BIOTECHNOLOGY

MAGADH UNIVERSITY, BODH GAYA -824234

SYLLABUS FOR M.Sc. BIOTECHNOLOGY (General)
BASED ON DBT, GOVT. OF INDIA

TWO YEARS COURSE – 4 SEMESTERS (Six Monthly)

List of Courses

Sl. No.	Course No.	Course Title	Remarks
1st Semester			
1.		Cell Biology & Biomolecules	80 Lectures -6 Credits
2.		Microbial Physiology & Genetics	40 Lectures -3 Credits
3.		Biochemistry, Computer Applications & Biostatistics.	66 Lectures -5 Credits
4.		Laboratory-1	05 Credits
2nd Semester			
5.		Molecular Biology & Genetic Engineering	80 Lectures -6 Credits
6.		Immunology	40 Lectures -3 Credits
7.		Micromolecules & Basic Enzymology	40 Lectures -3 Credits
8.		Laboratory-II	05 Credits
3rd Semester			
9.		Animal & Plant Biotechnology	80 Lectures -6 Credits
10.		Fermentation & Bioprocess Technology	40 Lectures -3 Credits
11.		Elective Papers- Biophysical Chemistry or Clinical Biochemistry or Environmental Biotechnology	02 Credits
12.		Laboratory-III	06 Credits
4th Semester			
13.		Project /Dissertation	12 Credits

All the papers (1 to 12) carry 100 marks and paper-XIII (Project work) carries 400 marks.

M.Sc. Biotechnology

COURSES

1st Semester

Sl. No.

1. (A) Cell Biology

1. Diversitiy of cell size and shape
2. Structure of Prokaryotic & Eukaryotic Cells
3. Microscopic techniques for study of cells
4. Plasma membrane, cell wall, their structural organization, memberane associated receptors, Artificial membranes (Liposomes)
5. Membrane proteins and principles of membrane organization
6. Cell organells & Secretion – Golgi complex, Endoplasmic reticulum, lysosome, Peroxisomes
7. Internalisation of macromolecules and particles – Endo and exocytosis
08. Cellular energy transactions – Role of Mitochondria and Chloroplast, Synthesis of ATP
09. Cell cycle- molecular events and model systems
10. Cell differentiation and development – cortical, nuclear erythrocytes
11. Biology of cancer
12. Senescence & Death

1. (B) Biomolecules

1. **Chemical foundations of Biology**-pH, pK, acids, bases, buffers, weak bonds and covalent bonds.
2. **Pinciples of thermodynamics**
3. **Amio Acids and peptides** – Structure & Classification, Chemical reactions and physical properties.
4. **Caboyhydrates:** Structure & Classification, Mono, Oligo & Polysaccharide, (reducing, Non-reducing sugars, Starch, glycogen pectic substances & cellulose) glycoside linkages

5. **Lipids :** Fatty acids, glycerol, waxes, phospholipids, sphingolipids, sterols, lipoprotein.
6. **Proteins:** General properties, Classification & separation, purification & criteria of homogeneity, end groups analysis, hierarchy in structure & Ramachandran map, degradation products, Synthesis of peptides & their application, Boc-chemistry, F moc-chemistry.
7. Separation techniques for different biomolecules.
8. Analytical techniques in biochemistry & biophysics for small molecules & macromolecules for quantisation.

2. Microbial Physiology and Genetics.

1. **The Beginning of Microbiology :** The discovery of the microbial world by Antony van Leeuwenhoek. The controversy over spontaneous generation, role of microorganisms in transformation of organic matter and in the causation of diseases, development of pure culture methods, the enrichment culture methods, and development of microbiology in the twenteeth century.
2. **Methods in Microbiology:** Pure culture techniques; the theory and practice of sterilization, principles of microbial nutrition, construction of culture media, enrichment culture techniques for isolation of chemoautot rophs, chemoheterotrophs and photosynthetic microorganisms.
3. Overview of Basic Metabolism and Microbial Nutrition.
4. **Metabolic Diversity among Microorganisms:** Photosynthesis in microorganisms, role of chlorophylls, carotenoids and phycobilins, calvin cycle, chemolithorophy, hydrogen-iron-nitrite-oxidizing bacteria, nitrate and sulfate reduction, methanogenesis and ace to genesis, fermentations-diverstity syntrophy, role of anoxic decompositions, nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

5. Prokaryotic diversity

Bacteria: Purple and green bacteria, Cyanobacteria, Homoacetogenic bacteria, gliding and sheathed bacteria, pseudomonades, lactic and propionic acid bacteria, endospores forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasma.

