

**UNIVERSITY OF BURDWAN**  
**B.Sc. Biotechnology (Hons) Syllabus w.e.f 2012-2013**

**Total Marks : 2400**

Each Part : 600 (Theory) + 200 (Practical)

Out of 100 marks in each paper, 20 marks are reserved for internal assessment in theory papers.

Part I (Each paper carries 80 marks)

- 101 **Chemistry I** (Chemistry of Biomolecules)
- 102 **Zoology I** (Genetics)
- 103 Microbiology
- 104 Cell Biology
- 105 Mathematics
- 106 Communicative English
- 107 **Chemistry II** (Practical Biochemistry)
- 108 Practical Microbiology

Part II (Each paper carries 80 marks)

- 201 **Chemistry III** (Physical & Organic Chemistry)
- 202 Molecular Biology
- 203 Recombinant DNA Technology
- 204 Fundamentals of Biochemical Engineering
- 205 Industrial Microbiology
- 206 **Botany I** (Plant Cell & Tissue Culture)
- 207 Practical Molecular Biology
- 208 **Botany II** (Practical Plant Tissue Culture)

Part III (Each paper carries 80 marks)

- 301 **Botany III** (Plant Biotechnology)
- 302 **Zoology II** (Animal Biotechnology)
- 303 Environmental Biotechnology
- 304 **Zoology III** (Immunology)
- 305 Fundamentals of Biostatistics Bioinformatics.
- 306 Group-A. **Chemistry IV** (Industrial Chemistry)
- Group-B- Industrial Management (Each group carries 40 marks)
- 307 Practical Environmental Biotechnology (Gr. A) and  
Biostatistics & Bioinformatics (Gr.B)
- 308 Dissertation.

**BIOTECHNOLOGY**  
**PART-I (1<sup>st</sup> YEAR)**

**BT- 101 Chemistry I (CHEMISTRY OF BIOMOLECULES)**

1. Carbohydrates: Definition; structure of carbohydrates- monosaccharide, aldohexoses and ketohexoses; Haworth Structure Anomeric structures of D-Glucose, mutarotation, pyranose and furanose rings; examples of different types of monosaccharide. Oligo- and polysaccharides- reducing (maltose) and non-reducing (sucrose), disaccharides; Glycoproteins, proteoglycans.

12L

2. Amino acids, peptides and proteins: Structures and important properties, Classification of amino acids, important physical and chemical properties of amino acids (optical isomerism, UV-absorption region, ionization, reactions due to amino group and carboxyl group). Primary structure of peptides and proteins-peptides bond formation, hydrolysis of peptides and proteins. primary, secondary, tertiary and quaternary structures. Classification of proteins (based on solubility and composition). C and N terminal amino acid determination. 11L

3. Lipids: Definition, distinction between fats and oils, structure of lipids (fatty acids, glycerolipids, sphingolipids)

6L

4. Nucleic acids: Structure of nucleic acids; nucleosides, nucleotides, primary structure, A, B and Z form of DNA. A preliminary idea of secondary structures of RNA and DNA. Melting point and denaturation of DNA.

6L

5. Enzymes: Definition of enzymes, important terms (enzyme unit, specific activity). Classification of enzymes; physico-chemical properties, factors affecting activity; mechanism of enzyme action, coenzymes, cofactors. 10L

6. Synthesis and breakdown of carbohydrates: Trapping of solar energy into chemical energy (PS-I & PS-II) in green plants, utilization of this energy to synthesize carbohydrate (Calvin cycle, CO<sub>2</sub> enrichment for the efficient operation of the cycle in C-4 and CAM plants), photorespiration (C-2 cycle), outline of Glycolysis, TCA cycle and Pentose phosphate pathway, gluconeogenesis; oxidative phosphorylation. 8L

7. Plant and animal hormones: Structures and function mode of action of IAA, GA<sub>3</sub>, Zeatin, ethylene and abscisic acid. General understanding of animal hormones; structure and function of insulin and androgen. 8L

8. Biochemical techniques: A preliminary idea about principle and use of chromatography (paper, thin layer, HPLC), colorimetry and spectrophotometry, ultracentrifugation. 4L

