volumetric mass transfer coefficient (k_La); oxygen transfer rate (OTR) and oxygen utilization rate (OUR).
4.	Media for industrial fermentation: Basic requirements of production medium; basic components and medium formulation: additional components-growth factors, buffers, precursors, inhibitors, inducers, antifoam, Composition of animal cell culture media. Media for inoculums development.
5.	Media and air sterilization in industrial fermentation.
6.	Microbial growth kinetics in batch and continuous cultures. Comparison between batch and continuous cultures.
7.	Preservation and improvement of industrially important microorganisms.
8.	Downstream processing: Introduction; removal of biomass and solid matters, foam separation, filtration, membrane separation, centrifugation, cell disruption, liquid-liquid separation, chromatography, drying and crystallization.
9.	Upstream and downstream processing of alcohol (ethanol), acid (acetic acid) and enzymes (protease and amylase).
10.	Nanotechnological applications in foods.

Suggested readings:

1. Food Biotechnology – D. Knoer
2. Process Biotechnology Fundamentals - S.N. Mukhopadhyay
3. Bioseparation – B. Sivasankar
4. Bioprocess Technology: Fundamentals and Applications; KTH, Stockholm.

5. Process Engineering in Biotechnology; Jackson, A.T. Prentice hall, Engelwood Cliffs.
6. Fermentation Microbiology & Biotechnology, Ed: EMT et-Mansi, CFA Bryce
7. Principles of Fermentation Technology; Stanbury, P.F.and Whitaker, A., Pergamon Press. Oxford.

BIT-4043 Medical Biotechnology (Core Theory)

Credits: 3

ESE- 40, IA- 10, Total marks- 50 Contact hours/week- 3 (L-3)

Unit	Lecture/Tutorial outlines

1. **Introduction to molecular medicine:** fundamentals of molecular medicine, molecular tools to decipher diseases.

2. **Cellular and Molecular Physiology:** Cellular basis of medical physiology and regulatory processes, Basic characteristics of cell signaling system, cross talk between different signaling pathways. Molecular mechanism of hormone action, receptors and molecular endocrinology. Medical and molecular oncology. Regulation of Cell Cycle and apoptosis.

3. **Personalized medicine**: Introduction, importance of OMICS based technological approaches and applications in personalized medicine.

4. **Molecular Diagnostics and Biomedical genetics**: Introduction, tools and applications.

5. **Clinical microbiology and molecular immunology**: Microbe-host interactions, concept of molecular Parasitology; Concept of BSL; basic mechanism of drug action and molecular mechanism of drug resistance. Immunogenetics, immunodiagnostics and immuno-prophylaxis. Applications of Bioinformatics, cheminformatics and Immuno-informatics as an analytical tool.

6. Clinical Research: Management in Clinical Science, Quality control in Diagnostics, Ethics committee function.

Suggested readings:

1. Medical Biotechnology—Judit Pongracz & Mary Keen, Elsevier, 2017.
2. Biomedical Science Practice: experimental and professional skills—Headley Glencross, Nessar Ahmed & Qiuyu Wang, Oxford University Press.
3. Biomedical Sciences: Essential Lab Medicine—Raymond Iles & Suzzane Doherty, Wiley, 2012.

BIT-4059 Dissertation (Core Project)

Credits: 9

Publication/Seminar/Training- 20, Quality/significance of work- 100,
Viva-voce- 30, Total marks- 150 Contact hours/week- 9 (P-18)

This course will be a project work during the whole semester on allotted days. Every student will be supervised by a faculty member in the project work on a chosen area of research as per mutual consensus of the student and faculty member.

i) 20 marks will be awarded for fulfilling any of the following (a-d) academic exercises.

