MAHARAJA GANGA SINGH UNIVERSITY
BIKANER

SCHEME OF EXAMINATION AND SYLLABUS

SEMESTER SCHEME

M.Sc. BIOTECHNOLOGY (semester I & II 2022- 2023)

M.Sc. BIOTECHNOLOGY (semester III & IV 2023- 2024)

M.SC. BIOTECHNOLOGY 2022 – 2024
Semester Scheme

SCHEME OF EXAMINATION

1. The number of papers and the maximum marks for each paper / practical are shown in the syllabus for the subject concerned. It will be necessary for a candidate to pass in the theory part as well in the practical part (wherever prescribed) of a subject / paper separately.
2. A candidate for a pass in each semester Examinations shall be required to obtain (i) at least 36% marks in the aggregate of all the papers prescribed for the examination and (ii) at least 36% marks in practicals / wherever, prescribed at the examination, provided that if a candidate fails to secure at least 25% marks in each individual paper at the examination and also in the Test/Dissertation/Survey Report/Field Works, wherever prescribed, he shall be deemed to have failed at the examination not withstanding his having obtained the minimum percentage of marks required in the aggregate for that examination. No division will be awarded at the Previous Examination. Division shall be awarded at the end of the final Examination on the combined marks obtained at the Previous and the Final Examinations taken together, as noted below:
   First Division 60% of the aggregate marks taken
   Second Division 48% together the Previous and Final Exam
3. If a candidate clears any Paper(s) prescribed at the Previous and / or Final Examination after a continuous period of three years, then for the purpose of working out his division the minimum pass marks only viz., 25% (36% in the case of practical) shall be taken into account in respect of such paper(s) / practical(s) are cleared after the expiry of the aforesaid period of three years; provided that in case where a candidate requires more than 25% marks in order to reach the minimum aggregate as many marks out of those actually secured by him will be taken into account as would enable him to make up the deficiency in the requisite minimum aggregate.

Teaching and Examination Scheme for

M.Sc. Biotechnology (Semester Scheme) Examination 2023

Session 2022-23

Paper Code	Paper Name	Lecture / week	Exam Hours	Maximum Marks		Minimum Passing Marks
				Internal Marks	External Marks	
Semester-I						
Theory Papers						
BT-101	Biochemistry And Metabolism	**3**	**3**	10	40	13 (25 %)
BT -102	Cell Biology	**3**	**3**	10	40	13 (25 %)
BT -103	Concept of Microbiology	**3**	**3**	10	40	13 (25 %)
BT -104	Molecular Biology	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72 (36% aggregate)**
BT -105 Practical I (Based on theory papers)		**3**	**6**	**25**	**75**	**36 (36% aggregate)**
Grand Total					**300**	

Semester-II						
Theory Papers						
BT- 206	Enzyme And Technology	**3**	**3**	10	40	13 (25 %)
BT -207	Biophysics And Biotechniques	**3**	**3**	10	40	13 (25 %)
BT -208	Genetic Engineering	**3**	**3**	10	40	13 (25 %)
BT -209	Concept of Immunology	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72 (36% aggregate)**
BT -210 Practical (Based on theory papers)			**6**	**25**	**75**	**36 (36% aggregate)**
Grand Total					**300**	
Semester-III						
Theory Papers						
BT -311	Plant Tissue Culture	**3**	**3**	10	40	13 (25 %)
BT -312	Animal Tissue Culture	**3**	**3**	10	40	13 (25 %)
BT -313	Environmental Biotechnology	**3**	**3**	10	40	13 (25 %)
BT -314	Biostatistics	**3**	**3**	10	40	13 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72 (36% aggregate)**
BT -315 Practical I (Based on theory papers)			**6**	**25**	**75**	**36 (36% aggregate)**
Grand Total					**300**	
Semester-IV						
BT-416	Industrial Biotechnology	**3**	**3**	10	40	13 (25 %)

BT-417	Bioinformatics and Computer Applications	**3**	**3**	10	40	13 (25 %)
BT-418	Dissertation/ Industrial Training Report	-	10 min presentation/ viva voce per student	20	80	36 (25 %)
				40	**160**	
Total Theory Marks					**200**	**72 (36% aggregate)**
BT -419 Practical (Based on theory papers)			**6**	**25**	**75**	**36 (36% aggregate)**
Grand Total					**300**	