9. Tutorial classes. 15L

## **BT-102 Zoology I ( GENETICS)**

1. Mendelian inheritance: Physical basis of inheritance, gene interaction, multiple alleles, complementation, linkage, recombination and chromosome mapping, Sex linked inheritance (w.r.t human, Drosophila) and cytoplasmic inheritance  
15L
2. Genetic changes: Mutation, Ames's test, structural changes in chromosomes (deletion, duplication, inversion & translocation) numerical changes in chromosomes (euploidy and aneuploidy) **15L**
3. Bacterial and viral genetic systems: Genomes of E. Coli and HIV. Concept of natural plasmids. Transformation, conjugation and transduction.  
**15L**
4. Human genetics: Molecular basis of genetic diseases (Huntington's disease) (Thalassemia and Hemophilia) and genetic counseling. Chromosomal abnormalities: Down's syndrome, cat's-cry Syndrome, Philadelphia chromosome, Turner and Klinefelter syndrome.  
**12L**
5. Population genetics: Hardy Weinberg Law. Factors affecting genetic equilibrium  
8L
6. Tutorial  
15L

## BT-103 MICROBIOLOGY

1. Microbial world: Discovery and developments in microbiology, Discovery of the role of microbes in the pathogenesis and transformation of organic matter. Microbial cell ultrastructure, Whittaker system, 3-kingdom classification, Carl Woese theory 10L
2. Microbial growth, basic metabolism and nutrition- an overview. ED pathway. 6L
3. Microbial metabolic diversity: Photosynthesis in microbes, chemolithotrophy, nitrate and sulfate reduction, methanogenesis and acetogenesis. 8L
4. Soil microorganism and nutrient cycling: carbon, nitrogen and sulfur cycles. 7L
5. Plant microbe interactions: Mycorrhizae, cyanobacteria and nitrogen fixing bacteria (including nitrogen fixation). 10L
6. Microbial infections and disease: Water-borne diseases (Cholera, Giardiasis), microbial food poisoning (Botulism, Staphylococcus) and food-borne infections: RTI (*Mycobacterium tuberculosis*), gastrointestinal infection (GI I) – hepatitis, STDI (AIDS), CNSI (rabies, tetanus). 12L
7. Chemotherapy and antibiotics: History of antibiotic discovery (chemicals inhibiting/ affecting) bacterial cell wall synthesis / function. Antibacterial agents (Penicillin, Methicillin, Streptomycin), antifungal agents (Griseofulvin, Amphotericin B, Nystatin) and antiviral agents (AZT, Acyclovir, Interferon) and their modes of action. 12L
8. Tutorial. 15L

**BT-104 CELL BIOLOGY**

1. Cellular basis of life: Cell doctrine, cells in general, diversity of cell size and shape, cell theory; structure of eukaryotes and prokaryotic cells (including viruses). 7L
2. Cellular information: The nucleus (ultra-structure), the organization of chromosomes (euchromatin and heterochromatin), nucleosome concept and chromosome packaging. 10L
3. The cell surface: Plasma membrane, membrane fluidity, movement across plasma membrane, Modification of plasma membrane (Plasmodesmata and desmosome), extra membrane component of cells. Plants and bacterial cell walls, an outline of extracellular substances of animal cells. 12L
4. Energy transduction: Mitochondria and chloroplast, structure and function, Endosymbiont theory. 8L
5. Endo-membrane system: Endoplasmic reticulum, Golgi apparatus, lysosomal system, plant cell vacuoles, microbodies structure and function. 8L
6. The cytoskeleton: Microtubules, microfilaments and intermediate filaments. (Structure in function). 4L
7. Cell reproduction: An outline of cell cycle, mitosis and meiosis. 8L
8. Microscopic techniques in cell biology: light, fluorescence, transmission and Scanning electron microscope. 8L
9. Tutorial 15L

1. Differential Calculus: Functions, Limit, Continuity (Graphical Method).  
Differentiation: second order (Algebraic, Logarithm, Exponential functions),  
Successive differentiation, Expansion of function optimum, Partial differentiation,  
Application of Euler's theorem, L'Hospital Theorem.  

