TUMKUR UNIVERSITY

COURSE STRUCTURE AND SYLLABUS
(CBCS SCHEME)

B.Sc Microbiology

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B.Sc PROGRAMME COURSE MATRIX FOR SEMESTER I-IV

SL NO	COURSE NUMBER IN SEMESTER	TITLE OF THE PAPER	TYPE OF INSTRUCTIONS & HOURS PER WEEK	CREDITS	HOURS OF EXAM (SEE) PER COURSE/SEM	MAX MARKS FOR IA/COURSE/SEM	MAX MARKS FOR SEE/COURSE/SEM	TOTAL MARKS/COURSE/SEM
1	**1.3**	Fundamentals of Microbiology & Biophysics	**T 4**	**4**	**3**	**10**	**90**	**100**
2	**1.4**	Microbiology Practical's – I	**P 4**	**2**	**3**	**-**	**50**	**50**
3	**2.3**	Microbial Diversity, Taxonomy & Culture Techniques	**T 4**	**4**	**3**	**10**	**90**	**100**
4	**2.4**	Microbiology Practical's – II	**P 4**	**2**	**3**	**-**	**50**	**50**
5	**3.3**	Microbial Metabolism, Microbial Genetics & Biostatistics	**T 4**	**4**	**3**	**10**	**90**	**100**
6	**3.4**	Microbiology Practical's – III	**P 4**	**2**	**3**	**-**	**50**	**50**
7	**4.3**	Molecular Biology, Genetic Engineering & Bioinformatics	**T 4**	**4**	**3**	**10**	**90**	**100**
8	**4.4**	Microbiology Practical's – IV	**P 4**	**2**	**3**	**-**	**50**	**50**
OPEN ELECTIVE								
9	**4.9**	Microbes and Mankind	**T2/P4**	**2**	**3**	**-**	**50**	**50**

B.Sc PROGRAMME COURSE MATRIX FOR SEMESTER V and VI

SL NO	COURSE NUMBER IN SEMESTER	TITLE OF THE PAPER	TYPE OF INSTRUCTIONS & HOURS PER WEEK	CREDITS	HOURS OF EXAM (SEE) PER COURSE/SEM	MAX MARKS FOR IA/COURSE/SEM	MAX MARKS FOR SEE/COURSE/SEM	TOTAL MARKS/COURSE/SEM
1	**5.1**	Agricultural and Environmental Microbiology	**T 3**	**3**	**3**	**10**	**90**	**100**
2	**5.2**	Food and Dairy Microbiology	**T 3**	**3**	**3**	**-**	**50**	**50**
3	**5.3**	Microbiology Practical's V/VI	**P 6**	**3**	**3**	**10**	**90**	**100**
4	**6.1**	Immunology and Medical Microbiology	**T 3**	**3**	**3**	**-**	**50**	**50**
5	**6.2**	Industrial and Microbial Technology	**T 3**	**3**	**3**	**10**	**90**	**100**
6	**6.3**	Microbiology Practical's VII/VIII	**P 6**	**3**	**3**	**-**	**50**	**50**

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B.Sc MICROBIOLOGY – TEACHING LEARNING TRANSACTIONS AND EXPECTED OUTCOMES

SEMESTER	TITLE OF THE OPTIONAL (III) SCIENCE (MICROBIOLOGY) SUBJECT	PAPER NO	TEACHING LEARNING TRANSACTIONS	EXPECTED OUTCOME
I	Fundamentals of Microbiology & Biophysics – *Theory Paper*	**1.3**	Class room lectures using ICT, e-learning and videos of various uses of microbes	This paper is expected to provide a basic understanding of microbes, structure, function applications and also analytical methods used in microbiology
	Microbiology Practical's – I	**1.4**	Hands on lab training and demonstrations	In this practical course the students will be trained in handling microbes, preparation of reagents buffer and media.
II	Microbial Diversity, Taxonomy & Culture Techniques – *Theory Paper*	**2.3**	Class room lectures using ICT, e-learning and videos of various uses of microbes. Recent discoveries on various microbial habitats will be discussed from state of the art publications and journals	Students will be able to study various habitats, methods of classification and culturing of different types of microbes in this paper
	Microbiology Practical's – II	**2.4**	Hands on lab training and demonstrations	Students will be able to isolate and culture microbes and characterize them using various culture methods
III	Microbial Metabolism, Microbial Genetics & Biostatistics – *Theory Paper*	**3.3**	Class room lectures using ICT, e-learning, models and solving statistical problems	Students will be able to gain an understanding of enzyme structure, classification and scope of thermodynamics. Also, the flow of information in prokaryotes and eukaryotes will be understood.
	Microbiology Practical's – III	**3.4**	Hands on lab training and demonstrations	Quantification of biomolecules, enzymes and effect of various parameters.

