


BACHELOR OF SCIENCE
in
BIOTECHNOLOGY

THREE-YEAR FULL-TIME PROGRAMME
(Semester wise Choice Based Credit System)

Curriculum and Syllabus

ALLAHABAD STATE UNIVERSITY,
CPI campus, Mahatma Gandhi Road, Civil lines,
ALLAHABAD – 211001 (U.P.)



**BACHELOR OF SCIENCE
IN
(BIOTECHNOLOGY)
THREE-YEAR FULL-TIME PROGRAMME**

AFFILIATION

The proposed programme shall be governed by Allahabad State University, Allahabad- 273009

PROGRAMME STRUCTURE

The B.Sc. (Biotechnology) Programme is divided into three Parts as under. Each part will consist of two Semesters as given below. Semester-I, II, III, IV and V has three core courses (two theory courses and one practical) and two elective courses (students can opt for any one elective course for the semester I, II, III, IV and V). Semester –VI (Third Year) comprises of two core courses namely Project work/Review and Seminar. The detail syllabus structure of the B. Sc (Biotechnology) programme is.

Course Number	Course Title	Type Core/Elective
SEMESTER-I		
BT-C-101	Basic Microbiology	Core
BT-C-102	Elements of Biochemistry	Core
BT-E-101	Bioethics and Biosafety	Elective
BT-E-102	Entrepreneurship Development	Elective
BT-C-103	Practical based on paper BT-C-101 & BT-C-102	Core
SEMESTER-II		
BT-C-201	Genetics	Core
BT-C-202	Cell Biology	Core
BT-E-201	Animal Biotechnology	Elective
BT-E-202	Plant Biotechnology	Elective
BT-C-203	Practical based on paper BT-C-201 & BT-C-202	Core
SEMESTER-III		
BT-C-301	Molecular Biology	Core
BT-C-302	Bioinformatics and Biostatistics	Core
BT-E-301	Bio-analytical tools	Elective
BT-E-302	Medical Microbiology	Elective
BT-C-303	Practical based on paper BT-C-301 & BT-C-302	Core
SEMESTER-IV		
BT-C-401	Bioprocess Technology	Core
BT-C-402	Immunology	Core
BT-E-401	Molecular Diagnostics	Elective
BT-E-402	Industrial Fermentations	Elective
BT-C-403	Practical based on paper BT-C-401 & BT-C-402	Core
SEMESTER-V		
BT-C-501	Recombinant DNA technology	Core
BT-C-502	Enzyme Technology	Core
BT-E-501	Environmental Biotechnology	Elective
BT-E-502	Genomics and Proteomics	Elective
BT-C-503	Practicals based on paper BT-C-501 & BT-C-502	Core
SEMESTER-VI		
BT-C-601	Project work /Review	Core
BT-C-602	Seminar	Core



B. Sc (First Year) SEMESTER-I

BASIC MICROBIOLOGY (BT-C-101)

UNIT I

History, development and scope of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization of Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms e.g. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

UNIT II

Cultivation and Maintenance of microorganisms: Nutritional categories of microorganisms, Methods of isolation, Purification and preservation.

UNIT III

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Bacterial Genetic System: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

UNIT IV

Control of Microorganisms: Physical, Chemical and Chemotherapeutic Agents. Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, Bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods.

Books Recommended:

- Brock Biology of Microorganisms, 9th Edition. By Michael T. Madigan, John M. Martinko, Jack Parker. Prentice Hall, Inc.
- Microbiology, 4th Edition. By Lansing M. Prescott, John P. Harley, Donald A. Klem. WCB McGraw Hill.
- General Microbiology, 5th Edition by Roger Y. Stanier, John L. Ingraham, Mark L. Wheelis, Page R. Painter, Macmillan Press Limited.
- Microbiology: Principles and Explorations, 5th Edition by Jacquelyn G. Black. John Wiley & Son, Inc.



ELEMENTS OF BIOCHEMISTRY

(BT-C-102)

UNIT I

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids. Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions

UNIT II

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides. Prostaglandins, Cholesterol. Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Doublehelical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

UNIT III

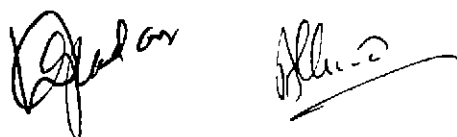
Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme. Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and Hyperthermophilic Archaea and Bacteria. Role of NAD⁺, NADP⁺, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxalphosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions.