20L
2. Integral Calculus: Definite & Indefinite integral (algebraic, Logarithm and  
Exponential functions) Area, Differential equation (First order exact differential  
equation and second order linear, homogeneous equation with constant co-efficient).  

15L
3. Statistics and Probability: Primary and secondary data, Frequency distribution,  
Diagrammatic representation, Population and sample, Law of statistical regularity,  
Mean, Median, Mode, Standard deviation and their simple problems. Methods of  
sampling, Basic concepts of probability, Poisson distribution, Normal distribution,  
Chi-square distribution, student's distribution. Test of Significance, Baye's theorem  

25L
4. Tutorial. 

20L

Objective [To develop the learners' language skills in English Listening, Speaking, reading and writing (LSRW) and to develop the learners' specific skills for communication in the field of Science, Technology and Computer Application.]

1. Communication and communicative activities the notions of encoder and decoder and the message and the medium 10L
2. Concise grammatical structures and key vocabulary for general as well as specific purpose accuracy and appropriateness in the use of English. 10L
3. English speech sounds and sound combinations. 5L
4. Elements of Spoken English. 10L
5. Topic of discourse, mode of discourse and style of discourse with special reference to scientific discourse. 10L
6. Writing notes, reports, proceedings etc. 10L
7. Expanding and summarizing. 5L
8. Narrating and describing. 5L
9. Tutorial for each topic. 15L

Practical on all language activities and communicative tasks- group discussion, seminar.



**BT-107 Chemistry II (PRACTICAL BIOCHEMISTRY) 100 Marks.**

Qualitative tests for sugars, amino acids, proteins & lipids;

Separation of amino acids by PC/TLC.

Quantitative estimation of sugars (DNS method, Anthrone reagent) and proteins (Folin-phenol and Bradford reagent)

Isolation and quantification of DNA (Diphenylamine method); RNA (orcinol method).

Analysis of oils-Iodine number, saponification value & acid number. Assay of enzymes from plant & animal sources (protease and catalase).

**BT-108 PRACTICAL (MICROBIOLOGY) 100 Marks.**

Sterilization; media preparation; isolation, culture and maintenance of microorganisms including storage methods; isolation of pure cultures from soil and water, microbial growth curves, effect of temperature, pH, carbon and nitrogen sources on growth. Microscopic examination of bacteria (curd, nodules) and yeast, Gram staining (E.coli, B.subtilis) and staining methods for spores, Antibiotic assay: Agar cup and tube dilution method. Fungal staining ( Penicillium, Aspergillus sp.)

## B.Sc. BIOTECHNOLOGY (HONS.), PART-II (2<sup>ND</sup> YEAR) SYLLABUS

### BT-201 CHEMISTRY-III (PHYSICAL AND ORGANIC CHEMISTRY)

1. Thermodynamics - Concept of energy, heat and work. Thermodynamics functions: internal energy, entropy, enthalpy and free energy. Bioenergetics – Spontaneity equation in terms of entropy and concept of equilibrium. Transport across membranes, Donnan equilibrium, 10L
2. Spectroscopy, Idea of electromagnetic radiation orbital theory, Concept of orbital. Beer's law and its importance. Fluorescence spectroscopy, Steady state fluorescence application in biology, UV-Vis spectroscopy. 10L
3. Radioactivity: Alpha, beta, gamma radiation, Law of radioactive decay. Unit of radioactivity. Idea of artificial. Radioactivity and Application of radioactivity- Radiolabelling 8L
4. Electrochemistry - Electrolytic dissociation and conduction. Ionic equilibrium, pH, indicator, acid base neutralization curve, buffer action, Bronsted acid, Henderson-Haselbach equation, preparation of buffer, buffer capacity. 10L
5. Properties of molecules structure of atom, Electronic theory of valency, Dipole moment, Hydrogen bonds, Van der waal's interactions, Electrostatic interactions, Hydrophobic interactions Transition state theory, Arrhenius equation. Preliminary ideas about zero, 1<sup>st</sup> and 2<sup>nd</sup> order reactions with examples. 8L
6. Alkanes structural formulae, Nomenclature, Homologous series, Alkene, Conformational analysis, Alkenes and alkynes, orbital picture. 4L
7. Monohydric alcohol, polyhydric alcohols, unsaturated alcohols, ether, carbonyl compounds and acids. 7L
8. Stereochemistry: Different types of isomerism- Geometric and Optical isomerism, Diastereoisomerism, Enantiomers, Chirality and asymmetry in relation to biomolecules. Mesomerism, Racemic modifications. Stereochemical nomenclature, R-S, EZ, DL, Pro-R, Pro-S, Erythro and Threo designation of enantiotropic atoms. Fischer, Newman, Sawhorse and Wedge structures and their interconversion. 3L
9. Aliphatic compounds of sulphur, phosphorus, organometallic compounds. Grignard Reagent and use. 4L
10. Nomenclature of aromatic compound. Reaction Mechanism: SN1 and SN2 reaction, E1 and E2 reaction of organic reactions. Saytzeff and Hoffmann elimination, Nucleophilic and Electrophilic aromatic substitution. Aromaticity orbital picture, Electromeric effect, mesomeric effect, Resonance and delocalization of  $\pi$  electrons in different organic compounds. 6L
11. Tutorials. 20L