M.Sc. BIOTECHNOLOGY
Semester I
Marking Scheme External Exam

Theory Paper	**Duration**	**Max. Marks**
Paper BT-101	3 Hrs.	40
Paper BT-102	3 Hrs.	40
Paper BT-103	3 Hrs.	40
Paper BT-104	3 Hrs.	40
Paper BT-105 (Combined Practical)	1 Day (6Hrs)	75

PAPER BT-101 BIOCHEMISTRY AND METABOLISM

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Structure, classification, properties and function of carbohydrates: Mono, di, oligo and polysaccharides, glycoproteins and peptidoglycans.
Metabolism of carbohydrates: Glycolysis, fermentation, TCA, Electon transport and Oxidative Phosphorylation Gluconeogenesis, HMP and glyoxlate pathways. Synthesis and breakdown of and glycogen.

Unit II

Structure, classification, properties and function of lipids. Metabolism of lipids: Biosynthesis of fatty acids and triacylglycerols, Fatty acids oxidation alpha, beta and omega-oxidation.

Primary structure of proteins: Confirmation of proteins and polypeptides- secondary, tertiary and quaternary structure; Ramachandran Plot, domains, motif and folds. Vitamins: Classification, properties, structure and functions.

Unit III

Structure, classification, properties and function of amino acids. Amino acid metabolism- amino acid deamination, urea cycle, common pathways of amino acid synthesis- Aspartate family, pyruvate family, aromatic amino acids family and histidine family.

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

SUGGESTED READINGS:

- Principles of Biochemistry, A.L. Lehninger, D.L. Nelson, M.M. Cox. , Worth Publishing.
- Harper's Biochemistry K. Robert, M.D. Murray, D.K. Granner, P.A. Mayes and V.I. Rodwell, McGraw Hill
- Biochemistry, Lubert Stryer, W H Freeman and Co., San Fransisco.
- Biochemistry, Donald Voet, Judtin E. Voet; Panima Publication

PAPER BT-102 CELL BIOLOGY

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

Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.

Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.

Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Ultrastructure and Function: Cell wall, Cell membrane, Transportation across biomembranes- Passive transport, facilitated transport, active transport (Na+, K+ & ATPase pump).

Nucleus, Mitochondria, Golgi bodies, Lysosomes, Endoplasmic reticulum, Peroxisomes, Plastids, Vacuoles, Chloroplast, Structure and function of cycloskeleton and its role in motility.

Unit II

Cell division and cell cycle: Mitosis and Meiosis, steps in cell cycle, Cytological, genetical and evolutionary significance of Mitosis and Meiosis, chiasma formation, Synaptonemal complex. Molecular events and regulation of cell cycle in eukaryotes. Check points, Cyclins and protein kinases, MPF (maturation promoting factor).

Unit III

Cellular communication and Signal transduction: Regulation of Hematopoiesis, general principles of cell communication, cell adhesion and role of different adhesion molecules, gap junctions, extracellular matrix, integrins.

Cell signaling hormones , neurotransmitter proteins, cell surface receptors , Signal transduction pathways, second messengers and their role in signal transduction, regulation of signaling pathways, light signaling in plants, bacterial chemotaxis and quorum sensing.

SUGGESTED READINGS:

- Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA
- Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc.
- Cell and molecular biology Gerald Karp
- Cell and Molecular Biology, E D de Roberties & E M F de Roberties (Jr) Lippincott Williams & Wilkins, Philadalphia
- Cell biology by Pollard and Earnshaw

PAPER BT-103 CONCEPT OF MICROBIOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) 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 and uses in agriculture, industry and environment of major groups: Fungi, Algae, Protozoa, Bacteria, Virus.
Introduction to concept of disinfection and sterilization: Physical and chemical methods of sterilization, trophic grouping, types of media, pure culture isolation techniques.
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. . Virus: Chemical and physical properties, virus isolation, purification, cultivation, serology, plaque assay and viral replication Elementary account of most common diseases caused by microorganism in human, animals and plants: Tuberculosis, Chickenpox, SAARS, AIDS, Ranikhet, Brucellosis, Mastitis, TMV, Citrus canker, Green ear.

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,. 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.