UNIT IV

Carbohydrates Metabolism: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. β -oxidation of fatty acids.

Books Recommended:

- Biochemistry by Stryer, Freeman publisher
- Biochemistry, Vol I, II, III by GeofferyZubey, WCB press
- Fundamentals of Biochemistry by Voet, Voet& Pratt, John Wiley publisher
- Principles of biochemistry by Albert Lehninger, David L Nelson & Michael M Cox, Mac Milan worth publisher.



BIOETHICS AND BIOSAFETY

(BT-E-101)

UNIT I

Bioethics – Necessity of Bioethics, different paradigms of Bioethics – National & International. Ethical issues against the molecular technologies. Biosafety– Introduction to biosafety and health hazards concerning biotechnology. Introduction to the concept of containment level and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).

UNIT II

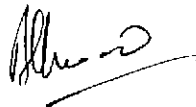
Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other International agreements related to biosafety; Cross border movement of germplasm; Risk management issues-containment.

UNIT-III

General principles for the laboratory and environmental biosafety; health aspects: toxicology, allergenicity, antibiotic resistance etc. Impact on environment; gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms. creation of superweeds/superviruses etc.

UNIT IV

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-isotopic procedures: Benefits of transgenics to human health, society and the environment.



ENTREPRENEURSHIP DEVELOPMENT (BT-E-102)

UNIT I : INTRODUCTION

Meaning, Needs and Importance of Entrepreneurship, Promotion of entrepreneurship, Factors influencing entrepreneurship, Features of a successful Entrepreneurship.

UNIT II : ESTABLISHING AN ENTERPRISE

Forms of Business Organization, Project Identification, Selection of the product, Project formulation, Assessment of project feasibility.

UNIT III : FINANCING THE ENTERPRISE

Importance of Finance / Loans and repayments, Characteristics of Business finance, Fixed capital management: Sources of fixed capital, working capital its sources and how to move for loans, Inventory direct and indirect raw materials and its management.

UNIT IV: MARKETING MANAGEMENT

Meaning and Importance, Marketing-mix, product management – Product line, Product mix, stages of product like cycle, marketing Research and Importance of survey, Physical Distribution and Stock Management.

UNIT V : ENTREPRENEURSHIP AND INTERNATIONAL BUSINESS

Meaning of International business, Selection of a product, Selection of a market for international business, Export financing, Institutional support for exports. Project Report on a selected product should be prepared and submitted.

Books Recommended:

- Holt DH. Entrepreneurship: New Venture Creation.
- Kaplan JM Patterns of Entrepreneurship.
- Gupta CB, Khanka SS. Entrepreneurship and Small Business Management, Sultan Chand & Sons.



PRACTICALS BASED ON PAPER BT-C-101 & BT-C-102 (BT-C-103)

- ✓ Isolation of bacteria & their biochemical characterization.
- ✓ Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
- ✓ Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
- ✓ Determination of bacterial cell size by micrometry.
- ✓ Enumeration of microorganism - total & viable count.
- ✓ To study activity of any enzyme under optimum conditions
- ✓ To study the effect of pH, temperature on the activity of salivary amylase enzyme.
- ✓ Determination of - pH optima, temperature optima, Km value, Vmax value. Effect of inhibitor (Inorganic phosphate) on the enzyme activity.
- ✓ Estimation of blood glucose by glucose oxidase method.
- ✓ Principles of Colorimetry: (i) Verification of Beer's law, estimation of protein. (ii) To study relation between absorbance and % transmission.
- ✓ Preparation of buffers.
- ✓ Separation of Amino acids by paper chromatography.
- ✓ Qualitative tests for Carbohydrates, lipids and proteins.



B. Sc (First Year) SEMESTER-II

GENETICS (BT-C-201)

UNIT I

Introduction: Historical developments in the field of genetics. Model organisms for genetic experimentation. Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity.