1. DNA-the master molecule of life.  
DNA as genetic material. Replication: an overview in prokaryotes, ( enzymes, semi conservative nature, bi-directional) Comparison with eukaryotic replication. Replication error, Telomere truncation and telomerase. 7L.
2. Types of Recombination: Homologous recombination and site specific recombination, transposition, Damage and repair UV induced lesions, formation of thymine dimer and repair by Enzymatic Photo reactivation and Excision repair. Mismatch repair & SOS., Double strand break repair, Hybrid dysgenesis. 7L.
3. Transcription and gene regulation: Prokaryotes: Structural genes, controlling sites, operons. The lac and trp operon. Eukaryotes the three RNA polymerases controlling transcription initiation, elongation and termination. 10L
4. RNA processing: spacer DNA, introns, exons, Primary transcript to the formation of mature mRNA. Exon-shuffling RNAi. 6L.
5. Genetic code, the nature and the feature of genetic code, RNA classes and their role. 6L.
6. Protein synthesis: aspects and mechanism of translation, codon-anticodon interaction. Polypeptide chain initiation, elongation and termination, prokaryotic vs. eukaryotic system. 6L.
7. Cellular communication, basic concepts of cell signaling. Preliminary ideas about second messenger, G Protein, Calcium ion, IP<sub>3</sub> & examples of protein kinases. 8L.
8. Molecular biology of cancer, Benign vs. malignant tumors, invasion and metastasis of tumour angiogenesis. Multistep-multigene process, example of colorectal carcinoma, involvement of oncogenes, tumor suppressor genes, p<sup>53</sup> the guardian of the genome. Philadelphia chromosome. 15L.
9. Tutorial for each topic. 25L

**BT-203****(RECOMBINANT DNA TECHNOLOGY)**

1. Various tools and methodologies, Hybridization, Southern & Northern, Western blotting, autoradiography, PCR, fundamentals of the molecular manipulation of DNA, Molecular cloning of DNA, Enzymes involved, Vectors, Plasmids (pBR322, pUC vectors.) Bacteriophages (M13,  $\lambda$ ) Cosmids and YAC, Expression vectors, Shuttle vector, Colony & Plaque hybridization, site directed mutagenesis. 15L
2. DNA libraries, Construction of cDNA and genomic DNA libraries. 6L.
3. Practical Application of Recombinant DNA technology.
  - a) Engineering of bacteria genetically engineered biopharmaceuticals (insulin and growth hormones)
  - b) Ti plasmid in plant biotechnology
  - c) Vaccine production (e.g., Hepatitis B) 10L.
  - d) Cloning disease genes (e.g., DMD gene)
4. Techniques in Biotechnology:- 10L.  
Gel Electrophoresis, pulse field, 2D gel  
Polymerase Chain Reaction, Types and modification  
DNA Sequencing Methods, Sanger, Maxam-Gilbert,  
Autosequencing
5. Basic Concepts molecular probes, RFLP, VNTR, SINE, LINE 7L
6. Molecular detection of disease: AIDS, sickle cell anaemia, cystic fibrosis, Duchenne muscular dystrophy. 12L
7. An overview of expanding areas: antisense RNA, genetically modified food. 10L
8. Tutorial for each topic. 20L