SUGGESTED READINGS:

- General Microbiology, Stainer, RY, Ingraham, JL, Wheelis, ML., and Painter, PR. The Macmillan Press Ltd., (2000).
- Principles of Microbiology, Atlas RM, Mosby, (1995).
- Microbiology, Davis BD et al., Harper and Row, (1990).
- Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
- Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
- Microbiology, Michael J Pelczar (Jr) ESC Chan, N R Kreig, Tata McGraw Hill.
- Microbiology, P. D. Sharma, Rastogi Publications

PAPER BT-104 MOLECULAR BIOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) 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, linking number , super coiled DNA, repetitive DNA, satellite DNA. DNA replication (enzymes, accessory proteins involved and mechanism), inhibitors of DNA replication

Recombination: Holliday junction, general and site specific recombination. Role of Rec A protein and other recombinase, DNA damage and repair.

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.

Unit III

Regulation of gene expression: Operon concept, positive and negative control- lac operon, trp operon, catabolic repression, antitermination, attenuation.Oncogenes: Viral and cellular oncogenes and tumor suppressor genes in man.DNA- transposable elements- types of transposable elements, its importance in variation and evolution.

SUGGESTED READINGS:

- Molecular Biology Labfax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd
- Molecular Biology of the Gene, Watson JD., Hopkins NH., Roberts JW., Steitz JA and Weiner AM (The Benjamin/Cummings Publ.Co
- Gene IX, Lewin B, Oxford University Press
- Molecular Cell Biology, Darnell J, Lodish H and Baltimore D, Scientific American Books, USA

- Molecular Biology of the Cell, Alberts B., Bray D, Lewis J., Ralf M., Roberts K. and Watson J.D., Garland Publishing Inc.
- Molecular Biology of the gene by Watson et al 4th ed.

SCHEME OF THE PRACTICAL EXAMINATION

M.SC. BIOTECHNOLOGY SEMESTER - I

Paper BT-105

Combined Practical Exam Based on Theory papers

Time: - 6 hrs. **Max. Marks- 75**

1.	Biochemistry experiment	(12)
2.	Cell biology experiment	(12)
3.	Microbiology experiment	(12)
4.	Molecular biology experiment	(12)
5.	Spots (5)	(10)
6.	Practical record	(10)
7.	Viva-voce	(07)

List of Practical Exercises

1. Preparation of acetate buffer, Phosphate buffer
2. Determination of pH of buffer
3. Qualitiative test of carbohydrates, protein , aminoacids, lipids.
4. Protein content in the given sample by Lowry method
5. Total sugar by anthrone reagent
6. Estimation of free amino acid by spectrophotometer
7. Estimation of total lipid
8. Analysis of oils-iodine number, saponification value, acid number.
9. Estimation of Glycogen from liver sample
10. Identification of different stages of mitosis from suitable plant material (onion root tips,
11. garlic root tips).
12. Identification of meiosis from suitable plant material (Onion floral buds).
13. Identification of cell organelles: Mitochondria, Chloroplast, Nucleus.
14. Study of mitotic index from suitable plant material.
15. Study of cyclosis in cells of suitable plant material.
16. To determine the osmotic fragility of RBC.
17. Preparation of Basic solid media for the routine cultivation of microorganisms
18. Isolation of Microorganisms from soil by the serial dilution agar plating method.
19. Obtain pure cultures of microorganisms by streak plate method
20. Isolation and Enumeration of microorganisms from food/milk/soil/sample
21. Bacteriological examination of water by multiple-tube fermentation
22. To perform the simple staining , Negative staining, gram staining,
23. Indole test ,MR-VP test
24. Extraction of genomic DNA and RNA
25. Plot absorption spectrum for DNA & find out ? max
26. Determine concentration of DNA/RNA in sample by spectrophotometer
27. Determine molecular weight of DNA by viscometer
28. Study of semiconservative replication in mammalian cells

Spots: Equipments available in the laboratory and used by the student. Slide of different microorganisms.

M.Sc. BIOTECHNOLOGY
Semester II
Marking Scheme External Exam

Theory Paper	Duration	Max. Marks
Paper BT-206	3 Hrs.	40
Paper BT-207	3 Hrs.	40
Paper BT- 208	3 Hrs.	40
Paper BT- 209	3 Hrs.	40
Paper BT- 210 (Combined Practical)	1 Day (6Hrs)	75

PAPER BT-206 ENZYME AND TECHNOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Enzymes: Properties, classification and nomenclature. Mechanism of enzyme action, Mechanisms of catalysis. transition state, Effect of substrate, temperature, pH and inhibitors on enzyme activity. Enzyme Kinetics Single substrate- steady state kinetics, Inhibitors and activators, Multi-substrate systems, Feedback inhibition.