UNIT II

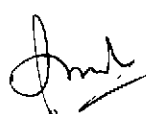
Non allelic interactions: epistasis(dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition –unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, middle repetitive sequences- VNTRs & dinucleotide repeats, repetitive transposed sequences- SINES & LINEs, middle repetitive multiple copy genes, noncoding DNA. Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, chromosome banding pattern, karyotype, giant chromosomes, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.

UNIT III

Chromosome and gene mutations: Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, variations in chromosomes structure - deletion, duplication, inversion and translocation, position effects of gene expression, chromosomal aberrations in human beings, abnormalities – Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

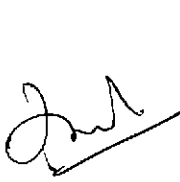
UNIT IV

Genetic linkage, crossing over and chromosome mapping: Linkage and Recombination of genes in a chromosome crossing over, Genetic mapping. Extra chromosomal inheritance: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. Evolution and population genetics: In breeding and out breeding, Hardy Weinberg law(prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.



Books Recommended:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (Latest Edition). Principles of Genetics. VIII Edition John Wiley & Sons.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (Latest Edition). Concepts of Genetics. IX Edition. Benjamin Cummings.
- Russell, P. J. (Latest edition). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (Latest Edition) Introduction to Genetic Analysis, W. H. Freeman & Co.

A handwritten signature in cursive script, possibly reading "J. S.", with a horizontal line underneath.A handwritten signature in cursive script, possibly reading "Klug", with a horizontal line underneath.A handwritten signature in cursive script, possibly reading "Russell", with a horizontal line underneath.

CELL BIOLOGY

(BT-C-202)

UNIT I

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III

Lysosomes: Vacuoles and micro bodies: Structure and functions. Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis: Nucleus: Structure and function, chromosomes and their structure.

UNIT IV

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

Books Recommended:

- Essential Cell Biology by *Bruce Alberts et al.*, Garland Publisher.
- Cell and Molecular Biology by *F. D P deRobertes*, LW & W Publisher.
- Molecular Biology of the Cell by *Alberts, Bray, Lewis, Raff, Roberts and Watson*, Garland Publishers.
- Molecular Cell Biology by *H. Lodish, D. Baltimore, A. Bark, S. L. Zipursky, P. Matsudaira and J. Darnell*, Scientific American Books



ANIMAL BIOTECHNOLOGY

(BT-E-201)

UNIT I

Introduction to animal cell and tissue culture, its advantages, limitations and applications. Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, established cell line cultures, maintenance of cell culture, culture media and role of serum in cell culture, organ culture.

UNIT II

Biology and characterization of the cultured cells. measurement of growth, measurement of viability and cytotoxicity. Scale up of animal cell culture, cell cloning cell synchronization and transformation. Animal propagation – Artificial insemination. Animal Clones. Conservation Biology – Embryotransfer techniques

UNIT III

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning. Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. Transgenic animals: Construction of transgenic animals, gene knockouts, ethical and biosafety considerations.

UNIT IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Books recommended:

- Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
- Culture of animal cells: A manual of basic techniques by R.I. Freshney, Willy-Liss and Sons publication.
- Animal cell culture technique by Martin Clynes, Springer publication.



PLANT BIOTECHNOLOGY

(BT-E-202)

UNIT I

History of plant cell and tissue culture: Culture media; various types of culture; callus, suspension, nurse, root, meristem, etc.; Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

UNIT- II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture and ogenesis. Significance and use of haploids, Ploidy level and chromosome doubling ,diploidization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT – III

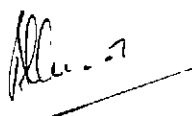
Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identification and selection of hybrid cells, Cybrids, Potential of somatic Hybridization limitations. Somaclonal variation.

UNIT – IV

Plant transformation technology: *Agrobacterium* mediated, Particle bombardment, Electroporation; transgene stability and gene silencing. Chloroplast Transformation. Genetic engineering for resistance against abiotic and biotic stresses; Genetic engineering for increasing crop productivity and quality improvement.