**BT-204****FUNDAMENTALS OF BIOCHEMICAL ENGINEERING**

1. Introduction: What is biochemical engineering , gene products and their processing, modification and application: utilization of gene products in basic and applied metabolism. 5L.
2. Enzyme engineering: Isolation and purification of enzymes, immobilization of enzymes: enzyme engineering ; synzymes, Uses of enzymes in food & beverage, textile, paper, leather industries. 20L.
3. Metabolic engineering : Cloning and expression of heterologous genes for a variety of purposes. Redirecting metabolic flow, overproduction of metabolites, limitations of metabolic engineering. 10L
4. Production engineering: Biochemicals from cultured plant cells and microbes, Improvement of biochemical production, biotransformation, production of hirudin (a polypeptide), phytase (an enzyme), polyhydroxybutyrate (a biodegradable plastic) and cytodextrins from starch, edible vaccines, production of single cell protein (SCP), commercial production of biofuels (Methane, Biodiesel, Bioethanol). Biopesticides (Bt, *Pseudomonas*), biofertiliser, biomineralization & phytomining. 25L
5. Bioreactors: Fermenter, solid state fermentation, aerobic and anaerobic fermentation. Immobilized cell bioreactors, enzyme reactors, biosensors. 10L
6. Tutorial for each topic 20L

**BT-205 (INDUSTRIAL MICROBIOLOGY)**

1. Importance of industrial microbiology, Historical background, perspective and prospects of industrial microbiology. 4L
2. Industrial Fermentor & its operation, sterilization, pasteurization and mixing, aeration, Methods of determining aeration capacity, bubble hold-up in an aerated mixing vessel, turbine impeller hydrodynamics, and flow pattern in a mixing vessel during aeration. Control of temperature. Surfactants. Pilot plant fermentor, Automated fermentor. 20L
3. Substrates of microbial process, different sources of carbon, nitrogen, trace elements growth factors. 6L
4. Kinetics of microbial processes, growth and multiplication of microorganisms, batch culture, continuous culture, steady state and non-steady state. 10L
5. Isolation of microbial products: mechanical separation & downstream processing. 8L
6. Industrial production: Organic acids (acetic & citric acids), amino acids (tryptophan, phenylalanine, glutamic acid), antibiotics (Penicillin & streptomycin), Alcoholic beverage production- Beer. 12L
7. Production of fermented foods- Cheese, Yoghurt and Sauerkraut. 8L
8. Tutorial for each topic. 20L

**BT-206 Botany I ( PLANT CELL AND TISSUE CULTURE)**

1. A general idea about morphology, taxonomy and anatomy of plants. 6L
2. Introduction and history of plant tissue culture. 2L
3. Totipotency. Outline of the methods of tissue culture, preparation of culture media, preparation of different explants suitable for specific organogenesis, cell, protoplast, haploid culture and their objectives. 16L.
4. Micropropagation: Selection of suitable explants (*in vitro* & *ex vitro*). Standardization of techniques: hardening methods and transfer to field. 8L
5. Somatic embryogenesis and production of synthetic seeds, commercial prospects. 6L.
6. Somaclonal variation & gametoclonal variation. 6L.
7. Tissue culture and its economic prospects.  
Micropropagation of orchids, forest plants and horticultural plants. 15L
8. Cryopreservation and its implications in conservation of plant genetic resource 4L.
9. Tutorial for each topic. 15L.

**BT-207**

**PRACTICAL CELL AND MOLECULAR BIOLOGY**

1. Preparation of chromosomes from: grasshopper (Meiotic), *Rhoeo discolor* (meiotic) *Allium* (meiotic mitotic), and *Drosophila* / *Chironomus* (polytene to demonstrate many strandness of chromosome)
2. Staining of Barr body from: buccal epithelium and Drumstick from blood.
3. Study of chromosomal aberration induced by BHC & pesticide (endosulfan ) in onion root tips.
4. Artificial induction of poly/aneuploidy in onion root by exposure to colchicines.
5. Gel electrophoresis for DNA and proteins and visualization by staining with proper dye.
6. Isolation of Plasmid DNA from bacteria & genomic DNA from plant tissue.
7. Bacterial transformation by plasmid DNA.