Unit II

Enzyme kinetics: Michaelis-Menten equation and its limitations, significance of Vmax and Kcat, linear plot Lineweaver-Burke plot, Eadie-hofstee plot method to study enzyme kinetics ,effect of substrate, pH and temperature on kinetics, co-factors and co-enzyme. allosteric enzyme and their kinetics. Isozymes, Zymogens, Multienzyme complexes Ribozymes and their applications. Enzyme activation, inhibition-competitive and non competitive

Unit III

Enzyme Isolation, purification and large scale production, enzyme immobilization: methods and advantages,Industrial production of enzymes: amylase, glucose oxidase, lipase, protease, production and their uses.Challenges and future trends Catalytic antibodies and Non-protein biomolecules as catalysts
Enzymes contributing in research diagnostics and sustainable industrial development (starch processing,, leather, pulp and paper manufacturing).

SUGGESTED READINGS:

- Enzyme Technology, M.F. Chaplin and C. Bucke, Cambridge University Press.
- Enzymes Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer
- Enzyme Kinetics: Behaviour and Analysis of Rapid Equilibrium and Steady State Enzyme Systems,I.H. Segel, Wiley-Interscience
- Industrial Enzymes & their applications, H. Uhlig, John Wiley and Sons Inc

- Fundamentals of Enzymology, Nicholas C Price and Lewis Stevens, Oxford Univ Press.

PAPER BT- 207 BIOPHYSICS AND BIOTECHNIQUES

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

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.
Concept of Energy- matter and energy, thermodynamics- entropy, enthalpy, Application of thermodynamics in biological systems.

Unit II

Introduction to Fractional precipitation: Gel filtration, Gel Electrophoresis, tracer techniques, autoradiography, Microcalorimetry.
Methods to elucidate structure of biochemical compounds found in living organisms: ultrafiltration, centrifugation, density gradient centrifugation, chromatography (PC,TLC, CC,GLC,HPLC).
Small and macromolecule quantification: Colorimetry, Photometry, Nephelomtery, Flamephotometry, Visible, UV and Atomic absorption spectroscopy.

Unit III

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

SUGGESTED READINGS:

- Biophysics, Vasantha Pattabhi, N. Gautham, Narosa Publishing House
- Essential of Biophysics, P. Narayanan, New Age International Publication
- Biophysics An Introduction RMJ Cotterill John Wiely and Sons NYork
- Basic Biophysics for Biotechnologist M Daniel Agrobios Jodhpur
- A text book of Biophysics RN Roy New Central book Agency Kolkotta
- Biophysics Dr. S Thiravia Raj Saras Publications Tamil Nadu
- Practical Biochemistry, Principles & Techniques, Keith Wilson and John Walker
- Bioinstrumentation, Webster.
- Principles & Practice of Bioanalysis, Richard F. Venn.

PAPER BT-208 GENETIC ENGINEERING

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Principles and methods of genetic engineering: Restriction endonucleases (types, classification and application), DNA ligases, Topoisomerases, Gyrases, 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 II

Molecular cloning: Construction of cDNA and genomic library, principles and practice of nucleic acid hybridization - southern, northern and western blotting techniques, colony hybridization 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 III

Molecular markers : RFLP, AFLP, RAPD and other Molecular markers, Physical maps- Fish, STS & restriction mapping 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.

SUGGESTED READINGS:

- Genetic Engineering Principle and Methods, Setlow J. K. & Hollaender, Plenum Press, New York.
- Advances in Biotechnology, Manjula K. Saxena and B.B.S.Kapoor, Madhu publications
- An Introduction to Molecular Biotechnology- Molecular Fundamentals, Methods and Applications in Modern Biotechnology, Edited by Michael Wink, Wiley
- Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
- 12. Elements of Biotechnology, P. K. Gupta, Rastogi & Company

PAPER BT-209 CONCEPT OF IMMUNOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.

Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

UNIT-I

Immunity: Innate Immunity, Adaptic immunity. Cell mediated and Humoral immunity , Components of immunity (Physical, cellular, genetic, inflammation) Apoptosis. Cells of immune system: B lymphocyte, T lymphocytes, macrophages, Nk cells, killer cells, PMN cells, Antigen Presenting cell. Organs (primary and secondary) of Immune System. Immune response (primary and secondary), Cytokines. Development of T-cell and B-cells & Clonal selection.

