Unified Syllabus Syllabus for
B. Sc. Biotechnology Three Year Degree Course

B. Sc. I year

Biochemistry and Biophysics-Paper-I (BBT-101) M.M.-100

Nature of biological materials: polymeric reactions, carbohydrate, lipids, proteins, nucleotides, nucleic acids, oxidation properties, pH, pKa and buffering, isomerism, types of chemical bonds, hydrophilic and hydrophobic group in biomolecules, neurotransmitters, hormones and growth factors, high energy biomolecules (ATP, GTP and Creatine phosphate).

Perspectives of biological macromolecules: The repeating units in nucleic acids and proteins, helicity, bending, looping, pleats, salt bridges etc. and their determinants, basis for intermolecular interactions with examples, enzyme substrate and antigen-antibody reactions, salient featured of biochemical reactions involved in the biosynthesis of amino acids, fatty acids and nucleotides.

Enzymes, proteins and non-protein enzymes: classification and nomenclature of enzymes, regulation of enzymes activity, coenzymes- structure and function of coenzymes and coenzyme A, kinetics of enzyme catalyzed reactions, isolation and purification of enzymes in food processing, medicine and production of chemical compounds.

Bioenergetics: laws of thermodynamics (First and Second laws), electrical properties of biological compartments, electrochemical gradients, membrane potential, charismatic hypothesis.

Energetic of a living body: Sources of heat limits to temperature, heat dissipation and conservation, Lambert-Baer law, spectrophotometry and colorimetry, primary events in photosynthesis, strategies of light reception in microbes, plants and animals, correction of vision faults, generation and reception of sonic vibrations, hearing as electrical properties of biological compartments, electricity as a potential signal, intra and inter nuclear interactions in biological system, spatial and changes compatibility of such interactions.

Cell Biology- Paper-II (BBT-102) M.M.-100

Cell a basic unit of living systems:- the cell theory, pre-cellular evolution, artificial creation of "cells", broad classification and ultrastructure of cell types (PPLOs, Bacteria, eukaryotic microbes, plant and animal cells), tissue, organ and organism at different level of organization of other genetically similar cells. ecology amplitude of cells in higher altitude, sediments, arctic, hot springs, arid, brackish and

freshwater environments, biochemical comparision of cells (proteins, lipids, carbohydrates, nucleic acids and metabolic pool).

Ultrastructure of cell membrane and cell organelle:- structure and function of cell organelles, ultrastrucure of cell membrane, cytosol, golgi bodies, endoplasmic reticulum (rough and smooth), ribosomes, cytoskeletal structures (actin microtubules etc), mitochondria, chloroplast, lysosomes, peroxisomes, nucleus (nuclear membrane, nucleoplasm, nucleolus)

chromosomes: discovery, morphology, chemical composition, structural organization of chromatids, centromere, telomere, chromatin, nucleosome organization, eu- and heterochromatin, special chromosomes (polytene, lampbrush chromosomes), banding patterns in human chromosomes.

Cell division and Cell cycle: mitosis and meiosis, interphase, comparision of mitosis and meiosis, cell cycle regulation.

Cell-cell interaction: cell locomotion (amoeboid, flagellar and ciliary), muscle and nerve cells, cell senescence and programmed cell death.

Cell differentiation: difference between normal and cancer cells,

Microbiology- Paper III (BBT-103) M.M.-100

History and development of microbiology: Pasteur's experiments, concept of sterilization, methods of sterilization (dry heat, wet heat, radiation, chemical and filtration), microscopy (optical, TEM and SEM), concept of microbial species and strains, growth curve, various forms of microorganism (bacteria, fungi , viruses, protozoa, PPLOs), nature of microbial cell surfaces, gram positive and gram negative bacteria, kinds of flagella, serotypes, nutritional classification of microorganism.

Genetic homogeneity in colonel populations:- isolation of auxotrophs (replica plating technique and analysis of mutation in biochemical pathways), microbial assay for vitamins and antibiotics, strain improvement by selection.