**BT-208 Botany II (PRACTICAL PLANT TISSUE CULTURE)**

1. Preparation of different culture media.
2. Callus culture: Media preparation, sub-culturing techniques.
3. Study of somatic embryogenesis and preparation of synthetic seeds.
4. Organ culture: shoot tip, nodal segment and leaf, study of percentage and differentiation with hormonal manipulation.
5. Standardization of Micropropagation techniques: shoot regeneration, root regeneration, hardening and transfer to pots (any two test materials).
6. Suspension culture.
7. Study of differentiation in cultures: Histological detection of xylem, phloem.
8. Identification of viable & non-viable plant tissue employing TTC test.
9. Identification with reasons: Fresh callus, Brown callus, Rhizogenesis, caulogenesis, caulorhizogenesis, somatic embryogenesis, Hardening, Rooted shoot, Axenic culture, Artificial seed, Hairy root.

**B.SC BIOTECHNOLOGY**  
**PART-III (3<sup>RD</sup> YEAR)**

**BT-301 Botany III (PLANT BIOTECHNOLOGY) 80L**

1. Introduction to plant breeding: Incompatibility, pure line selection, mass selection, back cross breeding, heterosis, inbreeding depression, male sterility, preliminary idea about breeder's, foundation and certified seeds, hybrid seed production. CMS lines, restorer line. 20L
2. Crop improvement through embryo rescue technique: embryo and ovule culture. 3L
3. Plant cells as production facility: Role of differentiated cultures in secondary metabolic production through suspension culture and hairy root culture. Commercial production of shikonin and **Berberine** 5L
4. Genetic engineering of plant – gene transfer systems, PEG mediated DNA uptake, gene-gun or Biolistic method, Agrobacterium mediated transformation, electroporation of protoplasts, selection of transformants, vectors used in plant transformation, promoters, terminators, and selectable markers in plant transformation, antibiotic and herbicide resistance markers, luciferase and GUS genes as reporters. 15L
5. Introduction of agronomically important genes in plants: Examples of genetically transformed plants which are commercialized. Eco-friendly pesticides and herbicide resistant genes in plants expressed in crop plants. Reservations about GMO foods. 15L
6. Biofertiliser as alternatives to chemicals fertilizers: Production and application of nitrogen fixing, free living and nodulating bacteria, phosphate solubilizing bacteria, non-symbiotic blue green algae. Symbiotic *Azolla Anabena* system VAM, organic manure: vermicompost, FYM. 7L
7. Tutorial classes. 15L

## **BT-302 Zoology II (ANIMAL BIOTECHNOLOGY) 80L**

1. Basic ideas of animal cells, taxonomy, morphology and phylogeny. 12L
2. Introducing Genes into Animal cells: 6L
  - i. Integration of DNA in mammalian cells
  - ii. Co-transfection
  - iii. The pSV and pRSV plasmids
  - iv. Viral vectors: Adeno and Baculo virus
  - v. Reporter genes: TK and HGPRT genes, antibiotic resistance genes.
  
3. Transferring genes into animal oocytes, zygotes, embryos and specific animal tissues with reference to Xenopus, Drosophila and mammals. Stem cell research. 8L
  
4. Animal tissue culture techniques. Primary cell line and permanent cell lines, media preparation, karyotyping. 8L
  
5. Animal Cloning, **SCNT and overview of Gene therapy and molecular medicine.** 8L
  
- 6. Transgenic animal and its application (Erythropoetin, TPA and Factor VIII).** 5L
  
7. In vitro fertilization, Sperm bank, Ovum bank, embryo splitting, Cryopreservation in animals, fetal cord blood preservation. 10L
  
8. Application of Biotechnology for human welfare: 10L
  - Production of hormones, vaccines, DNA fingerprinting.
  - Basic information about human and other genome sequencing.
  