UNIT-II

Antigens: Structure, properties and factors affecting antigenicity, haptens, Ajuvants, superantigens. Antibodies: Structure, function and diversity, antibody mediated functions, classes and biological activities. Monoclonal antibodies. Antigen-Antibody Interaction (Precipitation, Agglutination, neutralization, opsonisation, Immunofluorescence, Complement fixation test, Radio Immuno Assay, ELISA). The complement system.

UNIT-III

Major Histocompatibility Complex- structure, functions, MHC- restriction, Immunological tolerance. Hypersensitive reactions (Type I,II,III and delayed type (DTH). Immuno-deficiency Diseases. Vaccines: Live, killed, attenuated vaccines, recombinant DNA and protein based vaccines. **Autoimmunity:** Types and Treatment of autoimmune diseases.

SUGGESTED READINGS:

- Immunology, Richard A., Goldsby, Kuby et al, W. H. Freeman & Company, New York
- Essential Immunology, Ivan Roitt, Blackwell Science Ltd.
- Immunology-Understanding the Immune System Elgert K.D, Wiley Liss,
- Immunology 6th Edition, Roitt I., Brostoff J. and Male D., Mosby Harcourt Publishers

SCHEME OF THE PRACTICAL EXAMINATION

M.SC. BIOTECHNOLOGY-

SEMESTER - II

PAPER BT-210

Combined Practical Exam Based on Theory papers

Time: - 6 hrs.	**Max. Marks- 75**
1. Enzyme & technology experiment	(12)
2. Biophysics & Bioinstrumentation experiment	(12)
3. Genetic Engineering experiment	(12)
4. Immunology experiment	(12)
5. Spots (5)	(10)
6. Practical record	(10)
7. Viva-voce	(07)

List of Practical Exercises

1. Isolation of enzyme from plants/ bacteria.
2. Estimation of enzyme activity and ammonium sulphate fractionation/ centrifugation based size fractionation.
3. Determination of pH optima for an enzyme.
4. Effect of temperature on enzymatic activity.
5. Enzyme immobilization.
6. Quantitative estimation of catalase activity from leaf sample
7. Cell disruption using grinding and homogenizing.
8. Centrifugation for fractionation of homogenate.
9. Spectrophotometric/ colorimetric estimation of proteins.
10. Extraction and identification of amino acid by paper chromatography
11. Chromatographic Separation of biomolecules through TLC/GC/column chromatography
12. Preparation of standard curve to verify the Lambert Beer's law.
13. Plasmid isolation
14. Isolation of DNA
15. To make different types of electrophoresis buffer
16. Preparation of gel loading dyes/buffer
17. Preparation and examination of agarose gel
18. Agarose gel electrophoresis of DNA
19. Preparation of competent cells of the E. coli host.
20. Amplification of DNA through PCR
21. Restriction mapping
22. Plot standard curve for DNA by colorimeter method.
23. Plot standard curve for RNA by colorimeter method.
24. Determine purity of DNA in sample by UV method
25. Antigen-antibody agglutination
26. Determination of antigen-antibody reaction by radial immuno diffusion method.
27. Determination of antigen-antibody reaction by Ouchterlony double diffusion method

Spots: Scanning electron microscope, Transmission electron microscope, 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

M.SC. BIOTECHNOLOGY

SEMESTER – III

Marking Scheme External Exam

Theory Paper		Duration	Max. Marks
Paper	BT-311	3 Hrs.	40
Paper	BT-312	3 Hrs.	40
Paper	BT-313	3 Hrs.	40
Paper	BT-314	3 Hrs.	40
Paper	BT-315 (Combined Practical)	1 Day (6Hrs)	75

Paper BT-311 PLANT TISSUE CULTURE

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.

Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.
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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. endosperm culture, 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., Gene transfer and transgenic plants. Ethical issues related to transgenic plants. Cryopreservation: Germplasm conservation, protoplast- Isolation, culture, fusion cybrids, selection of hybrid cells, Application of plant protoplast culture in somatic hybridization and cybridization.

Unit III

Natural products (Secondary products): Introduction. Alkaloids production in plant tissue cultures, optimization for growth and production, time course of production, selection of cells for higher yields, extraction of alkaloids / steroids. Commercially used plant alkaloids and steroidsProduction of useful metabolites: Biotransformation, immobilization of cells, elicitors, hairy root culture. Application of plant tissue culture in plant pathology: Development of virus free plants, Application of biotechnology in breeding and crop improvement.

