

Department of Biotechnology
D.D.U Gorakhpur University, Gorakhpur (U.P.) 273 009

M. Sc. Course in Biotechnology

(Course structure and syllabus)

<i>Paper No.</i>	<i>Particulars of the Paper</i>	<i>Marks</i>
SEMESTER-I		
I	<i>Microbiology</i>	50
II	<i>Molecular Biology</i>	50
III	<i>Biochemistry & Biophysics</i>	50
IV	<i>Cell Biology</i>	50
V	<i>Practicals based on Paper-I, II, III & IV</i>	100
SEMESTER-II		
VI	<i>Enzyme Technology</i>	50
VII	<i>Recombinant DNA technology</i>	50
VIII	<i>Immunology and Immunotechnology</i>	50
IX	<i>Bioinformatics & Biostatistics</i>	50
X	<i>Practicals based on Paper VI, VII, VIII & IX</i>	100
SEMESTER-III		
XI	<i>Animal Biotechnology</i>	50
XII	<i>Plant Biotechnology</i>	50
XIII	<i>Biochemical Engineering</i>	50
XIV	<i>Environmental Biotechnology</i>	50
XV	<i>Practicals based on Paper XI, XII, XIII & XIV</i>	100
SEMESTER-IV		
XVI	<i>Biosafety, IPR and Bioethics</i>	50
XVII	<i>Genomics</i>	50
XVIII	<i>Proteomics and Nano-Biotechnology</i>	50
XIX	<i>Seminar</i>	50
XX	<i>Project work</i>	100
Total Marks		1200

Semester-I

PAPER-I (MICROBIOLOGY)

- History, development and scope of microbiology.
- Prokaryotic Cells: Structure and function, cell envelope (outer and inner membrane, surface polysaccharides, peptidoglycan, periplasmic space), flagella, pili, cell inclusions i.e. endospores, gas vesicles.
- Prokaryotic Diversity: Systematics and Taxonomy, Modern approaches to bacterial taxonomy, polyphasic classification, Ribosomal DNA sequencing, General characteristics of primary domains and of taxonomic groups belonging to Bacteria, Archaea and Eukarya, Nomenclature and outline of bacterial classification as per Bergey's Manual.
- Viruses: General properties, structure and classification of viruses based on their genomes, Bacterial (Phage Lambda), Plant (CaMV), Animal (Hepatitis, retroviruses) viruses, Viroids and Prions.
- Methods in Microbiology: Theory and practice of sterilization, Pure culture techniques, Principles of microbial nutrition, Construction of culture media, Enrichment culture techniques, Isolation and culture of aerobic and anaerobic bacteria, Culture collection, preservation and maintenance of microbial cultures.
- Microbial growth: The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth and Continuous culture.
- Metabolic Diversity among Microorganism: Microbial Nutrition: nutritional types and modes of nutrition in bacteria. Bacterial photosynthesis: structural and functional properties of pigments. Oxygenic and anoxygenic photosynthesis, photodynamic death. Chemolithotrophy; Hydrogen, Iron, Nitrite oxidizing bacteria; Nitrate and sulfate reduction; methanogenesis and acetogenesis; Nitrogen metabolism; Nitrogen fixation; Hydrocarbon transformation.
- Host-Parasite Relationship: Normal microflora of human body, entry of pathogens into the host, colonization and factors predisposing to infections, types of toxins (Exo-, Endo-, Entero-) and their structure, mode of actions, virulence and pathogenesis.
- Microbial Diseases: Epidemiology of infectious diseases with reference to tuberculosis, cholera, sexually transmitted diseases (AIDS), diseases transmitted by animal (rabies), insect (malaria), food borne disease (Salmonella) and pathogenic fungi.
- Chemotherapy / Antibiotics Antimicrobial agents; Antibiotics: Penicillins and Cephalosporins and Broad- spectrum antibiotics, sulfa drugs, Antifungal antibiotics, Mode of action, Molecular mechanism of drug resistance.

- Bacterial Genetic System: Transformation, Conjugation, Transduction, Recombination, bacterial genetic map with reference to *E coli*

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. Klein*. WCB Mc Graw 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.