Microbial agents of diseases: bacterial, viral, fungal and protozoan

Microbes in extreme environments: the thermophiles and alkalophiles, pathogenic microorganism, defense mechanism against microorganism, symbiosis and antibiosis among microbial population, nitrogen fixing microbes in agriculture and forestry.

Industrial microbuses and their uses: production of food (dairy and SCP) and antibiotics (with reference to penicillin and streptomycin), ferment centurion product, a survey of product from microorganism.

Genetics –Paper-IV (BBT-104) M.M.-100

Mendelian laws of Inheritance, test cross, back cross, incomplete dominance and co-dominance.

Lethality and interaction of genes.

Multiple alleles and Isoalleles, blood groups in human beings.

Chromosomes- Chemistry and ultrastructure, abnormal chromosomes, chromosome banding.

Structure and numerical aberrations involving chromosomes: evolution of wheat cotton and rice, hereditary defects- Kleinefelter, Turner, Cri-du-chat and Down syndromes.

Linkage and crossing over: Mapping of genes, interference, coincidence in pro- and eukaryotes.

Sex determination in plants and animal: sex linkages, non-disjunction as proof of chromosomal theory of inheritance.

Basic microbial genetics: conjugation, transformation, transduction and their uses in genetic mapping.

Concept of gene: classical and modern gene concept, pseudoallelism position effect, intragenic crossing over on rII locus in T4 phage.

Mutations-spontaneous and induced: chemical and physical mutagens, induced mutations in plants, animal and microbes for economic benefit of man.

Extra-chromosomal inheritance: Cytoplasmic inheritance, mitochondrial and chloroplast genetic systems.

DNA and RNA as genetic material: Replication, Gene expression (transcription and translation).

Practicals (BBT-105) M.M.-100

B. Sc. II year
Instrumentation & Bio-analytical Techniques-Paper-I (BBT-201) M.M.-100

Microscopy: Simple microscopy, Phase contrast microscopy, dark-field, florescence and electron microscopy (TEM and SEM).

Instruments, basic principle and usage: pH meter, absorption and emission spectroscopy, principle and law of absorption and radiation, use of densitometry, fluorimetry, colorimetry, spectrophotometry (UV, visible and IR), manometry, paleography, centrifugation (rpm and G, ultracentrifugation), atomic absorption, IR, NMR, fluorescence, X-ray crystallography.

Chromatography technique: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, affinity chromatography, ion exchange chromatography, gel filtration.

Electrophoresis: SDS-polyacrylamide gel electrophoresis, agarose gel electrophoresis, immunoelectrophoresis, isoelectric focusing.

Fermentation: Different type of fermenters, principle, operating characteristics of fermenters, computer control of fermentation process.

Radioisotope tracer technique, importance in biological studies, measures of radioactivity, autoradiography.

Biomathematics, Biostatics, Computers & Bioinformatics- Paper II- (BBT-202) M.M.-100

Mathematics: The set theory, properties of subsets; linear and geometric function, the binomial theorem of integer, limits of function, (basic idea of limit of functions without analytic definition) derivatives of function logarithm (definition & laws of logarithm, use of logarithm table), differentiation , integration (general introduction, significance and application for simple algebraic and trigonometric functions).

Biostatistics: Probability calculation (classical & axiomatic definition of probability, theorem on total and compound probability), standard distribution with important properties, simple problems involving binomial, poisson and normal variables, methods of sampling, collection of data, primary and secondary data, classification & tabulation, confidence level, statistics , idea of sampling, distribution and standard error, large samples; normal tests, measurement of dispersion (measures of location and desperation).

Computers: General introduction (characteristics, capabilities, generations), software, hardware; memory, control unit, arithmetic logic unit, output devices), software: (system software, application software, languages-low level, high level), interpreter, compiler, data processing; batch, online, real time (examples from bioindustries; e.g. application of computers in co-ordination of solute concentration, pH, temperature, etc., of a fermenter in operation); internet application.

Bioinformatics : Application of computers in biotechnology, genome analysis, sequence analysis, primer designing, phylogenetic analysis, database for biotechnology.