Archaea: Archaea as the earliest life forms, halophiles, methanogens, hyperthermophilic archaea thermoplasma.

Eukarya: Algae, fungi, slime molds and protozoa.

Viruses: Bacterial, plant, animal and tumour viruses, The discovery, classification and structure of viruses, lysogeny, DNA viruses, positive strand, negative strand, and double stranded RNA viruses, replication, examples of herpes, pox, adenoviruses, retroviruses, viroids and prions.

6. **Microbial Diseases:** Disease reservoirs, epidemological terminologies, infectious disease transmission, respiratory infections caused by bacteria and viruses, tuberculosis, sexually transmitted diseases including AIDS, diseases transmitted by animals (rabies, plague), insects and ticks (rickettsias, lyme disease, malaria), food and water borne diseases, public health and water quality, pathogenic fungi, emerging and resurgent infectious diseases.

7. **Host-Parasite Relationships:** Normal microflora of skin, oral cavity, gastrointestinal tract, entry of pathogens into the host, colonization and fact Ts predisposed to infections, types of toxins (Exo, Endo-, Entero) and their structure, mode of actions, virulence and pathogenesis.

8. **Prokaryotic Cells :** Structure-function, Cell walls of eubacteria (peptidoglycan) and related molecules, outer memberane of gram-negative bacteria, cell wall and cell memberane synthesis, flagella and motility, cell inclusions like endospores, gas vesicles.

9. **Chemotherapy / Antibiotics :** Antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad-spectrum antibiotics, antibiotics from prokaryotes, antifungal antibiotics, mode of actions, resistance to antibiotics.

10. **Bacterial Genetic System:** Transformation, conjugation, transduction, recombination, plasmids and transposing, bacterial genetics map with reference to E. Coli.

11. **Viruses and their Genetic System :** Phage and its life cycle, RNA phages, RNA viruses, retroviruses.
12. Genetic Systems of Yeast and Neurospora.
13. Extrachromosomal Inheritance
14. Mendelism and its significance, backcross and testcross.
15. Linkage and Linkage groups, gene mapping, 2-point and 3-point tests.
16. Chromosome Theory of Heredity: Sex-linked inheritance.
17. Interaction of genes: modification of Mendelian ratios.
18. Machanism of Sex determination in plants and animals.
19. Polyploidy and aneuploidy
20. Chromosome structure and its components, eu-and hetro-chromatin, normal and giant chromosomes, B-chromosomes.
21. Population genetics: Hardy-Weinberg Law and determination of gene frequency

3. (A) Biochemistry

1. **Glycolysis:** Reactions and formation of Pyruvate, Entry of Fructose, Galactose and Glycogen into glycolysis. Conversion of Pyruvate into ethanol, lactate or acetyl Co A.
2. **Citric Acid Cycle:** Formation of acetyl Co A from pyruvate, pyruvate dehydrogenase complex and its control, various steps and regulation of cycle, its stoichiometry, links with other metabolic pathways, glyoxylate cycle.
3. **Electron Transport and Oxidative Phosphorylation:** Energy yield by complete oxidation of glucose.
4. **Pentose Phosphate Pathway:** Generation of NADPH and interconnection with Glycolysis, various steps,
5. **Glyconeogenesis:** Synthesis of Carbohydrates by non-carbohydrate precursors, various steps difference with glycolysis, activation of pyruvate carboxylase by acetyl Co A, oxaloacetate shuttle, energy consumption,
6. **Photosynthesis:** its importance, photosynthetic sites, pigments and units. Absorption of light energy, action and absorption spectra, the two photosystems and their components.

   Light Reaction: Hill's experiment and its significance, cyclic and noncylic ETS and photophosphorylation, oxygen evolution.

   Dark Reaction : Calvin cycle, Halel and Slack cycle and Crassulacean acid metabolism, Photorespiration.
7. **Oxidation of Fatty Acids:** digestion, mobilisation and transport of fatty acid, mobilisation of stored triglycerids by hormones, activation of fatty acids and transport to mitochondria. β-oxidation of saturated fatty acids, oxidation of unsaturated fatty acids and oxidation of
8. **Biosynthesis of fatty acids:** Formation of malonyl Co A- fatty acid synthase complex and its reactions, shuttling of acetate out of mitochondria as citrate, regulation of fatty acid biosynthesis, biosynthesis of triglyceroles, membrance phospholipids.