PAPER - II (MOLECULAR BIOLOGY)

- Prokaryotic and eukaryotic genome organization (structure and organization of chromatin, cot curves and repetitive DNA), structural elements of chromosome and construction of artificial chromosome.
- DNA replication: Enzymes, accessory proteins and mechanism of prokaryotic and eukaryotic DNA replication.
- Fine structure of gene, molecular basis of spontaneous and induced mutations and their role in evolution; DNA damage and repair, DNA amplification and rearrangement.
- Transcription: Organization of transcriptional units, mechanism of transcription and its regulation in prokaryotes and eukaryotes, Operon concept, attenuation and antitermination controls, RNA processing (capping, polyadenylation, splicing), DNA methylation, heterochromatization, General and specific transcription factors, regulatory elements and mechanism of transcription regulation, transcriptional and post-transcriptional gene silencing, environmental regulation of gene expression.
- Translation: Genetic code, Prokaryotic and Eukaryotic translation, mechanisms for initiation, elongation and termination, regulation of translation, co-and post- translational modifications of proteins.
- Anti-sense and Ribozyme Technology: Inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, applications of anti-sense and ribozyme technologies.
- Homologous Recombination and Site-specific recombination.

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

PAPER – III (BIOCHEMISTRY AND BIOPHYSICS)

- Amino acids and proteins: classification, structure and properties of amino acids, primary, secondary, tertiary, quaternary and domain structure of proteins, reverse turns. Ramachandran plot, forces stabilizing protein structure, DNA-protein and protein- protein interactios, protein folding, misfolding and related diseases.
- Nucleic acids: Primary and secondary structure of nucleic acids, Waston-Crick model of DNA, structural polymorphism of DNA and RNA, three dimensional structure of RNA. Biosynthesis of purines and pyrimidines.
- Carbohydrates: Classification and structure of carbohydrates, polysaccharides, glycoproteins and peptido-glycans. Glycolysis and TCA cycle, glycogen bracadown and synthesis, gluconocogenesis, interconversion of hexoses and pentoses, oxidative phosphorylation.
- Lipids: classification, structure and functions, oxidation of lipids, biosynthesis of fatty acids, triglycerdes, phospolipids, sterols.
- Photosynthesis, photophosphorylation, photorespiration.
- Principles and application of thin layer and gas chromatography, HPLC and FPLC.
- Principles and applications of x-ray diffraction, fluorecence, UV, IR, ORD/CD, visible NMR, ESR and mass spectroscopy.
- Principles and applications of tracer techniques in biology, radiation dosimetry ; radioactive isotopes and half life of isotopes; effect of radiation on biological systems; autoradiography; cerenkov radiation; liquid scintillation spectrometry.

Books Recommended:

- Biochemistry by *Stryer*, Freeman Publisher.
- Biochemistry (3rd edition) Vol I, II, III by *Geoffery Zubey*, WCB press.
- Fundamental of Biochemistry by *Voet, Voet and Pratt*, John Wiley Publisher.
- Principles of Biochemistry by *Albert Lehninger, David. L. Nelson and Michael M Cox*, MacMilan Worth Publisher.

PAPER – IV (CELL BIOLOGY)

- Structure of prokaryotic and cukaryotic cells-isolation and growth of cells.
- Microscopic techniques: Principles and application of light, phase contrast, fluorecence, scanning and transmission electron microscopy, cytophotometry and flow cytometry, fixation and staining.

- Subcellular fractionation and criteria of functional integrity.
- Cellular organelles: Plasma membrane, cell wall, cytoskeleton their structural organization; Mitochondria; Chloroplast; Nucleus and other organelles and their organization. Genetic constitution of mitochondria and chloroplast. Model membrane Liposomes.
- Transport of nutrients, ions and macromolecules across membranes.
- Cell cycle: molecular events and regulation in model systems.
- Cellular responses to environmental signals in bacteria, plants and animals- mechanism of signal transduction.
- Biology of cancer: molecular biology and biochemistry of cancer, oncogenes, chemical carcinogenesis.
- Intracellular protein traffic, Secretory and endocytic pathways.
- Cellular basis of differentiation and development- cell division, gametogenesis and fertilization, differential gene activity and cell differentiation, Morphogenetic determinants in egg cytoplasm, genetic regulation of early embryonic development in *Drosophila*, homeotic genes.