9. Tutorial classes 15L

1. Introduction to environment Preliminary idea about ecology, ecosystem (**species, community, sere**), ecological balance and the role of biosphere in maintaining ecological balance. Global environmental problems – a brief introduction. Introduction to environmental biotechnology. **10L**
2. Environmental pollution – waste and pollutants: sources of wastes and pollutants, manufacturing, industrial, energy production, agriculture and dairy, transport, house-building and domestic activities. **4L**
3. Hazards from wastes and pollutants: biological agents present in waste: hazards from chemicals in wastes: hazards from physical pollutants: hazards from biomedical wastes: hazards from xenobiotic compounds. 8L
4. Pollution Control – waste treatments (liquid and solid); reducing environmental pollution of industrial wastes and effluents: removal of spilled oil and grease deposits; reducing environmental pollution of chemical herbicides, **ecofriendly** insecticides and fertilizers; environmental monitoring and biomonitoring: biosensors to detect environmental pollutants; biodegradation of xenobiotic compounds. **10L**
5. Environment and energy – renewable sources of energy (waste materials, biogas, energy crops, cellulose): energy and fuel using microorganisms (hydrogen production using hydrogenase and nitrogenase enzymes: hydrocarbon production): conservation of energy. 8L
6. Restoration of degraded lands- reclamation of toxic sites; reforestation through micropropagation; plants used for reforestation of adverse sites; development of environmental stress tolerant plants and crops; use of mycorrhizae in reforestation; use of microbes for improving soil fertility; bioremediation – reclamation of soils contaminated with heavy metals and reforestation. 13L
7. Concept of biodiversity and its conservation – present status and types of biodiversity; extinct and endangered species; red data book, steps to preserve biodiversity: concept of in situ and ex situ conservation of species; concept of gene or germplasm banks in conservation of endangered species. 10L
8. Water quality – water quality parameters; index of water quality; determination of physical (inorganic) parameters; determination of organic compounds; **Water** treatments for improving quality. **2L**
9. Tutorial classes. 15L

**BT-304 Zoology III (IMMUNOLOGY)****80L**

1. Immunity: Definition and types, **antigens and antibodies.** Cellular and soluble mediators of immunity. 6L
2. Antibodies, Immunoglobulins: Basic structure and classes. 4L
3. Major Histocompatibility Complex (MHC): Organization of MHC class I and class II genes, HLA Complex in human, Structure of MHC-I and MHC-II molecules; Cellular distribution and Regulation of MHC expression, **APC and its presentation.** 5L
4. Complement system: Nomenclature, activation pathways and regulation. 8L
5. Immunoglobulin genes: Chromosomal organization; Rearrangement of Ig genes and generation of germline antibody diversity; Class switching (elementary idea). **10L**
6. T cell antigen receptor (TCR): Structure and generation of diversity. 3L
7. Lymphocyte maturation: General features; Maturation of B and T lymphocyte.  
  
Immune Responses: T cell activation, **Proliferation**, differentiation and effector mechanism; B cell and humoral response – B cell activation, differentiation. 10L
8. Antigen – Antibody interactions: Molecular basis of antigen – antibody reaction; Antibody affinity and activity. Principal methods used to measure antigens and antibodies – precipitation, agglutination, Radio immunoassays (RIAs): Enzyme linked immunosorbent assay (ELISA); Western blotting. 10L
9. Immunization: Passive and active immunizations – vaccines( classical and genetically engineered). 4L
10. Hybridoma Technology: Steps in hybridoma production Application of monoclonal and polyclonal antibody. **5L**
11. Tutorial classes. 15L

