

Unit III

Vitamins: Classification, properties, structure and functions. Plant growth regulators: Auxins, gibberlins, cytokinenins, ethylene and abscissic acid: structure, functions and applications; animal hormones: nature, hormone action (including role of cyclic-AMP), hypothalamic control of pituitary, endocrine secretions of Pituitary, Pineal, Adrenal, Thyroid, Islets of Langerhans, Testis and Ovary.

Unit IV

Structure and properties of nucleic acids, double helical structures. Forces stabilizing nucleic acid structure. Metabolism of nucleotides: Synthesis of purine & pyrimidine nucleotides, catabolism of purines and pyrimidines.

Unit V

Enzymes: Properties, classification and nomenclature. Mechanisms of enzyme action (i.e. catalytic mechanisms). Michaelis-Menton equation. Effect of substrate, temperature, pH and inhibitors on enzyme activity. Feedback inhibition. Isozymes, Zymogens, Multienzyme complexes, Allosteric enzymes. Enzyme Isolation, purification and large scale production, immobilization, Enzymes contributing sustainable industrial development, starch processing-Textile, leather, pulp and paper manufacturing.

PAPER – II CELL BIOLOGY AND BIOPHYSICS

NOTE: There shall be three (3) sections in the question paper.

Section A (20marks) shall consist of 10 questions two from each Unit. Each question shall be of 2 (two) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.

Section B (25marks) shall consist of 5 questions (two from each unit, as internal choice). Each question shall be of 5 (five) marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words.

Section C (30 marks) shall consist of 5 questions, one from each Unit. Each question shall be of 10 (ten) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Methods to elucidate structure of biochemical compounds found in living organisms. Introduction to separation methods for different biomolecules: Filtration, centrifugation, density gradient centrifugation, chromatography (CC, PC, TLC, GLC, HPLC). Small and macromolecule quantification: Colorimetry, Photometry, Nephelometry, Flame photometry, Visible, UV and Atomic absorption spectroscopy.

Unit II

Introduction to Fractional precipitation: Gel filtration, Gel Electrophoresis, colony hybridization, tracer techniques, autoradiography, Microcolorimetry. Biophysics of nerves, muscles and membranes, physics of cellular process. Attractive and repulsive forces generated within the molecules and their overall effect on molecular interactions.

Unit III

Cell wall, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Structure and function of cytoskeleton and its role in motility. Mitosis and Meiosis, their regulation, steps in cell cycle and control of cell cycle. Regulation of Hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

Unit IV

Physical techniques in proteins, nucleic acids and polysaccharides structure analysis (IR, NMR, LASER, Raman spectroscopy, Mass spectroscopy, Fluorescence spectroscopy, Mossebäuer spectroscopy, and Atomic force microscope). Transportation across biomembranes- Passive transport, facilitated transport, active transport (Na⁺, K⁺ & ATPase pump).

Unit V.

Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .Bioelectronics: Biosensors, Biochips, Biocomputer, Bioplastics.

Cell signaling hormones & their receptor, Signal transduction pathways, second messengers, regulation of signaling pathways.

PAPER – III CONCEPT OF MICROBIOLOGY & IMMUNOLOGY

NOTE: There shall be three (3) sections in the question paper.

Section A (20marks) shall consist of 10 questions two from each Unit. Each question shall be of 2 (two) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.

Section B (25marks) shall consist of 5 questions (two from each unit, as internal choice). Each question shall be of 5 (five) marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words.

Section C (30 marks) shall consist of 5 questions, one from each Unit. Each question shall be of 10 (ten) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Introduction to microbiology: Scope and History, distinctive characters, classification (upto class level) and uses in agriculture, industry and environment of major groups: Fungi, Algae, Protozoa, Bacteria, Virus. Microscopy: Simple, light and compound microscope, phase-contrast, dark field, fluorescence and electron microscopy (TEM & SEM)- their principles and applications. Different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

Unit II

Morphology, fine structure, elementary chemistry and function of bacteria: cell wall, cell membrane, capsule, appendages and cytoplasmic inclusions. Introduction to concept of disinfection and sterilization: Physical and chemical methods of sterilization, trophic grouping, types of media, pure culture isolation techniques.