Books Recommended:

- Plant Tissue Culture: Application and Limitation by *S. S. Bhojwani and M K Razdan*, Elsevier Publication
- Plants, Genes and Agriculture by *Maarten J Chrispeels and David E. Sadava*, Jones & Bartlett Publishers
- An Introduction to Plant Tissue Culture by *M. K. Razdan*, Oxford & IBH Publishing Co. Pvt. Ltd.
- Plant Biotechnology: The genetic manipulation of plants by *Adrian Slater, Nigel Scott, and Mark Fowler*, Oxford University Press



PRACTICALS BASED ON PAPER BT-C-201& BT-C-202 (BT-C-203)

- ✓ Permanent and temporary mount of mitosis.
- ✓ Permanent and temporary mount of meiosis.
- ✓ Mendelian deviations in dihybrid crosses
- ✓ Demonstration of - Barr Body-*Rhoeo* translocation.
- ✓ Karyotyping with the help of photographs
- ✓ Pedigree charts of some common characters like blood group, color blindness and PTC tasting.
- ✓ Study of polyploidy in onion root tip by colchicine treatment.
- ✓ Study the effect of temperature and organic solvents on semi permeable membrane.
- ✓ Demonstration of dialysis.
- ✓ Study of plasmolysis and de-plasmolysis.
- ✓ Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
- ✓ Study of structure of any Prokaryotic and Eukaryotic cell.
- ✓ Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
- ✓ Cell division in onion root tip/ insect gonads.
- ✓ Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.



B. Sc (Second Year) SEMESTER-III

MOLECULAR BIOLOGY (BT-C-301)

UNIT I

DNA as genetic material, Structure of DNA, Types of DNA. Replication of DNA in prokaryotes and eukaryotes: Semi conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication. Fidelity of replication.

UNIT II

DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III

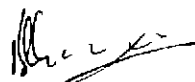
RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, poly adenylation, splicing rRNA and tRNA splicing.

UNIT IV

Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation, Post translational modifications of proteins.

Books Recommended:

- Molecular Biology of the Gene (4th Edition) *J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M Weiner*, The Benjamin/ Cummings Publ. Co. Inc, California
- Molecular Biology of the cell (3rd Edition) by *Bruce Alberts, Dennis Bray, Julian Lewis martin Raff, Keith Roberts and James D. Watson*, Garland Publishing, Inc, New York & London
- Gene Cloning and DNA Analysis (4th Edition) by *T.A Brown*, Blackwell Science
- Essential of Molecular Biology (3rd edition) by *G.M. Malacinski & D. Freifelder*, Jones & Bartlett Publisher



BIOINFORMATICS AND BIOSTATISTICS (BT-C-302)

UNIT I

History of Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Protein Information Sources, PDB, SWISSPROT, TREMBL, Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

UNIT II

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Outline of sequence Assembly, Mutation/Substitution Matrices, Pairwise Alignments, Introduction to BLAST, using it on the web, Interpreting results, Multiple Sequence Alignment. Phylogenetic Analysis.

UNIT III

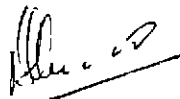
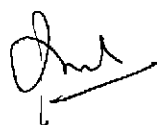
Types of Data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.

UNIT IV

Methods of sampling, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Problems on test of significance, t-test, chi-square test for goodness of fit and analysis of variance (ANOVA), Correlation and Regression. Emphasis on examples from Biological Science.

Books Recommended:

- Introduction to Bioinformatics by *Stephen A Krawetz and David D. Womble*, Humana Press.
- Bioinformatics: Sequence and Genome Analysis by *David W. Mount*, Cold Spring Harbor Laboratory Press
- Fundamental of Biostatistics (5th edition) by *Bernard Rosner*, Duxbury Thomson Learning.
- Basic Statistics (2nd edition) by *B. L. Agrawal*, Wiley Eastern India.
- Introductory Statistics for Biology Students by *T. A Hall*, Chapman & Hall publisher.
- Statistical Methods in Biology by *N. T. J Bailey*, Cambridge Press.



BIO-ANALYTICAL TOOLS

(BT-E-301)

UNIT I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III

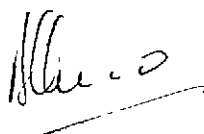
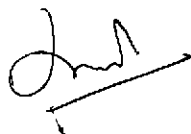
Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Books Recommended:

- Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates. MA.
- Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.