**BT-305 FUNDAMENTAL OF BIOSTATISTICS AND BIOINFORMATICS****Total 80L**

1. Statistical Data: A brief description and tabulation of biological data and their graphical representation. **4L**
2. Bivariate Data: Concept of dependence, method of least squares, correlation and regression. **4L**
3. Qualitative Data: Categorical data, association of attributes, rank correlation. **2L**
4. Population and sample: Sampling methods, standard error. **2L**
5. Elements of Statistical Inference: Types of error, standard parametric tests (z, t, chi-square, F), tests for goodness of fit, analysis of variance. **10L**
6. Elements of C language: Variables, condition checking and looping. **12L**
7. Bioinformatics: Definition and its application in different areas of Biotechnology. **2L**
8. Different databases: Genbank, FASTA, SWISS-PROT, NCBI,PDB. **3L**
9. Sequence alignment: Definition, Types and significance of Pairwise sequence alignment; Gap penalty and its importance in sequence alignment. **4L**
10. Different methods of pairwise sequence alignment: Dot Matrix, Dynamic programming Algorithm & k-tuple method; **6L**
11. Multiple sequence alignment: Definition and importance. **2L**
12. Search / Scanning algorithm: BLAST, PSI-BLAST and PHI-BLAST. Definition of Position Specific Scoring Matrix. **6L**
13. Relationship of Phylogenetic analysis of sequence alignment, Maximum parsimony method, Distance based method (Fitch-Margoliash method), testing of phylogeny using Boot strapping. **8L**
14. Basic protein structure modeling. **5L**
15. Tutorial classes **10L**

**Group – A Chemistry IV (Industrial Chemistry)**

1. Chemical Process Industries: Manufacture of Sulphuric acid, Nitric acid, common Salt, Soda ash, Hydrochloric acid, Caustic soda, Chlorine. 5L
2. Synthetic Nitrogen Products: Fixation of atmospheric Nitrogen, Direct synthesis of ammonia, Cyanamide. 3L
3. Phosphates, Phosphoric acid, super phosphate of lime. 3L
4. Fertilizers, mixed fertilizers, synthetic urea. 3L
5. Water for Municipalities, and for Industrial purposes, Sewage Disposal Plants. 4L
6. The Distillation of Coal for gas, coke, tar ammonia. 3L
7. Fuel gases, water gas, producer gas and natural gas. 4L
8. Synthetic textile fiber. 2L
9. Manufacture of cane sugar, beetsugar, corn starch, and glucose. 2L
10. Petroleum and its products, Saccharine, naphthalene. 2L
11. Synthetic Drugs – paracetamol & aspirin. 2L
12. Synthetic plastics and resins. 2L
13. Tutorial classes. 5L

**Group – B (Industrial Management)**

1. **Management: Concepts, levels, functions, skills of managers**, Managing three levels of behavior in organizations: individual employee behavior, group behavior and organizational behavior. Nature and functions of HRM and HRD, employees' selection and training, performance management, Thrust on Organizational dynamics – Organizational behavior and significance of individual, group and organizational dimensions. Emotional intelligence. 10L
2. Economic Aspects of Biotechnology industry, competitive forces and impact on strategy, regulation of genetic products, planning under uncertainty, the economic environment, research and development. 8L
3. Marketing aspects of Biotechnology  
Marketing of biotechnological products and services. Develop a marketing plan, the relationship between the sales and marketing functions, the difference between marketing a scientific product and a scientific customer service, market differentiation and a new product launch. 10L
4. Creating a Biotechnology Enterprise 7L  
Assessment of innovative technology, Intellectual Property Rights, patents and licensing, corporate law, preparing a business plan, raising money, government grants, strategic alliances and regulatory affairs. Quality control and Quality Assurance.
5. Tutorial classes. 5L

**BT-307 (Practical) Group A – Environmental Microbiology 50 Marks**

Analysis of water for

- a) BOD
- b) DO
- c) COD
- d) Coliform test
- e) Acid Production
- f) Gas Production
- g) IMViC Test

**Group B – Biostatistics & Bioinformatics**

**50 Marks**

*Biostatistics:*

- a) Exposure to spreadsheet package (EXCEL) and statistical software (R, STATISTICA)
- b) Summarization and graphical representation of biological data.
- c) Scatter plot and dependence analysis
- d) Fitting of statistical models.
- e) Test of significance problems with z, chi square, t and F.
- f) Analysis of variance problems for way and two way data.

*Bioinformatics:*

1. Searching of a particular gene or genome through NCBI.
2. Searching of a particular protein through SWISS PROT.
3. Database similarity searching of a gene or protein through BLAST.
4. Exporting the structure related data of a particular protein through PDB, viewing and listing of properties of 3D structure.

**BT-308 Dissertation and Viva-voce**

Dissertation-75 marks.

Viva-voce – 25 marks

Total – 100 marks.