SUGGESTED READINGS:

- Plant Cell and Tissue Culture, Narayanaswami, Tata Mc Graw Hill
- Plant Biotechnology, K. G. Ramawat, S. Chand and Company Ltd. Biotechnology Expanding Horizons, B. D. Singh, Kalyani Publishers
- Elements of Biotechnology, P. K. Gupta, Rastogi & Company

Paper BT-312 ANIMAL TISSUE CULTURE

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Introduction to animal cell and tissue culture, its advantages and limitations, Animal cell culture- Equipments and facilities for animal cell culture. solution and simple growth medium, pH maintenance in culture media and role of carbon dioxide, serum and- serum free media in cell culture, Biology and characterization of the cultured cells, measurement of growth, measurement of cell viability and cytotoxicity.

Unit II

Basic techniques in animal cell culture: Disaggregation of tissue and setting up of primary culture, secondary cell culture, established cell line cultures, maintenance of cell culture, cell cloning and cell synchronization Scaling up of cell cultures, bioreactors for animal cell cultures. Organ and Histotypic culture, Microcarrier culture Hybridoma Technology and monoclonal bodies.

Unit III

Stem cell cultures: Embryonic and adult stem cells, their isolation, culture and applications, animal cloning, micromanipulation, apoptosis. Application of animal cell culture- industrial application, and clinical application-production. Animal cloning and transgenic animals, Methods of genetic transformations and its uses gene knockouts, ethical and biosafety considerations.

SUGGESTED READINGS:

- Culture of Animal Cells: A Manual of Basic Techniques (5th Edition): R Ian Freshney. Wiley-Liss
- Animal Cell Culture – Practical Approach, Ed . John R W Masters. Oxford Univ Press.
- Animal Cell Culture: A practical approach by R.I. Freshney, IRL press.
- Animal cell culture technique by Martin Clynes, Springer publication.
- Animal Biotechnology, M. M. Ranga, Agrobios India.

Paper BT-313 ENVIRONMENTAL BIOTECHNOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

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

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).
principles of biomonitoring and application of biosensors for detection of environmental pollutants. Biomining: Use of microbes in biohydrometallergy and biomineralization, degradation of pesticides and other xenobiotics, genetic regulation of xenobiotic biodegradation, phytoremediation of disturbed ecosystems
.

Unit III

Application of microbes as biofertilizers and bioinsecticides, productivity improvement and crop protection, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals

Use and development of GEM for bioremediation, development of gene probes for environmental remediation & releasing and tracing GEMS. Emerging technologies : Microelectromechanical system (MEMs), genosensor technology, integrated treatment system with special reference to biodegradation of polychlorinated biophenyls (PCBs), PCB treatment process and design.

SUGGESTED READINGS:

- Environmental Biotechnology, Alan Scragg, Oxford University Press
- Introduction to Environmental Biotechnology, A. K. Chatterji, Practice Hall Of India.
- Environmental Science (5th Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill.
- Introduction to Biodeterioration , D Allsopp and K J Seal, ELBS/Edward Arnold. Cambridge Univ Press.
- Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India.
- Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press
- Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter.
- An Introduction to Environmental Biotechnology by Milton Wain Wright. Kluwar Acad Publ. Group, Springer

Paper BT-314 BIOSTATISTICS

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Biostatistics: population and sample. Statistical inference, Types of data, screening and representation of data. Frequency distribution, tabulation, bar diagram, histograms, pie diagram, cumulative frequency curves.Measures of central tendency-Mean, mode, median, measures of dispersion: range, variance, standard deviation, coefficient of variation. Simple linear regression and correlation. Brief idea of statistical softwares and their applications.

Unit II

Probability and distributions: definition and properties of binomial, poison and normal distributions. Random sampling, selection of simple random samples from a finite population, definition of sampling distribution, sampling variance and standard error. Stratified sampling and its advantages. Analysis of Variance (ANOVA), Idea of two types of errors and level of significance, test of significance, chi^2 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 - Dilution 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.