Unit III

Microbiology of air: Atmospheric microflora, air sampling devices (impactors, impingers) Air borne diseases and control of air borne diseases. Microbiology of water: Microbiology of fresh, marine and potable water, water purification, waste water and sewage disposal. Microbiology of food: Food spoilage, food preservation, food borne pathogens, food poisoning. Microbiology of soil: Soil microflora, interaction between microorganism in soil. Role of microbes in Carbon, Nitrogen, Phosphorous, Sulphur cycle in nature.

Unit IV

Elementary account of most common diseases caused by microorganism in human, animals and plants: Tuberculosis, Syphilis, Small pox, Chickenpox, SAARS, AIDS, Ranikhet, Brucellosis, Pebrine, Rinderpest, Mastitis, TMV, Citrus canker, Tikka, Green ear. Virus: Chemical and physical properties, virus isolation, purification, cultivation, serology, plaque assay and viral replication.

Unit V

Innate and Acquired immunity, Cells of immune system: B lymphocyte, T lymphocytes, macrophages, Nk cells and killer cells. Lymphokines, Immune response, clonal selection & development of B-cells, antigens, antibody structure and functions. Antigen-Antibody reactions. Major histocompatibility complex, MHC- restriction, complement system, immunological tolerance, principles and uses of RIA, ELISA, Immunofluorescence and immunological technique in diagnostics.

PAPER – IV MOLECULAR BIOLOGY & GENETIC ENGINEERING

NOTE: There shall be three (3) sections in the question paper.

Section A (20marks) shall consist of 10 questions two from each Unit. Each question shall be of 2 (two) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.

Section B (25marks) shall consist of 5 questions (two from each unit, as internal choice). Each question shall be of 5 (five) marks. The candidate is required to answer all 5 questions. The answers should not exceed 200 words.

Section C (30 marks) shall consist of 5 questions, one from each Unit. Each question shall be of 10 (ten) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Genetic material: Structure, chemical composition and organization (structure of chromatin, coding and non coding sequences, satellite DNA). DNA replication (enzymes, accessory proteins involved and mechanism), super coiled DNA, repetitive DNA, artificial chromosomes.

Recombination: Holliday junction, general and site specific recombination. Role of Rec A protein and other recombinase, DNA damage and repair. Biology of cancer: Viral and cellular oncogenes and tumor suppressor genes in man.

Unit II

Gene Expression: Prokaryotic & eukaryotic transcription (RNA polymerase, transcription factors, regulatory elements, mechanism). Post transcriptional modification: RNA processing (capping, polyadenylation, splicing, editing). Prokaryotic and eukaryotic translation, mechanism of initiation, elongation, termination and regulation. Co and post-translational modifications of proteins. Regulation of gene expression: Operon concept, positive and negative control-lac operon, trp operon, catabolic repression, antitermination, attenuation.

Unit III

Principles and methods of genetic engineering: Restriction endonucleases (types, classification and application), DNA ligases, Topoisomerases, Gyrase, Methylases, Nucleases and other enzymes needed in genetic engineering. Cloning vectors: Plasmids- organization, replication and incompatibility of plasmids, construction of plasmid vector, Ti plasmid. Phages: Characteristics of single and double phages, construction of phage vectors, cosmids, expression vector and other vectors (YAC & BAC), screening of recombinants.

Unit IV

Molecular cloning: Construction of cDNA and genomic library, principles and practice of nucleic acid hybridization - southern, northern and western blotting techniques, gel retardation, DNA finger printing and foot printing, chromosome walking, sequencing of DNA, site directed mutagenesis, polymerase chain reaction (PCR) and its application, gene therapy & its application, gene and protein targeting, antisense RNA technology & its application.

Unit V

Linkage maps, tetrad analysis, mapping with molecular markers & Physical maps- Fish, STS & restriction mapping Transposons, Transgenic animals. Methods of their production, ethics & morality. DNA probes and their applications in molecular diagnosis of genetic and other human disorders. Application of genetic engineering in agriculture, medical and industry. Biosafety regulations: Physical and biological containment. Intellectual property rights, patenting of biological materials, patenting laws in India.