MEDICAL MICROBIOLOGY

(BT-E-302)

UNIT I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of Gram positive bacteria: *S. aureus*, *S. pyogenes*, *B. anthracis*, *C. perferingex*, *C.tetani*, *C.botulinum*, *C.diphtheriae*, *M.tuberculosis*, *M. leprae*.

UNIT II

Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by Gram negative bacteria: *E.coli*, *N. gonorrhoea*, *N. meningitidis*, *P.aeruginosa*, *S. typhi*, *S. dysenteriae*, *Y. pestis*, *B. abortus*, *H. influenzae*, *V. cholerae*, *M.pneumoniae*, *T. pallidum* *M. pneumoniae*, *Rickettsiaceae*, *Chlamydiae*.

UNIT III

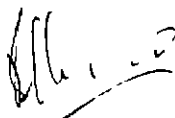
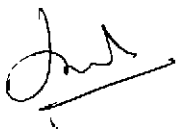
Diseases caused by viruses- Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

UNIT IV

Fungal and Protozoan infections. Dermatophytoses (*Trichophyton*, *Microsporun* and *Epidermophyton*) Subcutaneous infection (*Sporothrix*, *Cryptococcus*), systemic infection (*Histoplasma*, *Coccidoides*) and opportunistic fungal infections (*Candidiasis*, *Aspergillosis*). Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Books Recommended:

- Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.
- Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier. .
- Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.



PRACTICALS BASED ON PAPERS BT-C-301& BT-C-302 (BT-C-303)

- ✓ Preparation of solutions for Molecular Biology experiments.
- ✓ Isolation of chromosomal DNA from bacterial cells.
- ✓ Isolation of Plasmid DNA by alkaline lysis method
- ✓ Agarose gel electrophoresis of genomic DNA & plasmid DNA
- ✓ Preparation of restriction enzyme digests of DNA samples
- ✓ Demonstration of AMES test or reverse mutation for carcinogenicity
- ✓ Sequence information resource
- ✓ Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene ,Protein information resource (PIR)
- ✓ Understanding and using: PDB, Swissprot, TREMBL
- ✓ Using various BLAST and interpretation of results.
- ✓ Retrieval of information from nucleotide databases.
- ✓ Sequence alignment using BLAST.
- ✓ Multiple sequence alignment using Clustal W.



B .Sc (Second Year) SEMESTER-IV

BIOPROCESS TECHNOLOGY (BT-C-401)

UNIT I

Introduction to bioprocess technology. Range of bioprocess technology and its Chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT II

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application introduction processes. Principles of upstream processing – Media preparation. Inocula development and sterilization.

UNIT III

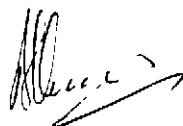
Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT IV

Introduction to downstream processing, product recovery and purification. Effluent treatment. Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic and gluconic), Solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline). Amino acids (lysine, glutamic acid), Single cell proteins.

Books recommended:

- Principles of fermentation technology by *PF Stanbury, A Whitekar and SJ Hull*, Aditya Books.
- Bioprocess Engineering; Basic Concept by *ML Suler & F Kargi*, PHI Press.
- Operational modes of bioreactors (BIOTAL Series), ButterworthHeinemann.
- A Textbook of Industrial Microbiology by *W Cruger & A Cruger*, W. H Freeman (Panima) Publisher.



IMMUNOLOGY

(BT-C-402)

UNIT I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II

Regulation of immunoglobulin gene expression - clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III

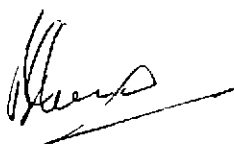
Major Histocompatibility complexes - Class I & Class II MHC antigens, antigen processing, Immunity to infection immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV

Vaccines & Vaccination - adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics - RIA, ELISA.

Books Recommended:

- Cellular and Molecular Immunology by *Abbas et al.*, Saunder Publication.
- Essential Immunology by *Roitt*, Blackwell Publisher.
- Immunology by *Kuby*, Freeman Publisher.
- Immunology-a short course by *Benjamini*, Wiley-Liss Publisher.