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.

PAPER –V (PRACTICALS BASED ON PAPER I, II, III & IV)

Semester-II

PAPER –VI (ENZYME TECHNOLOGY)

- 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 application of the involved techniques, viz. gel filtration, ion- exchange and affinity chromatography, centrifugation and electrophoretic techniques.
- Enzyme kinetics: Enzymatic reaction mechanisms, Michaels – Menten equation, Effects of substrate, pH, temperature and inhibitors on enzyme activity.
- Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification, general mechanistic principles, feedback inhibition, positive and negative cooperativity, allosteric enzymes.
- Isozymes, Multienzyme complexes
- Enzyme engineering: strategies, directed evolution, artificial enzymes, catalytic antibodies and degradation of unnatural substrates.
- Industrial enzymes (detergent, food, leather, dairy, medicines and chemicals).
- Immobilization: Introduction, methods, applications, advantages and disadvantages.

Books Recommended:

- Enzymes: Biochemistry, Clinical Chemistry by *T Palmor*, Horwood Press.
- Fundamentals of Enzymology: The cell and Molecular Biology of catalytic proteins, by *NC Price and Steven*, Oxford Press.
- Biochemistry (3rd edition) Vol I, II, III by *Geoffery Zubey*, WCB press.
- Fundamental of Biochemistry by *Voet, Voet and Pratt*, John Wiley Publisher.

PAPER - VII (RECOMBINANT DNA TECHNOLOGY)

- Molecular tools and their application: Restriction endonucleases, polymerases, nucleases, kinases, topoisomerases, gyrases, methylases and ligases.
- Cloning vectors: Plasmids, Bacteriophages, Cosmids, Phagemids, Artificial chromosomes (BAC, PAC, MAC).
- Construction of cDNA and genomic libraries and screening of libraries for selection of desired clones.
- Principles and techniques of nucleic acid hybridization, Southern, Northern and Western hybridization.
- Polymerase chain reaction: Principle, variations and applications.
- Techniques of *in-vitro* mutagenesis and protein engineering.
- DNA footprinting. Primer extension, SI mapping, RNase protection assay, Reporter assays.

- DNA Microarray: Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Genome analysis for global patterns of gene expression using fluorescent- labeled cDNA or end-labelled RNA probes. Analysis of single nucleotide polymorphisms using DNA chips.
- Expression strategies for heterologous genes: vector engineering and codon optimization. Host engineering, in vitro transcription and translation, expression in bacteria, yeast insects, mammalian cells and plants.
- T-DNA and transposon tagging: role of gene tagging in gene analysis, identification and isolation of genes.

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 VIII by *Benjamin Lewin*, Oxford University Press, U.K.

PAPER – VIII (IMMUNOLOGY AND IMMUNOTECHNOLOGY)

- Introduction: Phylogeny of Immune System, Innate and acquired immunity, Clonal nature of immune response, Primary and secondary immune response.
- Organization and structure of lymphoid organs.
- Antigen and superantigens.
- Structure and function of immunoglobulins.
- Major histocompatibility complex; Antigen processing and presentation.
- BCR and TCR, generation of immunological diversity.
- Complement system.
- Cells of the immune system:
Haematopoiesis and differentiation, lymphocyte trafficking, B lymphocytes, T- lymphocytes, Macrophages, dendritic cells, natural killer and lymphokine activated killer cells, Eosinophils, Neutrophils and mast cells.
- Regulation of immune response:
Generation of humoral and cell mediated immune responses, Activation of B-and T- lymphocytes, cytokines and their role in immune regulation, Immunological tolerance, Genetic control of immune responses.
- Cell- mediated cytotoxicity : Mechanism of T cell and NK cell mediated lysis, antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity, effector mechanism.