3. (B) Computer Applications, Biostatistics

1. Introduction of digital computers: organizations: low-level and high-level languages the binary number system.
2. Flow charts and programming techniques.
3. Introduction to Programming in Q basic and C.
4. Introduction to data structures and database concepts, introduction to Internet its applications.
5. Introduction to MS-office software, covering word processing, spreadsheets presentation software
6. Introduction to Harvar graphics/Sigma plotter.
7. Computer-oriented statistical techniques: Frequency table of single discrete variable Bubble sort, computation of mean, variance and standard deviation, t-test, correlation coefficient.
8. Bio-informatics and biotechnology.

(C) Biostatistics

1. Brief description & tabulation of data and its graphical representation.
2. Measure of central tendency & dispersion.
   Mean, Median, Mode, Range, Standard. Deviation, Degree of freedom, Idea of two types of errors and level of significance, Testing of hypothesis & reliability of estimates, tests of significnace (F and T test), hi-square test.
3. Simple linear regression and correlation.

4. Laboratory-1 : Based on Semester 1st Syllabus

2nd Semester

Molecular Biology and Genetic Engineering

1. Synthesis of DNA and RNA,. DNA/RNA polymerases in prokaryotes and eukaryotes.
2. DNA repair mechanisms: light dependent repair, excision repair, mismatch repair, post replication repair, error prone repair systems.
3. Mechanism of genetic recombination.
4. Denaturation and renaturation kinetics of DNA, repetitive and satellite DNA sequences in eukaryotic genomes, DNA/DNA hybridization, relatedness of different genes and species, palindromes.
5. Gene concept and fine structure of gene, complementation test, overlapping genes, exons and interons, oncogenes.
6. Transposable genetic elements in bacteria and eukaryotes, Retroposones their significance.
7. Genetic code: Nirenberg and Khorana's work, properties and deciphering the code, Wobble hypothesis, universality and degeneracy of code.
8. Protein synthesis an overview, Central dogma
   (a) Transcription in Pro and eukaryotes, RNA editing and removal of intron by RNA splicing (spliceosome).
   (b) Translation- Polypeptide chain initiation, elongation and termination post translational changes.
9. DNA replication in pro and eukaryotes - features in vivo and nature, replicons and multiple replicons, replication apparatus, primosomes and replisomes, replication forks (cairns expt), bidirectional replication in E. Coli.
10. Regulation of gene expression in pro and eukaryotes, attenuation, lac, trp, ala, and his.
11. Recombinant DNA technology and gene cloning, restriction endonucleases, amplification of DNA by polymerase chain reaction (PCR), molecular analysis of DNA (southern blot hybridisation), RNA (northern blot)and protein (western blot), construction and screening of DNA libraries, plasmids (Ti plasmid), transgenic plants and animals, blocking gene expression with antisense RNA.
12. Oncogenes & Tumour suppressor genes- Viral and cellular oncogenes, tumor suppresser gene from humans, structure, function & mechanism of action of PRB and P53 tumor suppressor proteins.

13. Antisense and Ribozyme Technology-Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications of antisense and ribozyme technologies.
14. Homologous Recombination : Holiday junction, gene targeting, gene disruption, FLP/ FRT and Cre/Lux combination, RecA and other recombinases.
15. Mapping of Genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence in situ hybridization for genome analysis, chromosome microdissection and micro cloning, molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counselling, pedigree, varietal etc. Animal trafficking and poaching: germplasm maintenance taxonomy and biodiversity.
16. Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, strategies for sequencing genome, packaging, transections and recovery of clones, application of sequence information for identification of defective genes.
17. Molecular tools and their applications: Restriction enzymes, modifications enzymes. DNA and RNA markers.
18. Nucleic acid purification, yield analysis
19. Nucleic acid amplification and its applications.
20. Gene cloning vectors: Plasmids, bacteriophages, phagemids, cosmids, chromosomes.
21. Restriction mapping of DNA fragments and map construction, nucleic acid sequencing.
22. cDNA synthesis and cloning: mRNA enrichment reverse transcription, cDNA primers, linkers, adaptors and their chemical synthesis, Library construction and screening.
23. **Alternative strategies of gene clonig:** Cloning interacting genes-two-and-three hybrid systems, cloning differentially expressed genes. Nucleic acid microarray arrays.
24. Site-directed mutagenesis and protein engineering.