SUGGESTED READINGS:

- Biostatistics-A foundation for Health Science, Daniel WW, John Wiley (
- Statistical Methods, Medhi J, Willey Eastern Limited, (
- Computational Statistics, Rao, MJM, Himalaya Publishing House
- Biostatistics, Arora and Malhan, Himalaya Publication
- Statistics, S. P. Gupta, Rastogi Publication
- Principles of Biostatistics M Paggana & Gaurveeau Duxbery Australia

SCHEME OF THE PRACTICAL EXAMINATION
M.SC. BIOTECHNOLOGY
SEMESTER - III
PAPER BT-315
Combined Practical Exam Based on Theory papers

Time: - 6 hrs. **Max. Marks- 75**

1.	Enzyme & technology experiment	(10)
2.	Biophysics & Bioinstrumentation experiment	(10)
3.	Genetic Engineering experiment	(10)
4.	Immunology experiment	(10)
5.	Spots (5)	(10)
6.	Practical record	(10)
7.	Viva-voce	(07)
8.	Industrial visit Report	(08)

List of Practical Exercises

1. Basic Knowledge of a Tissue Culture Laboratory
2. Sterilization Techniques
3. Initiation & maintenance of callus.
4. Cyto differentiation of tracheary elements in cultured explants.
5. Identification of secondary metabolites by TLC
6. Anther Pollen culture
7. Isolation, Purification & culture of protoplast
8. Somatic embryoids from vegetative cells of mature plants/ hypocotyl & Cotyledons of embryo.
9. Micro-propagation with shoot apex cultures.
10. Preparation of Murashige and Skoog (MS) stock solutions
11. Preparation of M.S. medium
12. Measurement of growth/ differentiation in plant tissue culture by fresh weight & dry weight.
13. Determination of mitotic index (MI) in callus/ suspension cultures.
14. Preparation of different solutions of Plant Growth Regulators
15. Preparation of ATC Media
16. Preparation of Sera
17. Primary Cell Culture
18. Preparation of established Cell lines
19. Cell Counting and Viability
20. Staining of Animal Cells
21. Preservation of Cells
22. Culture of Virus in Chick Embryo.
23. Embryo development: Chick developmental stages and Gastrulation.
24. Chloride content of water samples using arginometric method.
25. Estimation of dissolved oxygen and BOD in water & wastewater.
26. Determination of MPN in wastewater.
27. Determination of chemical oxygen demand (COD) of sewage sample.

28. Study on biogenic methane production in different habitats.
29. Test of heavy metals (Zn, Cu, Pb) tolerance in some identified bacteria.
30. Isolation of bacteria from various polluted sites (waste water, distillery waste) and their identification.
31. Sampling of water (Dussart flask water sampler)
32. pH of water using pH meter
33. Acidity/alkalinity of water samples.
34. Vam staining
35. Detection of coliforms for determination of the purity of potable water.
36. Baculovirus stock- preparation and titration using plaque colony.
37. Demonstration of methods for waste water treatment.
38. Bar graph of growth index from given data.
39. Biostatistics problems based on Mean, Mode, Median, Standard deviation, Variance, t-test, Chi square test.

- **Compulsory: Submission of Field / study tour report (visit some biotechnology department, institute and industrial firms)**

M.Sc BIOTECHNOLOGY

Semester IV

Marking Scheme External Exam

Theory Paper		**Duration**	**Max. Marks**
Paper	BT- 416	3 Hrs.	40
Paper	BT- 417	3 Hrs.	40
Paper	BT- 418 (Dissertation/ Industrial Training)	-	80
Paper	BT- 419 (Combined Practical)	1 Day (6Hrs)	75

Paper BT-416 INDUSTRIAL BIOTECHNOLOGY

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Isolation, preservation and maintenance of industrial microorganisms, microbial growth kinetics, media for industrial fermentation, media sterilization. Fermentation,Types of fermentation, Bioreactors : Design, operation and control,Types (batch, fed-batch, continuous bioreactor pulse, fluidized and

photobioreactors). Downstream processing (Recovery of microbial cells, cell disruption. Chromatography, membrane processes, drying and crystallization), whole cell immobilization and industrial applications.

Unit II

Industrial production of alcohol (ethanol), Alcoholic beverages: Beer, wine and whisky. 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: food preservation (drying, freezing, sterilization, pasteurization and irradiation of food products. Elementary idea of canning and packing, Production of mushroom, yoghurt, cheese, single cell protein and single cell oil

Unit III

Scaling up production and automation in plant propagation, Mass scale plant production , Hardening and acclimatization, green house management and operations, quality control, packaging and shipment, cost benefit analysis. Current status and commercial opportunities for genetically engineered plants for: Insect tolerance, virus tolerance, herbicide tolerance, pesticide tolerance, stress tolerance, Improvement of crop yield and quality, Development of male sterile plants. Principles of green chemical biotechnology: green extraction, green reactors and green technology for the production of Biomolecules, edible vaccines. Synthetic seeds: Progress and potential.