IV	Molecular Biology, Genetic Engineering & Bioinformatics – *Theory Paper*	**4.3**	Class room lectures using ICT, e-learning, models and working on bioinformatics programmes	In depth understanding of processes of replication, transcription, translation, and cell function. The central dogma of molecular biology where genetic material is transcribed into RNA and then translated into protein will be obtained by the students.
	Microbiology Practical's – IV	**4.4**	Hands on lab training and demonstrations	Students will perform various experiments related to DNA, RNA isolation and amplification and cloning
OPEN ELECTIVE	Microbes and Mankind	**4.9**	Student's will get an overview of the advantages and disadvantages of microbes to mankind	
V	Agricultural and Environmental Microbiology - *Theory Paper*	**5.1**	Class room lectures using ICT, e-learning, models and field visits	A detailed account of the role of microbes in agriculture and environment and its application for the betterment of mankind will be provided to the students
	Food and Dairy Microbiology – *Theory Paper*	**5.2**	Hands on lab training and demonstrations	Students will perform experiments related to isolation, characterization of microbes from various habitats and conduct tests for analysis of safe drinking water
	Microbiology Practical's – V/VI	**5.3**	Class room lectures using ICT, e-learning, models and industry visits	A detailed account of the role of microbes in food & dairy industry and its application for the betterment of mankind will be provided to the students
VI	Immunology and Medical Microbiology - *Theory Paper*	**6.1**	Class room lectures using ICT, e-learning, models	Students are expected to understand all aspects of the interrelationship between infectious agents and their hosts.
	Industrial and Microbial Technology - *Theory Paper*	**6.2**	Hands on lab training and demonstrations	Students will culture some clinically important microbes, characterize them and perform *in vitro* diagnostic tests
	Microbiology Practical's – VII/VIII	**6.3**	Class room lectures using ICT, e-learning, models and industry visits	Application of microbes for production of compounds, beverages and important supplements with high economic values will be discussed.

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B.Sc MICROBIOLOGY SYLLABUS (SEMESTER SCHEME)

Note:

1. All the theory papers have five units each.
2. For semester's I-IV, teaching –learning transaction for each unit is a minimum of 12 hours.
3. For semesters V and VI, teaching –learning transaction for each unit is a minimum of 9 hours.
4. Practical experiments shall be conducted individually and also in groups depending on the nature of the experiment.
5. Some demonstration experiments can also be included based on the teaching – learning requirements.
6. Open elective paper will have four units to be taught for eight hours each.

I SEMESTER

1.3 - Fundamentals of Microbiology & Biophysics- Theory Paper

Unit 1: (12 hrs)

1. Introduction, Branches of Microbiology, Scope and importance of microbiology. Applications of microbiology.
2. Discovery of microscope, bending of light, resolving power, numerical aperture, working distance and magnification. Construction, principle & applications of Compound microscope, Dark field microscope, Fluorescent microscope, Phase contrast microscope, confocal microscope, tunneling microscope, inverted research fluorescent microscope and Electron microscope (TEM & SEM).
3. Other Instruments: Principle, construction and applications of Laminar air flow, incubator, pH meter, hot air oven, incubator, centrifuge, colorimeter and colony counter.

Unit 2: (12 hrs)

1. Nature of dyes, Physical and chemical theories of staining,
2. Staining techniques –principle, procedure and applications of simple staining – negative staining, Differential staining- Grams and acid fast staining,
   Structural staining – cell wall, endospore, flagella and capsular staining, fungal staining-lacto phenol cotton blue staining.

Unit 3: (12 hrs)

1. Structure of Prokaryotic cell & its components -Cell morphology and arrangement, flagella, fimbriae, pili. Cell wall-chemical composition and characteristics (Gram positive & gram negative bacteria: lipoproteins, lipopolysaccharides, matrix proteins), function; plasma membrane (fluid mosaic model), function of cell membrane; Mesosomes, cytoplasm, ribosomes,-subunits and chemical composition; molecular chaperons, nucleoids, plasmids- types of plasmids, cytoplasmic inclusions, and endospores.
2. An overview of Eukaryotic cell structure, the plasma membrane and membrane structure, cytoplasmic matrix, microfilaments, intermediate filaments and microtubules, organelles of the biosynthetic, secretory and endocytic pathways, eukaryotic ribosomes, mitochondria, chloroplasts and nucleus and cell division, cilia and flagella; comparison of prokaryotic and eukaryotic cells.

Unit 4: (12 hrs)

1. Definition of terms-sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, micro biostatic agents and antimicrobial agent. Characteristics of antimicrobial agents.
2. Evaluation antimicrobial agents-Tube dilution and agar plate techniques-well method and disk diffusion method.
3. Physical methods of control-Principle, construction and application of most heat sterilization (Boiling, Pasteurization, Tyndalization and autoclaving).Dry heat sterilization (incineration and hot air oven). Filtration – Diatomaceous earth filter, Seitz filter, membrane filter and HEPA filter. Radiation- Ionizing radiation (X- rays) and non-ionizing radiation (UV-rays).
3. Chemical methods– alcohol, aldehydes, halogens, phenols, metallic salts, quaternary ammonium compounds and gaseous agents.