- Immunoprophylactic intervention: Basic concepts of vaccination and different types of vaccines.
- Hypersensitivity, Autoimmunity, Tumor immunology, AIDS and other immunodeficiencies.
- Antigen and antibody interactions, Immunodiffusion, Immunoelectrophoresis, RIA, ELISA, Hybridoma technology and monoclonal antibodies.

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.

PAPER - IX (BIOINFORMATICS & BIOSTATISTICS)

- Introduction to MS-Office software, Harvard graphics / Sigma potter, use of Internet and search engines (WWW, HTML, URLs, Netscape, Explorer, Google, PUBMED).
- Information sources for nucleotide and protein sequences (EMBL, NCBI, Genebank, Swiss Port, PDB). Introduction to the BLAST, Multiple sequence alignment, Phylogenetic analysis and detection of open reading frames (ORFs); Computer aided drug design computational techniques in structural analysis.
- Brief description and tabulation of data and its graphical representation.
- Measures of central tendency and dispersion: mean, median, mode, range, standard deviations, variance, Idea of two types of errors and level of significance, test of significance (F & I test); chi-square tests.
- Sample linear regression and correlation.

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.

PAPER –X (PRACTICAL BASED ON PAPER VI, VII, VIII & IX)

Semester-III

PAPER - XI (ANIMAL BIOTECHNOLOGY)

- Totipotency, nuclear transfer experiments, molecular events during fertilization, role of maternal contribution in early embryonic developments.
- Culture medium and role of serum.
- Measurement of viability and cytotoxicity.
- Biology and characterization of the cultured cells, measurement of growth.
- Basic techniques of mammalian cell culture: Primary and established cell line cultures, disaggregation of tissue and primary culture; maintenance of cell culture; cell separation; Application of animal cell culture.
- Scaling-up of animal cell culture.
- Cell cloning, synochronization and transformation.
- Stem cell cultures, organ culture, embryonic stem cells and their applications, nuclear transplantation, apoptosis.
- Gene Therapy and Transgenic animals: Genetic disorders, vector engineering, Somatic and germline manipulations, strategies of gene delivery, targeted gene replacement/ augmentation, gene correction, gene editing and gene silencing and construction of transgenic animals/ gene knockouts, ethical and biosafety considerations.
- Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, etc.

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*, Wiley-Liss and Sons Publication
- Animal Cell Culture Techniques by *Martin Clynes*, Springer Publications
- Developmental Biology by *S F Gilbert*, Sinauer Associates Inc.

PAPER – XII (PLANT BIOTECHNOLOGY)

- History of plant cell and tissue culture; Culture media; various types of culture; callus, suspension, nurse, root, meristem, etc.; *In vitro* differentiation; organogenesis and somatic embryogenesis.
- Micropropagation; Anther and microspore culture; Somaclonal variation; *In vitro* fertilization; *In vitro* germplasm conservation; Production of secondary metabolites; Synthetic seeds.

- Embryo culture and embryo rescue; Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
- Conventional versus non-conventional methods for crop improvement ; Present status and recent developments on available molecular markers, transformation and genomic tools for crop improvements.
- Plant transformation technology: *Agrobacterium* mediated, Particle bombardment, Electroporation ; transgene stability and gene silencing.
- Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc.) and biotic (insect pest, fungal, viral and bacterial diseases, weeds, etc.) stresses; Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, minerals nutrients, etc.) etc.
- Molecular marker-aided breeding, QTL, molecular marker assisted selection.
- Chloroplast Transformation
- Metabolic Engineering and Industrial Products: Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, biodegradable plastics, therapeutic proteins, edible vaccines, purification strategies.

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

PAPER – XIII (BIOPROCESS ENGINEERING AND TECHNOLOGY)

- Introduction to bioprocess engineering.
- Bioreactors.
- Isolation, preservation and maintenance of industrial microorganisms.
- Kinetics of microbial growth and death.
- Media for industrial fermentation.
- Air and media sterilization.
- Types of fermentation processes: Analysis of batch, fed-batch, and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (plused, photobioreactors etc.).