SCHEME OF THE PRACTICAL EXAMINATION M.SC. PREVIOUS BIOTECHNOLOGY BASED ON THEORY PAPERS

Combined Practical Exam

Time: - 5 hrs. (Each day) Max. Marks- 150

Min. Marks 54

- | | |
|--|------|
| 1. Biochemistry and enzyme technology | |
| (A) Major | (20) |
| (B) Minor | (10) |
| 2. Exercise in Microbiology & Immunology | |
| (A) Major | (20) |
| (B) Minor | (10) |
| 3. Exercise in Molecular & Genetic Engineering | |
| (A) Major | (20) |
| (B) Minor | (10) |
| 4. Spots (5) | (15) |
| 5. Practical record | (15) |
| 6. Review assignment | (20) |
| 7. Viva-voce | (10) |

List of Practical Exercises

Biochemistry and Enzyme technology

A. Major

1. Protein content in the given sample by Lowry method
2. Chlorophyll estimation
3. Total sugar by anthrone reagent
4. Estimation of free amino acid by spectrophotometer
5. Extraction and identification of amino acid by paper chromatography
6. Isolation and identification of steroid (TLC)
7. Estimation of total lipid
8. Quantitative estimation of catalase activity from leaf sample
9. Estimation of Glycogen from liver sample

B. Minor

1. Preparation of standard solution of acid and bases
2. Determination of pH of buffer
3. Precipitation of protein
4. Biurette test
5. Pka value and dissociation constant of acid
6. Total reducing sugar (Nelson and Somogyi method)
7. Starch hydrolytic activity
8. Casein hydrolytic activity
9. Catalase test
10. Lipid hydrolytic test
11. Citrate test
12. Nitrate reduction test

Microbiology and Immunology

A. Major

1. Determination of antigen-antibody reaction by radial immunodiffusion method.
2. Determination of antigen-antibody reaction by Ouchterlony double diffusion method
3. Isolation of Microorganisms from soil by the serial dilution agar plating method.
4. Obtain pure cultures of microorganisms by streak plate method
5. Isolation and Enumeration of microorganisms from leaf/milk/soil/sample
6. Bacteriological examination of water by multiple-tube fermentation

B. Minor

1. Preparation of Basic solid media for the routine cultivation of microorganisms
2. To perform the simple staining
3. To perform the gram staining procedure
4. Extraction and identification of dyes by TLC
5. Preparation of 0.2M acetate buffer
6. Indole test
7. MR-VP test
8. Bacterial spore staining
9. Capsule staining
10. Negative staining

Molecular and Genetic engineering

A. Major

1. Plant DNA isolation and RNase treatment
2. Plasmid isolation
3. Agarose gel electrophoresis of DNA
4. Plot absorption spectrum for DNA & find out λ_{max} .
5. Determine concentration of DNA/RNA in sample by spectrophotometer.
6. Determine molecular weight of DNA by viscometer
7. Preparation of competent cells of the E. coli host.
8. Amplification of DNA through PCR

B. Minor

1. Preparation and examination of agarose gel
2. To make different types of electrophoresis buffer
3. Preparation of gel loading dyes/buffer

4. Plot standard curve for DNA by colorimeter method.
5. Plot standard curve for RNA by colorimeter method.
6. Determine purity of DNA in sample by UV method

SPOTS

Scanning electron microscope, Transmission electron microscope, Autoclave, Electrical drying oven, Electrical bacteriological incubator. Electrophoresis apparatus, Laminar air flow, pH meter, Centrifuge machine, Spectrophotometer, UV Transilluminator, BOD Incubator, Bright field microscope, Dark field microscope, Phase contrast microscope, Fluorescent microscope, Electron microscope and all other equipments available in the laboratory and used by the student. Slides of different microorganisms.

Submission: A review assignment has to be submitted by each candidate followed by seminar.