Unit 5: (12 hrs)

1. General Introduction, scope and branches of biophysics; physical methods of determining the size, shape and molecular weight of molecules-surface tension, sedimentation and viscosity.
2. Radioisotopes-decay units of radioactivity, biochemical and diagnostic importance of radio isotopes and Autoradiography.
3. Analytical techniques- Principle and applications of centrifuge, ultra-centrifuge, UV-Visible spectrophotometer, chromatography-paper and TLC and X-ray crystallography.

References:

1. Aneja K.R. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.

2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company , New York.

3. Benson Harold J. Microbiological Application, WCB McGraw-Hill of India Private Limited.

4. Narayanan P. Essentials of Biophysics, New Age International, New Delhi.

5.Thiravia Raj S .Biophysics, Saras Publications, Tamilnadu.

6. Pelczar M.J. Chan E.C.S. and Krieg N.R. Microbiology, McGraw Hill Book Company, New York.

7. Prescott Lansing M. Harley John P. and Klein Donald A. Microbiology, WCB McGraw-Hill New York.

8. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.

9. Staner R,Y Ingraham J.L. General Microbiology, Prentice Hall of India Private Limited, New Delhi.

10. Dubey R. C and Maheshwari D K. A Text book of Microbiology , S. Chand & Company Ltd., New Delhi. Ational

11. Kamal, Rao G.P. and Modi D.R. Concepts of Microbiology, International Book Distributing Co, Lucknow.

1.4 – Microbiology Practical's – I

1. Safety measures in Microbiology Laboratory.
2. Study of student microscope and research microscope- Construction, working principle, care to be taken while using the microscope. Use of oil immersion objective.

3.Determination of resolving power and numerical aperture.

4. Study of instruments-Autoclave, hot air oven. Laminar air flow bench, Inoculation, chamber, inoculation loop and needle, Incubator, centrifuge, pH meter, Seitz filter, colony counter, colorimeter and spectrophotometer.
5. Cleaning and sterilization of glassware. Preparation and use of chromic acid.
6. Use of antiseptics and disinfectants : Phenol, ethyl alcohol, formaldehyde, iodine and detergents.
7. Study of aseptic techniques-preparation of cotton plugs for test tubes and pipettes, wrapping of petri- plates and pipettes, transfer of media and inoculum.
8. Staining of bacteria
   a) Simple staining-methylene blue staining
   b) Differential staining-Gram staining and acid fast staining.
   c) Structural staining-cell wall, endospore staining and capsule staining
9. Study of bacteria – cocci and rods.
10. Demonstration of Ascending and descending chromatography.

II SEMSESTER

2.3 - Microbial diversity, Taxonomy and Culture techniques - Theory Paper

Unit1: (12 hrs)

1. Introduction to microbial classification and taxonomy. Types of classification, Numerical taxonomy.
2. Identifying characters for classification, Systematics of bacteria, Whittaker's five kingdom classification of living system, Carl Woes' three domain system.
3. Comparison of the three domains of organisms- Bacteria, Archaea, Eucarya. Molecular taxonomy.
4. Nomenclature and Bergy's manual, phylogenetic overview of Archaea and bacteria.

Unit 2: (12 hrs)

1. Eubacteria : Cell morphology, function, reproduction and of:
   a) Photosynthetic eubacteria (cyanobacteria). Type study of *Anabaena* and *Spirulina.*
   b) Gliding bacteria (Myxobacteria and Cytophaga group).
   c) Gram negative eubacteria (Spirochetes, Rickettsia, Chlamydia)
   d) Gram positive eubacteria (Actinomycetes).
   e) Spore forming bacteria (spore formation and germination),
   f) Fermentative bacteria – metabolic character,
   g) Sulfur bacteria and Nitrogen fixing bacteria
   h) The mollicutes

2. Cell structure, special features and classification of archaea: Methanogens and halobacteria.

Unit 3: (12 hrs)

1. Basic concepts of Virology - General structure and properties of viruses, Virus Purification and assay.
2. Principles of Viral Taxonomy, Structure, multiplication, cultivation and significance of Viruses, Bacteriophage (T_4 and lambda), Plant viruses (TMV) Animal viruses (HIV and Herpes Virus), H1N1 & SARS.
3. An account on Viroid and Prions.

Unit 4: (12 hrs)

1. General characteristics, classification and reproduction of Algae: Type study of Algae (*Chlorella, Volvox, Chlamydomonas, Diatoms*)

2. Fungi: Salient features, general structure of fungi, reproduction and significance of fungi. Classification of fungi upto class (Basidiomycetes, Zygomycetes, Oomycetes, Ascomycetes, Deuteromycetes)
3. Protozoa: General characteristics, classification and reproduction of *Amoeba*, *Euglena, Paramecium* and *Plasmodium*.

Unit 5: (12 hrs)

1. Nutritional Requirements for growth of microorganisms, Uptake of nutrients by the cell.
2. Physical factors affecting growth of microorganisms: Temperature, pH and Oxygen.
3. Multiplication in bacteria-binary fission, budding and fragmentation.
4. Bacterial growth curve, synchronous growth. Continuous cultivation-chemostat and turbidostat. Counting of bacteria-Viable count- SPC, Total count-DMC and turbidity measurement.
5. Culturing techniques- Special Media. Enriched, selective, transport, differential maintenance and enrichment media, Methods of isolation of pure cultures-Serial dilution, pour plate, spread plate and streak plate. Maintenance of pure cultures. Cultivation of anaerobic bacteria-Anaerobic jar method.