25. **How to study gene regulation?** DNA transactions, northern blot, primer extension, Sl mapping, Rnase protection assay, Reporter assays.
26. **Expression strategies for heterologous genes:** Vector engineering and codon optimization, host engineering, in vitro transcription and translation, expression in bacteria, expression in yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.
27. **Processing of recombinant proteins:** Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
28. **Phage displa**y
29. **T-DNA and Transposon tagging:** Role of gene tagging in gene analysis, T-DNA and transposon tagging, identification and isolation of genes through T-DNA or transposon.
30. **Transgenic and gene knockout technologies:** Targeted gene replacement, chromosome engineering.
31. **Gene therapy:** Vector engineering, Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.
32. **Isolation of plasmids**
33. **Genomics and functional genomics**.

    Whole genome analysis: Preparation of ordered cosmid libraries, bacterial artificial chromosome libraries, shotgun libraries and sequencing. Conventional sequencing (Sanger, Maxam and Gilbert methods), automated sequencing.

    DNA Microarray: Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Genome analysis for global patterns of gene expression using fluorescent-labelled cDNA or end-labelled RNA probes. Analysis of single nucleotide polymorphism using DNA chips.

    Proteome analysis: Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein sports by mass spectroscopy. Protein microarrays. Advantages and disadantages of DNA protein microarrays.

6 Immunology

1. **The Antigen:** Concept of self and non self discrimination, factors contributing to Antigenicity and Immunogenecity, Epitopes and their mapping, nature of Band T cell epitopes, Hapten, types of Antigen, Mitogen and synthetic peptides as antigens.
2. **The Immune System:** Innate and adaptive immunity, organs involved in immune response, primary and secondary lymphoid organs, cells involved in the immune. Response, lymphocyte traffic.
3. **The Immunogenic Molecule:** Structure and function of Ig molecule, sequence analysis, function of heavy and light chains, antigen binding and effect on functions. Antigenic determinants of Ig molecule, structure of various isotypes, generation of antibody diversity, V-J and V-D-J rearrangements in Ig genes, the Ig super gene family.
4. **The antigen-Antibody Interactions:** Affinity, Avidity, Specificity and Cross reaction, methods for studying and forces involved in Ab-Ag interactions.
5. **Monoclonal Antibody and Hybridoma Technology:** Generation of monoclonal antibodies by hybridoma technology and genetic engineering, their use in immunology, molecular biology, biochemistry and biotechnology. Advantages over polyclonal antibodies.
6. **Major Histocompatible Complex:** Organisation of MHC genes, interaction of gene products with other cells, MHC class I and class II molecules, functions, polymorphism, haplotypes, probing for various MHC molecules, susceptibility to diseases, restriction.
7. **T Cell Receptor (TCR):** Structure, function and generation of diversity in T cell receptor molecules. TCR- peptide-MHC interactions. Super antigens.
8. **Antigens Presentation:** Processing and association of antigenic fragments with MHC class I and class II molecules.
9. **B-Cell Activation:** B cell development pathways. Virgin B cells, B plasma cells and B memory cells. Unique molecules of B sell surface, allelic exclusion and secretion.
10. **T Cell Activation:** Development pathways in thymus. T helper cells and T cytotoxic cell activation. A, B, Y and TCR bearing T cells. Auto reactive and memory T cells. T cell hybridoma.
11. **Cytokines:** Structure and their receptors, cloning and expression of Cytokine genes, Signal transduction by cytokine receptor and modulation of immune response. Cytokine profile in diseases, cytokine therapy.