REFERENCES :

1. Genetic Engineering Principle and Methods, Setlow J. K. & Hollaender, Plenum Press, New York.
2. Biochemistry, Donald Voet, Judtin E. Voet; Panima Publication
3. Advances in Biotechnology, Manjula K. Saxena and B.B.S.Kapoor, Madhu publications
4. Microbiology, P. D. Sharma, Rastogi Publications
5. Immunology, Richard A., Goldsby, Kuby et al, W. H. Freeman & Company, New York
6. Biophysics, Vasantha Pattabhi, N. Gautham, Narosa Publishing House
7. Essential of Biophysics, P. Narayanan, New Age International Publication
8. An Introduction to Molecular Biotechnology- Molecular Fundamentals, Methods and Applications in Modern Biotechnology, Edited by Michael Wink, Wiley
9. Molecular Biology of the Cells, Alberts et al., Garland Publications Inc NY and London
10. Cell and Molecular Biology, E D de Roberties & E M F de Roberties (Jr) Lippincott Williams & Wilkins, Philadelphia
11. Biochemistry, Lubert Stryer, W H Freeman and Co., San Fransisco.
12. Immunology, Janis Kuby, W H Freeman and Company, USA
13. Essential Immunology, Ivan Roitt, Blackwell Science Ltd.
14. Microbiology, Michael J Pelczar (Jr) ESC Chan, N R Kreig, Tata McGraw Hill.
15. Fundamentals of Enzymology, Nicholas C Price and Lewis Stevens, Oxford Univ Press.

M.SC. FINAL BIOTECHNOLOGY - 2018

A. Theory Papers	Maximum Marks
11. Cell and Tissue Culture	100
2. Environmental Biotechnology	100
3. Biostatistics, Bioinformatics & Computer Applications	100
4. Industrial Biotechnology	100
Total	400

Scheme of Practical Examination

	Time: 5 hrs. (Each day)	Maximum marks: 200	Minimum marks: 72
1- Experiment in Cell and tissue culture (20)			(a) Major
(b) Minor		(15)	
2- Experiment in Industrial biotechnology			
(a) Major		(20)	
(b) Minor		(10)	
3- Exercise in Environment biotechnology			
(a) Major		(15)	
(b) Minor		(10)	
4- Biostatistics problem		(15)	
5- Computer exercise			(15)
6- Spots (5)		(15)	
7- Viva-voce		(20)	
8- Project Report		(25)	
9- Practical Record		(20)	

PAPER – V CELL AND TISSUE CULTURE

Unit I

Introduction and History of Plant Tissue Culture: Tissue culture media, composition and preparation - Balance salt solution, simple growth medium, chemical, physical & metabolic function of different constituent of culture media. Callus culture & Suspension culture- Initiation and maintenance. Single cell clones, somaclonal variation, somatic

embryogenesis. In vitro pollination: Embryo culture & embryo rescue. Anther/Pollen culture: Production of haploid plants and homozygous lines.

Unit II

Clonal propagation (Micropropagation): Establishment of whole plant in soil, methods of micropropagation. Applications: Forestry, floriculture, agriculture, conservation of biodiversity and threatened plant species. Cryopreservation: Germplasm conservation, protoplast- Isolation, culture, fusion cybrids, selection of hybrid cells and regeneration of hybrid plants, symmetric and asymmetric hybrids.

Unit III

Natural products (Secondary products): Introduction. Alkaloids production in plant tissue culture, optimization for growth and production, time course of production, selection of cells for higher yields, extraction of alkaloids / steroids. Commercially used plant alkaloids and steroids. Cloning, mechanism of production. Production of useful metabolites: Biotransformation, immobilization of cells, elicitors, hairy root culture.

Unit IV

Application of plant tissue culture in plant pathology: Development of virus free plants, growth of obligate parasite in culture, development of disease resistance, screening of germplasm. Application of biotechnology in breeding and crop improvement. Anther culture: Production of haploids, embryo culture, endosperm culture, somatoclonal and gametoclonal variant selection. Gene transfer and transgenic plants. Ethical issues related to transgenic plants. RFLP, AFLP, RAPD and other Molecular markers.

Unit V

Introduction to salt solution and simple growth medium biology of culture cells, measuring parameters of growth. Basic technique of mammalian cell culture in vitro: Organ and Histotypic culture. Microcarrier culture, cell synchronization and cell culture. Application of animal culture. Animal cloning and transgenic animals. Hybridoma Technology and monoclonal bodies.