a. Every student is required to publish the findings in part/full in a poster/paper in conference/seminar/symposium, etc. The expenditure incurred, if any, will be reimbursed by the University subject to a maximum of Rs. 8000 per student.
b. In case **'a'** is not applicable, every student is required to attend a minimum of 3 seminars. The expenditure incurred in all 3 seminars will be reimbursed by the University subject to a maximum of Rs. 8000 per student.
c. If **'b'** is not applicable, every student is required to attend hands on training of minimum 7 days pertaining to the chosen area of research for dissertation. The training should be outside the University, preferably outside the state in accredited and reputed laboratories. TA and DA will be reimbursed by the University subject to a maximum of Rs. 8000 per student.
d. If **'c'** is not applicable, every student is required to publish one popular science article in Everyman's Science/leading newspapers, preferable Assam Tribune, Dainik Assam, and other equally reputed dailies.

ii) 40 marks will be awarded for the quality of the work. Quality will be evaluated based on a minimum number of 4 figures and tables (independent of each other). The marks will be awarded jointly by external and internal examiners.

iii) 40 marks will be awarded jointly by external and internal examiners for performance in viva-voce.

BIT-4066 Industrial Biotechnology (Open Elective Theory)

Credits: 6

ESE- 80, IA- 20, Total marks- 100 Contact hours/week- 6 (L-5, T-1)

1. General Concept: History of biotechnology, traditional and industrial biotechnology, Biotechnological innovations in industry.

2. Upstream processing I: Microorganisms in industrial use. Screening industrially important microorganisms, strain development strategies, synthetic biology, immobilization methods, media formulation, industrial sterilization.

3. Upstream processing II: fermentation equipments, types of fermenters for plant cells, animal cells, and microbes, Single batch, continuous, surface, batch and fed batch, submerged and solid state fermentation. Process, control, optimization of fermentation parameters. Determining efficiency of growth of microbes and product formation, stoichiometry, maintenance, biomass, yield, P/O quotients, metabolite overproduction, efficiency. Reactor kinetics and large scale production.

4. Downstream processing: Solid-liquid separation (flocculation, filtration, centrifugation), release of intracellular products (cell disruption methods), concentration by evaporation, liquid liquid extraction, membrane filtration, precipitation, adsorption, chromatographic purification (ion exchange, gel filtration, affinity, hydrophobic interaction), formulation (freeze drying, crystallization).

5. Commercially successful industrial biotechnological products from microbes, animal and plant cells. Bioremediating approaches in industries and sustainable waste management.

6. Industrial food fermentation: Use of microbes in production of bread, cheese, vinegar, diary products, confectionary, bakery and oriental fermented food products. Single cell proteins, mushroom products, fermented beverages, wine and beer.

Suggested readings:

1. Fermentation Microbiology and Biotechnology—E.M.T El. Mansi, C.F.A. Brye, Arnold L Demain & A.R. Allman, CRC Press, Boca Raton, USA.
2. Cruegers Biotechnology: A textbook of Industrial Microbiology—Wulf Crueger, Anneliese Crueger, edited by K.R.Aneja, Medtech Publications.
3. Bioseparations: Downstream processing for biotechnology—Paul A Belter, E.L. Cussler & Wei-Shou-Hu, Wiley Press.

BIT-4072 Advanced lab visit (Core/Graded)

Credits: 2
ESE- 30, IA- 8, Total marks- 40 Contact hours/week- 2 (FW-4)

Supervised visit to a reputed and accredited lab in India will have to be mandatorily accomplished by every student. The visit will be fully funded by University. January will be the ideal time for the visit. Minimum two labs/research institutes/facilities are to be visited. Every student will be required to submit a detailed report of the visit to the labs/research institutes/facilities within 15 days of the visit. Field work/visit to advanced lab in the country may be scheduled for specified period that matches the contact hours accruing through the semester.

i) The report should contain two sections representing the two labs/research institutes/facilities. Each section should have the following structures:

a. Brief profile of the lab/research institute/facility.

b. Technical details about facilities/instruments/innovations observed. For effective presentation, student may use tables/figures, etc.

c. Comments on work environment/culture/maintenance/ethics followed/ Status of accreditation by NABL, ISO, etc.

d. Any other relevant details.

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