12. **Humoral Immune Response:** Conditions for generation of humoral response, primary and secondary immune response, affinity maturation of antibodies. T dependent and T independent antigens and response to them, humoral response to diseases.
13. **Cell Mediated Immune Response (CMI) :** Generation of activated T cytotoxic and T helper cell. Delayed type of hypersensitive reaction, CMI and protection, balance between humoral response and CM.
14. **Complementary System:** Complement molecules and activation of complement system, classical and alternative pathways, consequences of activation and diseases.
15. **Hypersensitive Reactions:** Type I (Ig E), Type II (Ig mediated), Type III (Immune complex mediated), Type IV (cell mediated), DTH and protective response.
16. **Auto Immune Response and Disease:** Auto immune disease in humans and animals, therapy and prevention. MHC and T cells in auto immune response.
17. **Immune Regulation and Tolerance:** Regulation of immune response, experimental regeneration of tolerance, mechanism of induction of B cell and T cell tolerance.
18. Brief introduction to the life cycle and molecular biology of some important pathogens of **AIDS, Malaria, Hepatitis, Tuberculosis, Filaria, Kalazar.**
19. **Vaccine:** Concepts in vaccine development. Subunit vaccine. Success of smallpox vaccine.
20. **Tumour Immunology:** Immunodeficiency diseases, transplantation immunology.
21. **Application of immunological methods in Biotechnology.**
22. **Transplantation**.

7. Macromolecules & Basic Enzymology

1. **Enzymes**

(a) General Characteristics, Nomenclature and Classification.

(b) Chemical nature – apoenzymes and coenzymes

(c) Mode of action, Energy considerations, Enzyme Kinetics, Michaelis Menten equation.

(d) Properties and factors affecting enzyme activity, inhibition and activation of enzymes.

(e) Acid-Base catalysis and other mechanism of catalysis.

(f) Constitutive and inducible enzymes, Isozymes-3

(g) Allosteric enzymes and regulation.

(h) Enzymes Immobilization: Methods of immobilization, covalent bonding to support physical absorption and entrapment, effects of immobilization on enzyme characteristics, analytical industrial and therapeutic uses of immobilized enzymes.

2. **Transport** of Biomolecules into the cell.
3. **Signal Transduction** cascades (molecular recognition): Receptors-Phophotidyl inositol, Ca++ as a cytosolic messenger, calmodulin, and plant receptors.
4. **Vitamins:** water soluble and lipid soluble, general consideration.
5. **Plant growth regulator:** biochemistry, assay, metabolism and role of Auxin, Cytokinins, Gibberellins, ABA and ethylene.
6. Transposable genetic elements in bacteria and eukaryotes, Retroposons their significance.
7. Enzymes Allosteric eynzyme, mnemornical enzyme, kinetics of enzyme inhibitors.
8. **Ribozymes & Catalytic antibodies:** Functional proteins, Structure & drug targets (enzymes & receptors).
9. **Protein:** Protein and protein, ligand interactions, physical & chemical methods for study.
10. **Protein & nucleic acid data bases:** Structral comparision at secondary & tertiary levels.
11. **Glyco & lipoprotein :** Structure & Function.
12. **Organization of macromolecular complexes:** Chromatin & ribosomes.
13. **Physical & chemical methods** for immobilization of small & macromolecules.
14. **Nucleic Acid hybridization**- Structural analysis & biological studies.
15. **Heterocyclic compounds and secondary metabolites** in living systems-nucleotides, pigments and isoprenoides.
16. **Conformational propeties of polynucleotides and polysaccharides** – Secondary and tertiary structural features and their analysis-theoretical and experimental; protein folding-biophysical and cellular aspects.
17. **Enzymes catalysis in solution:** Kinetics and thermodynamic analysis, effects of organic solvants on enzyme catlysis and structural consequences.
18. **Computer Aided drug** designing, computational techniques in structural analysis; nanoparticles.

8. Laboratory II : Based on semester 2nd syllabus

3rd Semester

9 A Animal Biotechnology

1. **Introduction to animal biotechnology:** Vaccines, immunoneutralization, transgenic, production of recombinant vaccines using mammalian tissue cultures.
2. **Animal cell cultures:** Growth medium and brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Measuring growth parameters. Basic techniques of mammalian cell cultures in vitro. Cell synchronization and cell transformation. Application of animal cell culture.
3. **Vaccine production by recombinant DNA technology:** Selection of target antigens for vaccine development, Identification and cloning of genes for target antigens. Expression of target antigens in prokaryotes and eukaryotic hosts. Construction of chimeric proteins as target antigens. Conjugation of target antigens with antigen carrier molecules to improve immunogenecity. Immunoprophylaxis by live attenuated recombinant viruses, attenuated vaccinia virus and adenovirus as vectors hetrologous target antigens.
4. Application of nucleic acid hybridization to diagnosis of microbial infections and to genotype analysis.
5. **The micro manipulation of farm animal embryos:** Anatomy and physiology of embryos in relation to micromanipulation, Instrumentation, culture methods, combining embryo cells, intracellular manipulations and conservation of manipulated embryos. Application.
6. **Gene transfer** through micro injection, production of transgenic animals and prospects of transgenic livestock, Embryo aM gamete sex selection: Nuclear transplantation, sperm selection, embryonic sex selection (cytological methos and by use of Y – chromosome specific gene probes).
7. **Biotechnology in animal breeding strategies.**