References:

1. Alexopoulas C.J. and Mims C.W. Introductory Mycology, New Age International, New Delhi
2. Aneja K.R. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
3. Atlas R.M. Microbiology-Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson Harold J. Microbiological Applications, WCB McGraw-Hill New York.
5. Bold H.C. and Wynne M.J. Biology of Microorganisms, Prentice Hall of India Private Limited, New Delhi.
6. Brock T.D. and Madigan M.T. ,Biology of Microorganisms, Prentice Hall of India Private Limited.
7. Mehrotra R.S. and Anejs K.R. An Introduction to Mycology, New Age International, New Delhi.
8. Polczar M.C Chan, Microbiology McGraw Hill Book Company, New York.
9. Prescott Lansing M. Harley, John P. and Klein Donald A. Microbiology WCB McGraw Hill New York.
10. Salle A.J. Fundamental Principles of Bacteriology Tata McGraw-Hill Publishing Company limited New Delhi.

11. Stanier R.Y. Ingraham J.L. General Microbiology, Prentice Hall of Indian Private Limited, New York.
12. Dr. H. A. Modi, Elementary Microbiology, Volume I (Fundamentals of Microbiology) Akta Prakashan, Nandiad.

2.4 - Microbiology Practical's – II

1. Preparation of Media-Nutrient broth, Nutrient Agar, Martin's Rose Bengal medium, Sabouraud's Agar.
2. Isolation of bacteria and Fungi from soil
   a) Preparation of serial dilutions.
   b) Spread plate and pour plate techniques.
   c) Streaking techniques for isolation and purification of bacteria.
   d) Methods of inoculation of different microbes in selective media.
   e) Study of colony characteristics of bacteria
   f) Identification of bacteria and fungi.
3. Motility of bacteria by hanging drop technique.
4. Measurement of size of cells by micrometry.
5. Counting of yeast cells and fungal spores using Haemocytometer.
6. Study of fungi-Identification of fungi by tease-mount method using Lactophenol cotton blue
7. Study of viruses (Bacteriophage, TMV and HIV) (Charts)
8. Type study of *Aspergillus, Penicillium, Yeast, Rhizopus* and *Fusarium* (Specimens)
9. Study of protozoa-*Amoeba, Paramecium* and *Euglena* (Permanent slides)
10. Study of Blue-green algae-*Anabaena* and *Spirulina.* (Specimens)

Note: Students have to submit to two fungal and one Blue-green algae slide (permanent) for the examination.

III SEMESTER

3.3 - Microbial Metabolism, Microbial Genetics and Biostatistics- Theory Paper

Unit 1: (12 hrs)

1. A brief account of the properties, classification and importance of carbohydrates, lipids and proteins.
2. Introduction, properties, nomenclature and classification of enzymes.
3. Inhibitors of enzymes: Irreversible, Reversible -competitive, Non-competitive, Uncompetitive.
4. Definition and Mechanism of an enzyme reaction, Factors affecting enzyme activity. isozymes, ribozymes, enzyme unit, specific activity, Michaelis-Menton equation-Derivation, Allosteric enzymes -Properties and mechanism., Allosteric Regulation, Covalent Modification, Feedback Inhibition.

Unit 2: (12 hrs)

1. Scope of thermodynamics. Concept of free energy, Enthalpy, Standard Free Energy change of reaction, Entropy. First and Second law of Thermodynamics. Open and Closed system. 2.
2. Structure and properties of ATP, Standard Free energy change of hydrolysis of ATP and other high energy compounds Biological oxidation-reduction reactions. Structure and Function of NAD and FAD.
3. Bacterial photosynthesis - photosynthetic pigments, photosynthetic apparatus in prokaryotes, photosynthesis in purple and green bacteria.

Unit 3: (12 hrs)

1. Breakdown of carbohydrates· Glycolytic pathways- EMP, HMP shunt/pentose phosphate pathway and ED; TCA cycle. Aerobic respiration - ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy - oxidation of inorganic compounds - N, S, Fe and H.
2. Fermentative modes in microorganisms - alcoholic, Lactic acid - hetero and homo, acetic acid, propionic acid, butyric acid, mixed acid and butanediol fermentation.

Unit 4: (12 hrs)

1. Genomic organization in Prokaryotes and Eukaryotes.

2. Chemical composition of DNA and RNA, Watson and Crick model of DNA. Types of DNA - A, B, Z and H, Super coiling of DNA.
3. Semi conservative method, Rolling circle model, Origin of replication, Primers and template, Replication fork, Unidirectional and Bi-directional (Theta & sigma modes of replication) .
4. Recombination in bacteria- Conjugation, Transformation and Transduction.
5. Molecular basis of mutations, Point and frame shift mutation, Spontaneous and induced mutations. Physical mutagen – ultra violet radiations, X- rays v. Biological mutagen – plasmids & transposons Detection of mutations- replica plate method and mutation repair- photoreactivation, excision repair, SOS repair, Trans dimer synthesis.