- Measurement and control of bioprocess parameters.
- Downstream processing: Introduction, removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and crystallization.
- Whole cell immobilization and its industrial application.
- 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 protein.
- Use of microbes in mineral beneficiation and oil recovery.
- Introduction to food technology:
 - a. Elementary idea of canning and packing.
 - b. Sterilization and pasteurization of food products.
 - c. Technology of typical food/ food products (bread, cheese, idli)
 - d. Food preservation.

Books recommended:

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

PAPER – XIV (ENVIRONMENTAL BIOTECHNOLOGY)

- Environment: Basic concepts and issues.
- Environmental pollution: types of pollution, methods for the measurement of pollution, methodology of environmental management- the problem solving approach, its limitations.
- Air pollution and its control through biotechnology.
- Water pollution and its control: water as a scarce natural resource, need for water management, measurement of water pollution, sources of water pollution, waste water treatment-physical, chemical and biological treatment processes.
- Microbiology of waste water treatments, aerobic process : activated sludge, oxidation ditches, trickling filters, towers, rotating discs, rotating drums, oxidation ponds.
- Anaerobic processes: anaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors.

- Treatment schemes for waste water of dairy, distillery, tannery, sugar, and antibiotic industries.
- Microbiology of degradation of xenobiotics in environment-ecological considerations, decay behaviour & degradative plasmids; hydrocarbons, substituted hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.
- Bioremediation of contaminated soils and wasteland.
- Biopesticides in integrated pest management.
- Solid wastes: sources and management (composting, vermiculture and methane production).
- Global environmental problems: 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.* Wc Brown.
- Environmental Microbiology by *A.H. Varman*, ASM Press.
- Biodegradation and Bioremediation by *Alexandar, M.* Wiley International.

PAPER – XV (PRACTICAL BASED ON PAPER XI, XII, XIII & XIV)

Semester-IV

PAPER – XVI (BIOSAFETY, IPR AND BIOETHICS)

- Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Caragena protocol on biosafety, WTO and other international agreements related to biosafety; Cross border movement of germplasm; Risk management issues-containment.
- 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.
- 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.
- The WTO and other international agreements; Intellectual properties , copyrights, trademarks, trade secret, patents, geographical indications, etc.; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing ; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings:

Singh BD, 2007. Biotechnology: Expanding Horizons. Kalyani
<http://patentoffice.nic.in>

PAPER – XVII (GENOMICS)

- Human, animal, plant, bacterial and yeast genome projects: an overview
- Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, molecular markers in genome analysis; RELP, RAPD, STS, Microsatellite, SCAR (Sequence characterized amplified regions), SSCP (single strand conformational Polymorphism), and AFLP analysis, FISH and GISH for genome analysis.
- Whole genome analysis: Genome size, strategies for sequencing genome, ordered genomic libraries (Cosmid, YAC, BAC libraries), DNA sequencing: conventional (Sanger, Maxam and Gilbert method) and automated.
- Functional genomics: DNA chips and their use in transcriptome analysis; mutants and RNAi in functional genomics.

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.

PAPER-XVIII (PROTEOMICS AND NANOBIO TECHNOLOGY)

- Proteomic technology, identification and analysis of proteins by 2D analysis, mass spectrophotometry, NMR and X-ray crystallography, MALDI-TOF, Differential display proteomics, protein-protein interactions, yeast hybrid two system and phage display.
- Chemical, physical and biological properties of biomaterials and bioresponse; biomineralization, biosynthesis, and properties of natural materials (proteins, DNA and polysachharides).
- Preparation and characterization of nanoparticles; Nanoparticular carrier system; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano-imaging, Metabolic engineering and gene therapy.

Books recommended;

- 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.

PAPER - XIX (SEMINAR)

- Each students of M.Sc. Biotechnology has to deliver a Seminar on topic allotted to him and will be evaluated by one external and one internal examiner.

PAPER - XX (PROJECT WORK)

- Each students of M. Sc. Biotechnology has to carry out project work allotted by the concerned guide and has to submit a dissertation after completion of the project work which will be evaluated by a panel of examiner comprising of Coordinator/Head, One external and one internal examiner.