Molecular Biology Paper-III (BBT-203) M.M.-100

Molecular basis of life: Structure and function of DNA and RNA, DNA replication both prokaryotes and eukaryotes; DNA recombination (molecular mechanisms, prokaryotes and eukaryotes), DNA repair.

Insertion elements and transposons: Transposable elements in *Drosophila* and maize

Organization of genetic material: split genes, overlapping genes, pseudo genes, cryptic genes.

Genetic code: Properties of genetic code, codon assignments, chain initiation and chain termination codons, wobble hypothesis.

Structure of prokaryotic genes: Prokaryotic transcription, prokaryotic translation, prokaryotic gene expression (lac, his, trp operon, catabolite repression).

Structure of eukaryotic genes: Eukaryotic transcription, eukaryotic translation.

Prokaryotic gene regulation: Operon model for regulation of lac genes; positive control of lac operon; molecular details of lac operon; regulation of trp operon.

Eukaryotic gene expression: Levels of control of gene expression; RNA processing transport, mRNA translation, mRNA degradation and protein degradation control.

Gene organization and expression in mitochondria and chloroplast

Immunology and Immunotechnology- Paper-IV (BBT-204) M.M.-100

Historical perspective of immune system and immunity; innate and specific immunity, the organs and cells of immune system.

Antibody structure in relation to function and antigen-binding; types of antibodies and their structure; isotypes, allotypes, idiotypes.

Measurement of antigen-antibody interaction, agglutination, immunodiffusion.

Histocompatibility: structure of MHC class, I, II & III antigens & their mode of antigen presentation, MHC restriction; antigens & antigen city.

Humoral immunity and clonal selection theory, cell mediated immunity.

Immunoglobulin gene: genetic basis of creation of antibody diversity, effect of T cell function.

Immunity to infections of diseases: Vaccines (attenuated and recombinant) and vaccination, antibodies in targeting therapeutic agents.

Autoimmunity and autoimmune diseases: Hashimoto's thyroidties, myasthenia gravis, Rheumatoid arthritis, pernicious anemia, asthama.

Immunotechnology: Hybridoma technology, monoclonal antibodies, production and purification of monoclonal antibodies, immunotoxins, monoclonal antibodies, immunodiagnostics and immunotherapeutics.

Immunoassay: solid immunoassay & their chemistry, florescence immunoassays, immunoelectrophoresis, IRMA, ELISA, RIA, Western blotting etc.

Practicals (BBT-205) M.M.-100

B. Sc. III year

Recombinant DNA Technology–Paper-I (BBT-301) M.M.-100

Introduction to gene cloning and its uses, tools and techniques: plasmids and other cloning vectors, DNA, RNA, cDNA.

Restriction enzymes and other reagents, techniques, laboratory requirements, safety measures.

Purification of DNA from bacterial and animal cells, manipulation of purified DNA.

DNA library: Genomic DNA and cDNA libraries, their advantages and limitations

DNA Introduction of DNA into living cells and their screening.

Application of cloning in gene analysis (obtaining clone of a specific gene, studying gene location, structure expression).

Expression of foreign genes in prokaryotes and eukaryotes.

Production of proteins from cloned genes: gene cloning in medicine (pharmaceutical agents such as insulin, growth hormone, plasminogen activator, clotting factors, interferon, recombinant gene therapy for genetic diseases).

Nucleic acid oligonucleotides and immunoscreening of libraries and other probes.

Isolation and characterization of genes

Analysis of DNA by southern blotting

Analysis of RNA by northern blotting

Analysis of proteins by western blot techniques, Dot blots and slot blots.

RFLP, AFLP

PCR: Basic principles and its modification, application and uses.

Site-directed mutagenesis

Plant Biotechnology-Paper-II-(BBT-302) M.M.-100

Introduction to in vitro methods: Terms and definitions, use of growth regulators, beginning of *in vitro* cultures in India, ovary and ovule culture *in vitro* pollination and fertilization, embryo culture, embryo rescue after wide hybridization and its applications, endosperm culture and production of triploids.