Unit 5: (12 hrs)

1. Sample and population
2. Data presentation-Dot diagram, bar diagram, Histogram, frequency curve
3. Central Tendency-Mean, Median, Mode Summation notations
4. Standard Deviation, Variation, Q-test, T-test, F-test

References:

1. Freifelder David, *Microbial Genetics,* Narosa Publishing House, New Delhi.
2. Gerald Karp, *Cell Biology,* McGraw Hill Book Company, New York.
3. Moat A.G. and Foster S.w., *Microbial Physiology,* John Wiley and Sons, New York.
4. Nelson David L. and Cox.Michael M., *Lehninger Principles of Biochemistry,* Macmillan PresslWorth Publishers, New Delhi
5. Pelczar M.J., Chan E.C.S. and Krieg N.R, *Microbioiogy,* McGraw Hill BookCompany, New York.
6. Prescott Lansing M., Harley John P.and Klein Donald A., *Microbiology,* WCB McGraw: Hill, New York.
7. Salle A.J., *Fundamental Principles of Bacteriology,* Tata McGraw- Hili Publishing Company Limited, New Delhi.
8. Stanier R.Y., Ingraham J.L., *General Microbiology,* Prentice Hall of India Private Limited, New Delhi.
9. Stickberger M.W., *Genetics,* Prentice Hall of India Private Limited, New Delhi.
10. Voet D. and Voet J.G., *Biochemistry,* John Wiley and Sons, New York.
11. Lehninger's Principles of Biochemistry, D. Nelson & M. Cox, 5th edition, Macmillan Worth Publications

12. Molecular Biology of the gene, JD Watson, Baker, Bell, 4th / 5th edition, Pearson Education Publications
13. Concepts of Genetics 7th edition, Klug & Cummings, Pearson Education Publications
14. Genes IX, Lewin, Oxford Publications
15. Genetics – a molecular approach, Peter Russell, 3rd edition, Pearson Publications
16. Fundamental bacterial genetics, Nancy Trun& Janine Trempy, (2004), Blackwell Publications
17. Outlines Of Biochemistry, 5th edition, Eric E Conn , Paul K Stumpf ,George Bruening, Roy H. Doi John Wiley & Sons
18. Biochemistry Berg JM, Tymoczko JL, Stryer L. 6th edition, New York: W H Freeman
19. A biologist's physical chemistry, J. Gareth Morris, Hodder Arnold Publications
20. Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons

3.4 - Microbiology Practical's – III

1. Qualitative tests for Proteins, Amino Acids Carbohydrates, Nucleic Acids & Lipids
2. Estimation of reducing sugar glucose - by DNSA method
3. Estimation of Protein by Lowry's method
4. Sorenson-formol titration for amino acid estimation
5. Study of Bacterial Enzymes - Study of Amylase, Urease, Catalase & Lipase Producers
6. Effect of variables on enzyme activity (amylase)
7. Effect of U.V. light on bacteria.
8. Isolation of streptomycin - resistant mutants (gradient plate technique)
9. Determination of dry and wet weight of microbes (yeast/fungi)
10. Charts on Genetic recombination in Bacteria -Conjugation - F+ *v/s* F-, Hfr+ *v/s* F-, F' v/s F Transformation - Griffith's experiment and mechanism, Transduction - generalized and specialized
11. Determination of standard deviation.

IV SEMESTER

4.3 -Molecular Biology, Genetic Engineering and Bioinformatics –Theory Paper

Unit 1. (12 hrs)

1. Types of RNA and their functions.
2. Protein Synthesis in Prokaryotes - Ribosomes, types of RNA involved in transcription, translation, and mechanism of protein synthesis, and protein inhibitors.
3. Gene Structure and expression
4. Regulation of gene expression in prokaryotes - The operon concept, Induction and repression, The *lac* operon. Tryptophan operon, Attenuation

Unit 2. (12 hrs)

1. Model Organisms **-**Characteristics of a model organism. Examples of model organisms used in study.
2. Tools for rDNA technology - DNA manipulative enzymes: Restriction enzymes 1, 2 and 3, Ligases and other DNA modifying enzymes- methylation by methylase enzyme.
3. Gene cloning vectors - Salient features, Plasmids - properties, types, pBR322 and pUC18 and pUC18 series vectors, bacteriophages - A and M13, Cosmids – properties; shuttle vectors – YAC, BAC
4. Vectors for plants and animals: *Agrobacterium tumifaciens,* SV 40.

Unit 3: (12 hrs)

1. Gene Cloning: *In vitro* construction of r-DNA molecules: Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). Cutting of DNA molecules· Physical methods, enzymatic methods & Joining of DNA molecules – Homopolymer tails, Linkers, Adapters.
2. Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Microparticle bombardment.
3. Screening and selection of recombinant host cells: Insertional inactivation, *In situ* Colony/DNA hybridisation, and immunological techniques.