SUGGESTED READINGS:

- Industrial Biotechnology, G. Read, Presscott and Dunns, Chapman and Hall
- Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, Biochemical Engineering Fundamentals (2nd ed), JE Baily & DF Ollis, McGraw Hill Book Co. New York. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm.
- Bioprocess Engineering: Basic Concepts (2nded), ML Shuler, & F Kargi, Prentice Hall, Engelwood Cliffs.

Paper BT-417 BIOINFORMATICS & COMPUTER APPLICATIONS

NOTE: There shall be three (3) sections in the question paper.
Section A (10 marks) shall consist of 10 questions (at least three from each Unit). Each question shall be of 1 (ONE) marks. The candidate is required to answer all the questions. The answers should not exceed 50 words.
Section B (1**5 marks**) shall consist of 9 questions (three questions from each unit). Each question shall be of 3 (three) marks. The candidate is required to answer 5 questions selecting at least one question from each unit. The answers should not exceed 200 words.
Section C (**15 marks**) shall consist of 5 questions (at least one from each Unit). Each question shall be of 5 (five) marks. The candidate is required to answer any three questions. The answers should not exceed 500 words.

Unit I

Computer and their organization: Hardware, software, liveware and firmware. Introduction to M.S. office (word, powerpoint and excel), 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.

Unit II

Bioinformatics: Introduction, objectives, bioinformatics and data analysis. Data base concept, 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 III

Phylogenetic analysis: prediction method using protein and nucleic acid 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.

SUGGESTED READINGS:

Bioinformatics: A practical guide to the analysis of genes and proteins. Baxevanis A.D and Ovellette B.F.F., Wiley-Interscience
Bioinformatics, Baxevanis Ouellette, Wiley-Less Publication
Computer Fundamentals, Pradeep K. Sinna et al, BPB Publications
Introduction to Informatics, Attwood, Parrt, Smith, Pearson Education
Instant Notes in Bioinformatics, Westhead, Parish and Tuxjman Viva Book Pvt Ltd

Paper BT 418: Dissertation/ Industrial Training

Scheme of examination

Students are advised to complete Dissertations preferably in some outside research institute/industry or otherwise in the University/College in the first 45 days starting from the beginning of the session.

The student shall prepare a report of his/her work carried out as mentioned below and shall present it to the external examiner. The examiner will evaluate the work carried out and shall award the marks accordingly.

Maximum Marks: 80 **Duration: 10 min per student**

Minimum Passing Marks: 20

The student will select a topic of research in consultation with his/her supervisor/guide to do a research work or carry out a case study on any topic related to biotechnology or allied sciences.

SCHEME OF THE PRACTICAL EXAMINATION

M.SC. BIOTECHNOLOGY

SEMESTER - IV

PAPER BT- 419

Combined Practical Exam Based on Theory papers

Time: - 6 hrs. **Max. Marks- 75**

1. Industrial Biotechnology experiment (24)
2. Bioinformatics & Computer applications Exercise (24)
3. Spots (5) (10)
4. Practical record (10)
5. Viva-voce (07)

List of Practical Exercises

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 oryzai/ Bacillus lichenforis using bran in small scale solid state fermentation and its assay.
11. Production of microbial polysaccharides and yield estimation.
12. Quality test of given milk sample by standard plate count method
13. Determination of quality of milk sample by methylene blue reductase test.
14. Role of Yeast in Bread making.
15. Production of curd from microorganisms.
16. To study general methods of food preservation (e.g. Temperature, Salt, Moisture).
17. Study of food-spoilage microorganisms in fresh, canned, fermented food and meat.
18. Green extraction of biomolecules.
19. Retrieval of protein and nucleotide sequences from suitable databanks
20. Similarity searches using BLAST and FASTA
21. Online tools for PCR primer generation and restriction analysis
22. Visualization of genome maps-usage of Mapviewer from NCBI resource
23. Bar graph of growth index from given data.
24. Introduction to M.S. office (Software covering M.S. word, M.S. Excel, M.S. Power point animation technique) Corel draw.
25. Use of internet.

Spots based on: Laboratory instruments and Techniques