PAPER - VI ENVIRONMENTAL BIOTECHNOLOGY

Unit I

Global environmental problems, their impact and biotechnological approaches for management: Ozone depletion, UV-B, green house effect and acid rain. Water pollution and its biological control: Water as natural resource, need for water management, sources of water pollution.

Unit II

Biological treatment processes: Water supply treatment, waste water collection, preparing potable water, removal of microbial contaminants. Aerobic treatment processes - Activated sludge, oxidation ditches, ponds, trickling filter, towers, rotating disc, rotating drums. Anaerobic treatment processes - Anaerobic digestion & anaerobic filters. Treatment schemes for waste waters of - Dairy, distillery, sugar industries & antibiotic industries.

Unit III

Scope, application & concept of cleaner technology. Solid wastes: Sources safety and management (ensilage, composting, vermiculture and biogas production). General hazardous waste, radioactive and other hazardous waste, bioscrubbing heavy metals and organic pollutant (Bioaccumulation, Biosorption).

Unit IV

Application of microbes as biofertilizers and bioinsecticides: for productivity improvement and crop protection, principles of biomonitoring and application of biosensors for detection of environmental pollutants. Biomining: Use of microbes in biohydrometallurgy and biomineralization, degradation of pesticides and other xenobiotics, genetic regulation of xenobiotic biodegradation, phytoremediation of disturbed ecosystems.

Unit V

Use and development of GEM for bioremediation, development of gene probes for environmental remediation & releasing and tracing GEMS.

Emerging technologies or environmental bioremediation: Microelectromechanical system (MEMs), genosensor technology, gene probes - nah operon, integrated treatment system with special reference to biodegradation of polychlorinated biphenyls (PCBs), PCB treatment process and design.

PAPER - VII BIOSTATISTICS, BIOINFORMATICS & COMPUTER APPLICATIONS

Unit I

Computer and their organization: Hardware, software, firmware and firmware. Operating system (command line and WIMP). Elementary idea about programming languages- Q Basic and C. Introduction to M.S. office (Software covering M.S. word, M.S. Excel, Corel draw/Haward graphics, Powerpoint and animation technique). Introduction to data structure and database concepts, introduction to internet and its application. Computer aided learning (CAL) in Biotechnology, fermentation technology, imaging, simulation and mathematical modeling. Computer oriented

statistical techniques: Frequency table of single discrete variable, bubble sort, computation of mean, variance and standard deviation, t- test, correlation coefficient.

Unit II

Biostatistics: Introduction, definition and needs. The sample and population. Statistical inference, parameter and statistics. Types of data (Internal, proportion, count). Mean, mode, median, variance and standard deviation. Elementary idea of probability, definition and properties of binomial poison and normal distributions. Elementary idea of random sampling, selection of simple random samples from a finite population, definition of sampling distribution, sampling variance and standard error. Idea of two types of errors and level of significance, test of significance, chi2 test of independence and homogeneity test based on Z and T statistics.

Unit III

Standard curves, correlation, testing significance of correlation coefficient. Statistical basis of biological assays. Response - dose metameter - Delusion assays. Direct and indirect assays. Quantal responses. Probit, logit, LD 50, ED 50, PD 50 standard line interpolation assay. Parallel line assay (4point, 6point assays), stope ratio assay. Statistical modeling. Ordination techniques and their uses. Resource utilization models.

Unit IV

Bioinformatics: Introduction, objectives, bioinformatics and data analysis. Data base concept, elementary knowledge of structured query language. Biological, microbiological and virology databases, cell gene banks related sites, biodiversity information databases. Genome analysis. DNA / Genome sequencing. Finding and retrieving sequences. Sequence data base. Protein and nucleic acid sequence database. Structural database. Identifying protein sequence from DNA sequence.

Unit V

Phylogenetic analysis: prediction method using protein and nucleic acid sequences. Submitting DNA sequence to databases. Searching database for similar new sequences. Computer tools for sequence analysis. Finding and retrieving sequences. Introduction to sequence alignment . Alignment of pairs of sequences. Multiple sequence alignments. Homology algorithms (BLAST, FASTA) for proteins and nucleic acids. Optimal alignment methods. Substitution scores and gap penalties. Annotations of genes. DNA and Protein micro array. Analysis of single nucleotide polymorphism using DNA chips. Proteome analysis: Two dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy.