Introduction to the process of embryogenesis and organogenesis and their practical applications: Clonal multiplication of elite species (micropropagation), maxillary bud, shoot-tip

and meristem culture, haploid production and their applications, somaclonal variations and applications (treasure your applications), practical applications of tissue and organ culture (summarizing the practical application of all the above mentioned technique) single cell suspension, culture and their applications in selection of variants mutants with and without treatment (of haploid culture preferably).

Introduction to Protoplast isolation: principle and application, testing of viability of isolated protoplasts, various steps in the regeneration of protoplasts. Somatic hybridization-an introduction, various methods for fusing protoplasts, chemical and electrical, use of markers for selection of hybrid cells, practical applications of somatic hybridization (hybrid vs. cybrids).

Use of plant cell, protoplast and tissue culture of genetic manipulation of plant: introduction to *A. tumefaciens*, tumor formation on plants using *A. tumefaciens* (monocots vs. dicots), rot formation using *A. rhizogenes*, practical application of genetic transformation.

Transgenic plant for the production of human therapeutics, edible vaccines, herbicides, insect resistance, production of secondary metabolites, biotransformation, elicitors, immobilized cells.

Medical Biotechnology-Paper-III (BBT-303) M.M.-100

General metabolism, special secondary metabolites/products (insulin, growth hormone, interferon, t-plasminogen activator, factor VIII etc.).

Expressing cloned proteins in animal cells.

Overproduction and processing of chosen proteins, the need to express in animal cells.

Production of vaccines in animal cells.

Production of monoclonal antibodies.

Growth factors promoting proliferation of animal cells (EGF, FGF, PDGF, IL-I, IL-2, NGF, erythropoietin).

Bioreactors for large scale culture of cells, transplanting culture cells.

Preservation and maintenance of animal cell lines, cryopreservation and transport of animal germplasm (i.e. semen, ovum and embryo).

Transgenic animals.

In vitro fertilization and embryo transfer.

Production of antibodies, vaccines, interferon's, receptors, growth factors, lysosomes, their use in drug delivery and disease control.

Biotechnology in disease diagnosis and disease treatment.

Drug designing, drug delivery and targeting.

Production of artificial tissues/ organs.

Biotechnology in fertility control.

Gene therapy.

Forensic medicine.

Environmental and Industrial Biotechnology -Paper-IV (BBT-304) M.M.-100

Renewable and non-renewable resource

Conventional fuel and their environmental impacts (firewood and animal wastes, coal, petroleum and animal oil).

Modern fuels and their environmental impacts (methanogenic bacteria and biogas, microbial hydrogen production), conversion of sugars to ethanol, the gasohol experiment, solar energy converter-hopes from the photosynthetic pigments.

Possibility of plant petroleum industry and cellulose degradation for combustible fuel, treatment of municipal wastes and industrial effluents, degradation of pesticides and other toxic chemicals by microorganism, *B. thuringiensis* and biopesticides, enrichment of press-mud by microorganism (bioaccumulation and biomineralizatiaon).

Biofertilizers (nitrogen fixing microorganisms, mycorrhiza).

Environmental impact and assessment of transgenic organism..

Bio-assessment of environmental quality.

Fermentation: The fermentation industry, select ion of industrial microorganisms, production process: fermentation media aeration, pH, temperature, batch versus continuous culture, immobilized enzymes, protein engineering, downstream processing and product recovery, food industry, waste as fermentation substrate, solid state fermentation.

Dairy: Transgenic cows, lactose utilization, fermented dairy products

Biosensors.

Genomics and Proteomics, Patenting, Product Regulation, Entrepreneurship Development etc. Paper-IV (BBT-305) M.M.-100

Genomics

Genome evolution and phylogenetics.

The origin of genomes.

Acquisition of new genes.

DNA sequencing- chemical and enzymatic methods.

The origin of introns.

Restriction mapping.

DNA and RNA fingerprinting

The Human Genome.

Proteomics

Basic principles of protein structure.

Modeling of three-dimensional structure of a protein from amino acid sequence.

Modeling mutants.

Evaluating protein structure.

Designing protein.

Analysis of nucleic acid/protein sequence and structure data, genome and proteome data using web-based tools.

Intellectual property rights, patenting, product regulation, entrepreneurship development