Unit 4: (12 hrs)

1. Molecular Techniques - PFGE, 2-d electrophoresis, Southern, Northern & Western blotting, DNA sequencing – Sanger's manual & automated methods, Basic PCR and different types of

PCR (RT-PCR, qPCR, LA-PCR), Genomic and cDNA libraries, DNA synthesizer, Electrophoresis, RFLP, DNA Micro array.

2. Applications of Genetic Engineering - Strain Improvement to increase fermentation yield, Transgenic plants - Bt cotton, Golden rice, Animal Pharming, Insulin production, Metagenomics, Gene therapy, DNA fingerprinting .
3. Potential hazards and safe guards of genetic engineering .

Unit 5. (12 hrs)

1. Introduction to Bioinformatics, Genomics - structural, functional and comparative genomics, Proteomics- structural and functional proteomics,
2. Annotation, Transcriptomics, Metabolomics, Pharmacogenomics.
3. Sequence alignment & all related terms in bioinformatics
4. Genome projects – an overview of genome projects of human and other model organisms of Human Genome Project.
5. Database, tools and their uses-
   i. NCBI, ExPASY proteomics server, EBI
   ii. Importance, Types and classification of databases
   iii. BLAST with one example
   iv. Database (EMBL, Genbank, SWISSPORT)
   v. Pair-wise sequence alignment –16srRNA analysis, 18s rRNA analysis, Multiple sequence alignment, Phylogenetic tree.

References:

1. Gerald Karp, *Cell Biology,* McGraw Hill Book Company, New York.
2. Nelson David L. and Cox Michael M., *Lehninger Principles of Biochemistry,* Macmillan PresslWorth Publishers, New Delhi
3, Pelczar M.J., Chan E.C.S. and Krieg N.FI., *Microbiology,* McGraw Hill Book Company, New York.
4. Prescott Lansing M., Harley John P. and Klein Donald A., *Microbiology,* WCB McGraw- Hill, New York.
5. Salle A.J" *Fundamental Principles of Bacteriology,* Tata McGraw- Hill Publishing Company Limited, New -Delhi.
6. Stanier R.Y., Ingraham J.L., *General Microbiology,* Prentice Hall of India Private Limited, New Delhi.
7. Watson James D., *Recombinant DNA,* Scientific American Books, Now York.

8. Introduction to Bioinformatics, Arthur Lesk, 3rd edition, Oxford University Publications
9. Introduction to Bioinformatics, T. K. Attwood & D. J. Parry-Smith, (2003), Pearson Education Publications
10. Bioinformatics, David Mount, 2nd edition, Cold Spring Harbor Laboratory Press
11. A Textbook of Biotechnology, R.C. Dubey, 2010, S. Chand and Co Ltd.
12. Advances in Biotechnology, S. N. Jogdand, 2007, 2nd edition

4.4 Microbiology Practical's – IV

1. Preparation of buffers - citrate and phosphate buffers.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
4. Isolation of plasmid DNA from bacteria and separation by gel electrophoresis
5. Isolation of genomic DNA from *E. coli.*
6. Restriction digestion of DNA
7. In vitro DNA ligation
8. Phage Titration.
9. Demonstration of replica plate technique.
10. Bioinformatics (ORF finder, 6 frame translations, nucleotide & protein BLAST, restriction fragment analysis, protein structure, KEGG)
11. Charts on genetic engineering
    a) pBR 322
    b) pUC 18 and 19
    c) SV 40
    d) Bacteriophages - A
    e) Gene cloning
    f) Selection of recombinants by replica plate technique
    g) YAC, BAC

OPEN ELECTIVE PAPER

4.9 Microbes and Mankind

Unit 1: (08 hrs)

1. Introduction to microbiology, branches of microbiology, applications of microbiology and instrumentation involved in studying microbes.
2. Structure and classification of microbes
3. Growth and cultivation of microbes
4. Control of microbes

Unit 2: (08 hrs)

1. Microbes in soil: Types, role and significance
2. Microbes in agriculture: Beneficial and harmful microbes
3. Microbes in air: Types, role and significance
4. Microbes in water: Pollution and water borne diseases

Unit 3: (08 hrs)

1. Microbes in food: Types of microbes associated with food, food spoilage and food borne illness.
2. Preservation of food: Methods of food preservation
3. Microbes in dairy products: Beneficial and harmful microbes
4. Microbes in industry: Use of microbes for production of value added products

Unit 4: (08 hrs)

1. Diseases caused by microbes I: Bacterial and Viral diseases
2. Diseases caused by microbes II: Fungal and Protozoan diseases
3. Prevention and treatment of diseases: Vaccines and chemotherapeutic agents
4. Health and Immunity

References:

1. Atlas R.M. Microbiology-Fundamentals and applications, Macmillan Publishing Company, New York.
2. Benson Harold J. Microbiological Applications, WCB McGraw-Hill New York.
3. Bold H.C. and Wynne M.J. Biology of Microorganisms, Prentice Hall of India Private Limited, New Delhi.
4. Brock T.D. and Madigan M.T. ,Biology of Microorganisms, Prentice Hall of India Private Limited.