MOLECULAR DIAGNOSTICS (BT-E-401)

UNIT I

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solidphases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immunohistochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays.Applications of enzyme immunoassays in diagnostic microbiology

UNIT II

Molecular methods in clinical microbiology:Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphismand plasmid finger printing in clinical microbiology, Laboratory tests in chemotherapy:Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibilitytests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT III

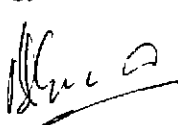
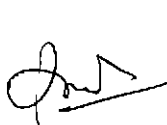
Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors.Epitope design and applications. Immunodiagnostic tests.Immuno florescence. Radioimmunoassay.

UNIT IV

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

Books Recommended:

- Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
- Bioinstrumentation, Webster
- Advanced Instrumentation, Data Interpretation, and Control of Biotechnological processes,J.F. Van Impe,Kluwer Academic
- Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited byPaniker CKJ). University Press Publication.
- Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.
- Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition. Elsevier.
- Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.
- Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein'sMicrobiology. 7th edition. McGraw Hill Higher Education.
- Microscopic Techniques in Biotechnology, Michael Hoppert



INDUSTRIAL FERMENTATIONS

(BT-E-402)

UNIT I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionic acid, butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol, hydrogen, biodiesel, microbial electricity, starch conversion processes; Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti cancer agents, amino acids.

UNIT II

Microbial products of pharmacological interest, steroid fermentations and transformations. Overproduction of microbial metabolite, Secondary metabolism – its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

UNIT III

Purification & characterization of proteins, Upstream and downstream processing, solids and liquid handling. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultracentrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

UNIT IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics: effect of pH and Temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer coefficient (K_a) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Books Recommended:

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology 2nd edition, Elsevier Science Ltd.
- Salisbury, Whitaker and Hall. Principles of fermentation Technology,



PRACTICALS BASED ON PAPERS BT-C-401& BT-C-402 (BT-C-403)

- ✓ Bacterial growth curve.
- ✓ Calculation of thermal death point (TDP) of a microbial sample.
- ✓ Production and analysis of ethanol.
- ✓ Production and analysis of amylase.
- ✓ Production and analysis of lactic acid.
- ✓ Isolation of industrially important microorganism from natural resource.
- ✓ Differential leucocytes count
- ✓ Total leucocytes count
- ✓ Total RBC count
- ✓ Haemagglutination assay
- ✓ Haemagglutination inhibition assay
- ✓ Separation of serum from blood
- ✓ Double immunodiffusion test using specific antibody and antigen.
- ✓ ELISA.



B. Sc (Third Year) SEMESTER-V

RECOMBINANT DNA TECHNOLOGY (BT-C-501)

UNIT I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Principle and applications of Polymerase chain reaction (PCR), Variations in PCR.

UNIT II

Principle of nucleic acid hybridization, Southern, Northern and Western hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, Expression strategies for heterologous genes: vector engineering, codon optimization, host engineering, expression in bacteria, yeast, insects, mammalian cells and plants, *in-vitro* transcription and translation, T-DNA and transposon tagging.

UNIT III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples.

UNIT IV

Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Φ plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants. Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Books Recommended:

- iGenetics by *Peter J Russell*, Benjamin/ Cummings, New York
- From Genes to Clones: Introduction to gene technology, by *Ernst-L Winnacker*, VCH Publication, Germany
- Principles of Gene Manipulation: An Introduction to genetic Engineering (6th Edition) by *R.W. Old and S.B. Primrose*, Blackwell Publication
- Genes IX by *Benjamin Lewin*, Oxford University Press, U.K.



ENZYME TECHNOLOGY

(BT-C-502)

UNIT I

Nomenclature and classification of enzymes, general properties of enzymes, active sites, cofactors and specificity. Isolation, purification and large scale production of enzymes with principles and applications of the involved techniques, viz gel filtration, ion exchange and affinity chromatography, centrifugation and electrophoretic techniques.

UNIT II

Enzyme kinetics: Enzymatic reaction mechanisms, Michaelis-Menten equation. Effect of substrate, pH, temperature and inhibitors on enzyme activity. Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification, feedback inhibition, positive and negative cooperativity, allosteric enzymes.

UNIT III

Isozymes, multienzyme complexes, artificial enzymes, catalytic antibodies. Enzyme engineering-strategies, directed evolution, degradation of unnatural substrates.