9 B. Plant Biotechnology

1. Introduction and history.
2. Tissue culture media (composition and preparation). Explant source. Culture conditions.
3. Initiation and maintenance of callus and suspension cultures. Single cell clones. Biochemical parameters. Production of secondary metabolites.

4. Microcutting culture from mature plants for rapid clonal propagation. Shoot tip culture for production of virus free plants.
5. Organogenesis: Regeneration of plantlets from callus. Somatic embryogenesis. Somatic embryogenesis.
6. Anther, pollen and ovary culture for production of haploid plants and homozygous lines.
7. Field transfer of in vitro produced plants. Artificial seeds.
8. Protoplast isolation, culture and fusion: Selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids.
9. In vitro pollination, embryo culture and embryo rescue technique.
10. Nuclear cytology of cultured plant cells and somaclonal variations.
11. Cryopreservation, slow growth and DNA banking for germplasm conservation.
12. Gene transfer and transgenic plants, RFLP, RAPD and AFLP as molecular markers.
13. Application of plant tissue culture.

10. Fermentation and Bioprocess Technology

1. Introduction, range of fermentation processes, chronological development, component parts of a fermentation process. Isolation of micro-organisms important for industry.
2. Growth rate analysis: Growth rate parameters, specific growth rate, doubling time, validity of exponential growth law, growth yield, metabolic quotient, effect of substrate concentration, Monodkinetits, determination of Ks, definition of lag period. Preservation and quality control.
3. Improvement of industrial micro-organisms: Mutants overproducing primary metabolites, mutants overproducing secondary metabolites, use of recombinant systems, improvement of properties other than the yield of product.
4. Types of fermentation processes: analysis of batch, fed batch and continuous bioreactors, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.).
5. Sterilization: Medium sterilization, design of a batch sterilization process, calculation of a ‘del’ factors, holding time, scale up to sterilization, continuous methods, filter sterilization.
6. Fermentor design: Basic functions offer mentor, aseptic operation, body construction, aeration and agitation other fermentation vessels.

7. Process control: Measurement and control of bioprocess parameter like temp. D.O., speed, pH, antifoam etc. Basic principles of feedback control, proportional, integral and derivative control.
8. Down stream processing
9. Whole cell immobilization and their industrial applications.
10. Industrial production of chemicals: Alcohol (ethanol), acids (citric, acetic, gluconic), Solvents (glycerol, acetone and butanol), Antibiotics (penicillin, streptomycin, tetracycline), Amino acids (lysine, glytamic acid), Single cell protein.

Elective Papers

11.(A)

(a) Biophysical Chemistry

1. Intra and inter molecular forces electrostatic interactions and Hydrogen bonding interactions.
2. Vander Waals and Hydrophobic interactions.
3. Disulphide bridges
4. Role of water and weak interactions.

(b) Structure of Proteins

1. Conformational properties of polypeptides
2. Primary and secondary structure α-helix, β-sheet structures etc.
3. Tertiary and quaternary structure
4. Structural features of membrane proteins
5. Conjugated and metal binding proteins
6. Secondary and tertiary structure prediction of protein conformation.

(c) Multiple equilibrium

1. Titration of proteins to evaluate net and total charge
2. Scatchard and Hill plots
3. Folding-unfolding equilibrium and denaturation of proteins
4. Effect of temperature and solvent condition on the thermodynamics of protein folding-unfolding equilibrium
5. Kinetics of protein folding.