PAPER - VIII INDUSTRIAL BIOTECHNOLOGY

Unit I

Isolation, preservation and maintenance of industrial microorganisms, microbial growth and death kinetics, media for industrial fermentation, air and media sterilization. Types of fermentation processes: Analysis for batch, fed-batch and continuous bioreactors, stability and microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulse, fluidized, photobioreactors etc.). Environmental control of bioreactors. Downstream processing, whole cell immobilization and industrial applications.

Unit II

Industrial production of alcohol (ethanol), acids (citric acid and gluconic acid), solvents (glycerol, acetone, butanol), antibiotics (Pencillin, Streptomycin, Tetracycline), amino acids (Lysine, Glutamic acid), steroids, hormones and vaccines. Introduction to food technology: Elementary idea of canning and packing, sterilization and pasteurization of food products. Production of mushroom, cheese, single cell protein, single cell oil and other dietary products.

Unit III

In vitro approaches to genetic manipulation of plants. Application of plant protoplast culture in somatic hybridization and cybridization. Current status and commercial opportunities for genetically engineered plants for: Insect tolerance, virus tolerance, herbicide tolerance, pesticide tolerance, stress tolerance. Development of male sterile plants.

Unit IV

Synthetic seeds: Progress and potential. Scaling up production and automation in plant propagation. Use of robotics in plant production. Mass scale plant production , Principles of green chemical biotechnology, green synthesis, green extraction, green reactors and green technology for the production of Biomolecules.

Unit V

Hardening and acclimatization: Success and bottle necks, green house management and operations, quality control, packaging and shipment, costbenefit analysis. Global market, commercial opportunities in plant tissue culture with special reference to plant tissue culture industries in India.

M. SC. FINAL BIOTECHNOLOGY

Scheme of Practical Examination
Maximum marks: 200

Time: 5 hrs. (Each day)
Minimum marks: 72

1- Experiment in Cell and tissue culture

(a) Major

(20)

(b) Minor

(15)

2- Experiment in Industrial biotechnology

(a) Major	(20)
(b) Minor	(10)
3- Exercise in Environment biotechnology	
(a) Major	(15)
(b) Minor	(10)
4- Biostatistics problem	(15)
5- Computer exercise	(15)
6. Spots (5)	(15)
7- Viva-voce	(20)
8- Project Report	(25)
9- Practical Record	(20)

Practical Exercises **Experiments in Cell and Tissue culture**

Major

1. Initiation & maintenance of callus.
2. Cyto differentiation of tracheary elements in cultured explants.
3. Identification of secondary metabolites by TLC
4. Anther Pollen culture
5. Isolation, Purification & culture of protoplast
6. Somatic embryoids from vegetative cells of mature plants/ hypocotyl & Cotyledons of embryo.
7. Micro-propagation with shoot apex cultures.
8. Embryo development: Chick developmental stages and Gastrulation.

Minor

1. Basic Knowledge of a Tissue Culture Laboratory
2. Preparation of Murashige and Skoog (MS) stock solutions
3. Preparation of M.S. medium
4. Measurement of growth/ differentiation in plant tissue culture by fresh weight & dry weight.
5. Determination of mitotic index (MI) in callus/ suspension cultures.

Exercises in Industrial Biotechnology

Major

1. Yogurt preparation using suitable bacterial isolates /dairy starter culture
2. Microbiological quality of given food item.
3. Production of spawn from button mushroom.
4. Cultivation of mushroom.
5. Production of Lactic acid.
6. Antimicrobial activity of tissue extracts against gram+ & gram- bacteria.
7. Production of single cell proteins from algae.
8. Demonstration of production of antibiotics (penicillin) by microbes.
9. Production of pectinase by *Aspergillus niger* using wheat bran coffee pulp using small scale fermenter and its assay.
10. Production of α amylase using *Aspergillus oryzae*/ *Bacillus licheniformis* using bran in small scale solid state fermentation and its assay.
11. Production of microbial polysaccharides and yield estimation.

Minor

1. Quality test of given milk sample by standard plate count method
2. Determination of quality of milk sample by methylene blue reductase test.
3. Role of Yeast in Bread making.
4. Production of curd from microorganisms.
5. To study general methods of food preservation (e.g. Temperature, Salt, Moisture).
6. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.