UNIT IV

Industrial enzymes: In detergent, food, leather, dairy, medicines and chemical industries. Enzyme immobilization: Introduction, methods, applications and limitations.

Books recommended:

- Enzymes: Biochemistry, Clinical Chemistry by T. Palmor, Harwood press
- Fundamentals of Enzymology: The cell and molecular biology of catalytic proteins, by NC Price and Steven, Oxford press.
- Biochemistry, Vol I, II, III by Geoffery Zubey, WCB press
- Fundamentals of Biochemistry by Voet, Voet & Pratt, John Wiley publisher



ENVIRONMENTAL BIOTECHNOLOGY (BT-E-501)

UNIT I

Introduction to Environmental Science: Environmental Pollution: Classification of pollutants, Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles. Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact – Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol.

UNIT II

Air, Water, Soil, Noise and Thermal pollution: Their source, Effect and biotechnology based control measures. Solid waste pollution and its management. Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products.

UNIT III

Treatment of municipal waste and Industrial effluents. Bio-fertilizers Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)

UNIT IV

Biobleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals. Ozone depletion, UV-B, Green-house effect and acid rain, their impact and biotechnological approaches for management

Books recommended;

- Biotechnology – Expanding Horizons by *B.D. Singh*. 2nd Edition Kalyani Publishers.
- Microbial Ecology: Fundamentals & Applications by *Atlas, R.M. We Brown*.
- Environmental Microbiology by *A.H. Varman*, ASM Press.
- Biodegradation and Bioremediation by *Alexandar, M.* Wiley International.



GENOMICS AND PROTEOMICS

(BT-E-502)

UNIT I

Introduction to Genomics, DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clonecontig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

UNIT II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

UNIT III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE. Determination of covalent structures – Edman degradation.

UNIT IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. *Denovo* sequencing using mass spectrometric data.

Books recommended;

- Genomes by *T.A. Brown*, John Wiley & Sons Ltd, New York
- Genome analysis (Volume I, II, III and IV) a Laboratory Manual by *Bruce Birren, Eric D. Green, Sue Klapholz, Richard M. Myers and Jane Roskams*, Cold Spring Harbor Laboratory Press.
- Discovery Genomics, Proteomics and Bioinformatics, *Campbell AM & Heyer L*, 2004, Pearson Education.
- Discovery genomics, proteomics and bioinformatics. *Campbell AM & Heyer L*, 2004, Pearson education.
- Methods in proteome and protein analysis, *Kamp RM*, 2004, Springer.
- Handbook of nanostructured biomaterials and their applications in Nanobiotechnology. *Nalwa HS*, 2005, American Scientific Publication.
- Nanobiotechnology, *Niemeyer CM & Mirkin CA*. 2005. Wiley Interscience.



PRACTICALS BASED ON PAPERS BT-C-501& BT-C-502 (BT-C-503)

- ✓ Isolation of chromosomal DNA from plant cells
- ✓ Isolation of chromosomal DNA from *E.coli*
- ✓ Qualitative and quantitative analysis of DNA using spectrophotometer
- ✓ Plasmid DNA isolation
- ✓ Restriction digestion of DNA
- ✓ Making competent cells
- ✓ Transformation of competent cells.
- ✓ Demonstration of PCR
- ✓ Isolation of enzyme from the given sample.
- ✓ Purification of enzyme from the crude extract.
- ✓ Effect of substrate concentration on enzyme activity.
- ✓ Effect of temperature on enzyme activity.
- ✓ Effect of pH on enzyme activity.
- ✓ Effect of metals and chemical reagents on enzyme activity.
- ✓ Performing enzyme immobilization by Calcium alginate entrapment method.



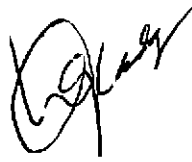
B. Sc (Third Year) SEMESTER-VI

PROJECT WORK/REVIEW (BT-C-601)

Each Student will have to submit an allotted PROJECT WORK/ REVIEW on specific topics related with different area of biotechnology and will submit a report on which *viva-voce* will be conducted.

SEMINAR (BT-C-602)

Each student will have to present ONE Seminar on the topic ALLOTTED covering different areas of Biotechnology and will be evaluated by power point presentation.



~~BT-405: Dissertation~~