V SEMSESTER

5.1 Agricultural and Environmental Microbiology- Theory Paper

Unit 1: (09 hrs)

1. Soil-definition, types, physical and chemical characters, soil profile, Soil Microorganisms-Bacteria, fungi, actinomycetes, algae, protozoa, and viruses.
2. Interactions between plants and microorganisms-types of interactions (positive and negative) Microorganisms of rhizosphere, rhizoplane and phylloplane, mycorrhiza (Types and its applications).
3. Microbes and biogeochemical cycles-Nitrogen, sulphur, carbon and phosphorous.
4. Bioleaching-Copper and Iron-ore form available, areas of deposits, methods of leaching, mechanism and significance.
5. Biodegradation-Cellulose, Pectin, plastics and pesticides. Microbes and organic pollutants; environmental laws and issues concerning release of genetically engineered microbes.
6. Xenobiotic compounds-Persistance and biomagnification of xenobiotic compounds, bioremediation .

Unit 2: (09 hrs)

1. Microorganisms in agriculture- physiology of Nitrogen fixation, Symbiotic- Rhizobium, Non-symbiotic-*Azotobacter*, BGA and associative-*Azospirillum* associations.
2. Biofertilizers-Definition, Types (bacterial, fungal, phosphate solubilizers, BGA, Plants-Azolla); kind of association, mode of application and merits.
3. Biopesticides-Introduction types (bacterial-*Bacillus thruingiensis*, Viral –NPV, fungal-*Trichoderma*), Mode of action, factors influencing, genes involved and target pests.

Unit 3: (09 hrs)

1. Microbial Pathogenicity – Virulence factors, enzymes, toxins (host and non-host specific), growth regulators, virulence factors in viruses (replicase, coat proteins, silencing suppressors) in disease development.
2. Defence mechanism in plants- Structural and biochemical, Host-pathogen interaction.
3. Study of microbes as plant pathogens-Fungi- *Puccinia, Plasmopara, Cercospora, Pyricularia* and *Erisyphe*
4. Bacteria- *Xanthomonas oryzae* X*anthomonas sacchari, Hamelia vastatrix*
5. Mycoplasma-Sandal spike, grassy shoot;
6. Viruses-TMV, Tomato leaf curl, little leaf of brinjal.

7. Control of plant diseases – Principles and practices, cultural practices, chemical methods, biological methods and genetic engineering for disease resistant plants.

Unit 4 : **(09 hrs)**

7. Air microbiology- Introduction definition, atmospheric layers, sources of microorganism, air micro flora of indoor and outdoor air. Factors affecting air micro flora, significance of air borne microbes, endo toxins, control and management of air borne microbes.
8. Techniques of trapping air borne microorganisms-gravity slide, plate exposure, vertical cylinder, Hirst spore trap, Rota rod sampler, Andersen sampler, Bukard trap, hand held air sampler, impingers and filtration. Advantages and disadvantages of these techniques.
9. Biohazards in occupational environment, allergy testing.

Unit 5: (09 hrs)

1. Water microbiology- Introduction, natural waters, distribution of microorganisms in the aquatic environment.
2. Sources and types of water pollution, biological indicators of water pollution.
3. Water-borne diseases-Bacterial (Cholera), Viral (Hepatitis A) and Protozoan (Amoebiasis).
4. Determination of the sanitary quality of water-MPN index, membrane filtration,
5. Biological Oxygen Demand. Chemical oxygen demand.
6. Water purification in municipal water supply, parameters of potable water. Solid waste management and waste water treatment.

References:

1. Alexander M. Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopulas C.J and Mims C.W. Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
4. Hirst, C.J. Environmental Microbiology, ASM Press, Washington D.C.
5. Mehrotra R.S. Plant Pathology Tata McGraw Hill Publications Limited, New Delhi.
6. Pelczar M.J. Chan E.C.S and Krieg N.R. Microbiology McGraw Hill Book Company, New York.
7. Prescott Lansing M. Harley John P. and Klein Donald A. Microbiology, WCB McGraw-Hill New York.
8. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
9. Stacey R.H. and Evans H.J. Biological Nitrogen Fixation, Chapman and Hal Limited, London.

10. Stanier R.Y. Ingra. General Microbiology, Prentice Hall of India Private Limited, New Delhi.
11. Subbarao N.S Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.

5.2 Food and Dairy Microbiology - Theory Paper

Unit 1: (09 hrs)

1. Food as substrate for microorganisms- pH, moisture, water activity, oxidation – reduction potential, nutrient content, inhibitory substances and biological structure, various factors affecting growth and activity of microorganisms in foods.
2. Different type of microorganisms associated with foods, general characteristics, classification, identification and importance, contamination sources, role in food spoilage and desirable fermentations.
3. Physical and chemical properties of milk. Types of Milk (skimmed, toned and homogenized. Concept of clean milk (as per National Dairy development Board (NDDB) norms.
4. Types of microorganisms in Milk - bacteria, fungi and yeast.
5. Sources of microbial contamination of raw milk and their relative importance in influencing quality of milk during production, collection, transportation and storage. Clean milk production and antimicrobial systems in raw milk. Microbial changes in raw milk during long storage. Microbiological grading of raw milk.