(d) Techniques for the study of Macromolecular structure

1. Ultracentrifugation: Sedimentation velocity and equilibrium, determination of molecular weights.
2. Viscosity
3. Micro calorimetry
4. Circular Dichroism spectroscopy
5. UV, visible and Fluorescence spectroscopy
6. X-ray Diffraction
7. Nuclear Magnetic Resonance (NMR)

11 (B) Clinical Biochemistry

1. **Diseases due to defects in protein synthesis**
   a. **Relationship of electrophoretic** protein with different diseases, antigenicity of insulin, Geneticaly engineered insulin due to no conservative mutation, Abnormal collagen synthesis, Hyperlipid proteinemias, Hypolipidoproteinemia, Proteins and infectious agents (mad cow disease) ruin diseases.
   b. **Plasma levels of amino acids:** Deficiency of urea cycle enzyme, Macrocytic anemia, spina bifida, Folic acid deficiency, nonlectotic hyperglycinemia.
2. **Diseases due to defects in DNA metabolism**
   a. High uric acid levels in blood - gout and nucleotide metabolosm.
   b. DNA vaccines, DNA probe in medicine.
   c. Topoisomerase in cancer treatement, Therapeutic potential of triplex DNA formation.
   d. Human genome project, Genic medicine, Genetherapy, Xeroderma pigmentosum, Colon cancer
   e. Cystic fibrosis: Codon defect mutation, Post translation modification, Premature protein degradation.
3. Diseases due to defects in RNA metabolosm
   a. Antibiotics and toxins, Targeting RNA polymerase, Fragile X syndrom, Staphylococcal resistance to erythromycin, Involvement of transcriptional factors in carcenogenema.
4. Cancers - Proteinkinase inhibitors as anticancer drugs, Detection of carcinogens (AMES test) Defective repair of DNA and cancer, cancer and glycolysis, Cervical cancer and ubiquitin, SERM and Breast cancer.
   a. Topoisomerase in cancer treatment, therapeutic potential triplex DNA formation, human genome Project, gene Therapy, pyruvatekinase deficiency.
   b. Anticancer drugs that block synthesis of thymidate.

5. Anemia - Haemolytic anemia, Sickle cell anemia, Nonconservative mutation, Macrocytic anemia, Vitamin deficiency and anemia.
6. Thalassemia - Defect in mRNA synthesis, Protein synthesis, Prenatal diagnosis, Colour blindness.
7. Blood groups - Haemophilia
8. Urea cycle
9. Pellagra
10. Gout
11. Cholesterol: Nutritional consideration, Hypercolesterolemia and atherosclerosis, Clinical management of cholesterol level.
12. Osteoporosis: relationship of diet with osteoporosis, Abnormal collagen synthesis, Hormonal, Dietary, Renal, Osteodystrophy.
13. Acidosis: Blood bicarbonate, Pyruvate dehydrogenase deficiency, Leigh disease Glycolysis, Arotic acid urea, Diabeter ketoacidosis.
14. Alkalosis: Respiratory acidosis, Chronic acidosis.
15. Arthritis: Callogen synthesis, Rheumatoid arthritis.
16. Vitamin deficiency and diseases
17. Hormones: Chemistry of peptide, Proteinaceous hormones, atecholamine thyroid hormones, Steroidal hormones & their biosynthesis.

11. (C) Environmental Biotechnology

(a) **Biogeochemical cycling:** Carbon, nitrogen and sulfur cycle

(b) **Biomonitoring:** Biomonitoring of water quality (physical, chemical and biological), Role of microbes in biomonitoring of water quality, indicator organisms, biosensors

(c) **Wastewater treatment methods**-Trickling filter-microbial community, design, operation, Activated sludge-microbial community, design, operation; treatment of solid wastes Anaerobic treatment of wastewater and sludge.

(d) **Bioremediation:** Treatment of industrial effluents (pesticides and toxic chemicals), biodegradation, bioremediation, bioaugmentation; oil spillage and degradation of hydrocarbons

(e) **Biofuels:**

* Brief idea about renewable and non-renewable energy resources
* Conversion of domestic and agro-wastes into ethanol
* Methanogensis and biogas production
* Plant based fuel (biodiesel etc.)
* Hydrogen as fuel and its microbial production.

(f) **Biofertilizer:** Introduction, types and application: Characteristics. mass cultivation and quality control of

(1) Nitrogen fixers: *Rhizobiun. Azospirillum, Azotobacter and Cyanobacteria: Azolla Anabaena azollae association.*

(2) Phosphate solubilizers: Mycorrhiza

(g) **Biological control of insects:** Bacterial, viral and fugal pesticides

(h) **Microbial mining:** Microbial enhanced recovery of mineral resources: Use of microbes in oil recovery.

12. Laboratory-III : Based on Semester 3rd Syllabus

4th Semester

13. Project / Dissertation : Four to Six month project training.

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