Exercises in Environmental Biotechnology

Major

1. Chloride content of water samples using arginometric method.
2. Estimation of dissolved oxygen and BOD in water & wastewater.
3. Determination of MPN in wastewater.
4. Determination of chemical oxygen demand (COD) of sewage sample.
5. Study on biogenic methane production in different habitats.
6. Test of heavy metals (Zn, Cu, Pb) tolerance in some identified bacteria.
7. Isolation of bacteria from various polluted sites (waste water, distillery waste) and their identification.

Minor

1. Sampling of water (Dussart flask water sampler)
2. pH of water using pH meter
3. Acidity/alkalinity of water samples.
4. Vam staining
5. Detection of coliforms for determination of the purity of potable water.
6. Baculovirus stock- preparation and titration using plaque colony.
7. Demonstration of methods for waste water treatment.

Exercises in Biostatistics, Bioinformatics & Computer applications

1. Bar graph of growth index from given data.
2. Biostatistics problems based on Mean, Mode, Median, Standard deviation, Variance, t-test, Chi square test.
3. Introduction to M.S. office (Software covering M.S. word, M.S. Excel, Corel draw).
4. Power point and animation technique.
5. Use of internet.

Spots based on: Laboratory instruments, Microscopes and Techniques

Project Report: Submission of a Project report based on visit to Research Centre/Institution/ Industry

References

1. Computational Statistics, Rao, MJM, Himalaya Publishing House
2. Biostatistics, Arora and Malhan, Himalaya Publication
3. Statistics, S. P. Gupta, Rastogi Publication
4. Computer Fundamentals, Pradeep K. Sinna et al, BPB Publications
5. Plant Cell and Tissue Culture, Narayanaswami, Tata Mc Graw Hill
6. Plant Biotechnology, K. G. Ramawat, S. Chand and Company Ltd.
7. Animal Biotechnology, M. M. Ranga, Agrobios India.
8. Industrial Biotechnology, G. Read, Presscott and Dunns, Chapman and Hall
9. Environmental Biotechnology, Alan Scragg, Oxford University Press
10. Introduction to Environmental Biotechnology, A. K. Chatterji, Practice Hall Of India.
11. Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
12. Bioinformatics, Baxevanis Ouellette, Wiley-Less Publication
13. Introduction to Informatics, Attwood, Parrr, Smith, Pearson Education
14. Westhead, Parish and Tuxjman, Instant Notes in Bioinformatics, Viva Book Pvt Ltd
15. Advances in Biotechnology, Manjula K Saxena and B.B.S.Kapoor, Madhu publications
16. An Introduction to Computational Biochemistry, Tsai, C. Stan, John Wiley & Sons
17. Industrial Biotechnology, Shekar
18. Elements of Biotechnology, P. K. Gupta, Rastogi & Company

□□□

Commercial Micropropagation / Tissue Culture as an Industry

1. Status of Tissue Culture Industry in India. Indian and Global marketing potential.
2. Commissioning of a commercial tissue culture unit (Large/small) – Design and commissioning- Media room, Inoculation facility, Culture Rooms, Wash and Dispensing Facility, Autoclaving facility, Storage, Power Supply Unit with Standby Facility. Waste disposal unit, Use of

Solar Energy. Assessing Equipment, Lab ware, Chemicals requirements.

3. Hardening Unit Designing for Warm and Temperate climates. Construction of Automated and Small Make Shift Green Houses. Hardening Procedures.
4. Scaling up of Micropropagation Protocols:
 - (i) Axillary Enhancement
 - (ii) Automated Somatic Embryogenesis
5. Sterilization Procedures and Clean Air Management. Handling of contamination in Tissue Culture Units.
6. Risk factors in Tissue Culture units, Biosafety Measures and Waste Disposal
7. Economics of Micropropagation: Packaging, Transport, Supply Chain Management. Introduction of Cost Effective Measures at all stages of commissioning, Production and Supply.
8. Quality Control Measures. GMP and HACCP requirements. Patent Requirements. Government Policy for support of Tissue Culture Industry.