Unit 2: (09 hrs)

1. Food spoilage and food poisoning- Spoilage of canned food, cereals, fruits, vegetables, meat and fish.
2. Food poisoning-Endotoxin, staphylococcal poisoning, botulism and salmonellosis, Mycotoxins produced by fungi-Aflatoxin in stored food and grains.
3. Spoilage of milk -Succession of microorganisms in milk leading to spoilage, Souring, lactic and fermentation Colour and flavor defects, Sweet curdling , Stormy fermentation, Ropiness and proteolysis.
4. Diseases of dairy animals and milk borne diseases.
5. Food sanitation and control. -
   HACCP, Indices of food sanitary quality and sanitizers

Unit 3: (09 hrs)

1. Food preservation-Principles of food preservation Methods of food preservation-high temperature, canning, freezing, dehydration, chemical preservatives and radiation. hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocin.
2. Methods of preservation of milk and milk products, Pasteurization, sterilization and dehydration.
3. An account on condensed and dried milk.

Unit 4: **(09 hrs)**

1. Microbial examination of food-DMC, viable colony count, examination of fecal Streptococci.
6. Microbiological analysis of milk., Rapid platform tests-organoleptic, Clot on boiling (COB), titratable acidity alcohol test ,DMC, sedimentation test and pH. Standard plate count, Reductase test- MBRT, Resazaurin test, Brucella ring test and tests for mastitis, Somatic cell count.

Unit 5: (09 hrs)

1. Microbial food products- Single cell proteins-yeast and spirulina, Single cell oils
2. Fermented Milk Products- Yogurt-Types & production, Cheese-types and production-Cheddar & Cottage, Cultured Butter milk.
3. Fermentedfoods-Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh and probiotics.
4. Genetic Engineering and Dairy industry.

References:

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.

2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Hammer B.W. and Babal, Dairy Bacteriology, Prentice Hali Incorporated, London.
4. Jay J.M. Modern Food Microbiology, CBS Publishers and Distributors, New York.
5. Prescott Lansing M. Harley John P. and Klein Donald A. Microbiology, WCB, McGraw-Hill New York.
6. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing, Company Limited, New Delhi.
7. Varnam A.H. and Evans M.G. Food borne Pathogens, Wolfe Publishing House, London.

5.3 Microbiology Practical V/VI

Agricultural and Environmental Microbiology

1. Isolation and enumeration of bacteria and fungi from rhizosphere and rhizoplane.
2. Study of Rhizobium from legume root nodules (gram staining)
3. Isolation of actinomycetes from soil microorganisms using Glucose Aspergine agar by plate methods
4. Study of antagonism between soil microorganisms by plate methods -Bacteria Vs Bacteria, Bacteria vs. Fungi, Fungus vs. Fungus, Actinomycetes v/s. Bacteria/Fungi.
5. Study of plant pathogens-Tikka Disease, Sandal Spike, Downy Mildew, Coffee rust and Tomato Leaf Curl.
6. Study of airborne microorganisms (bacteria and Fungi)in different environments by exposure plate method.
7. Study of fungi in seeds by blotter method.
8. Effect of fungicidal seed treatment on fungal plant pathogen.
8. Study of air samplers-Anderson's sampler, Hirst Spore trap, Rotorod sampler and vertical cylinder.
9. Determination of Biological Oxygen Demand.
10. Microbial examination of water by coli form, MPN methods-for potable and sewage water.
11. Study of fungi-*Cladosporium*, *Helminthosporium*, *Mucor, Curvularia, Altenaria, Geotrichum* and *Trichoderma.* (specimens)

Food and Dairy Microbiology

1. Isolation and identification of microbes from infected fruits and vegetables.
2. Isolation and identification of microbes from curd, idli batter, and Stored foods-Jams, Jellies, Sauce and Pickles.
3. Isolation and identification of microorganisms from canned food.
4. Bacterial examination of milk by SPC
5. Bacterial examination of milk by DMC
6. MBRT
7. Evaluation of ice cream for coli forms and *E. coli.*
8. Microbiological quality of Paneer.
9. Estimation of Fat content in milk by Gerber's method
10. Estimation of Lactose in milk.
11. Production and detection of Aflatoxins from fungi by paper chromatography/TLC and bioassay of aflatoxins.
12. Study of food borne pathogens-*Clostridium, Staphylococcus*, and *Salmonella*

SEMESTER VI

6.1 Immunology and Medical Microbiology-Theory

Unit 1: (09 hrs)

1. History and scope of Immunology, Overview of immune system.
2. Immunity: Definitional, types-natural, acquired, active, passive. Mechanism of immune response
3. Antigens-Definition, types of antigens, chemical nature, antigenicity, immunogenicity, hapten, epitopes, mitogens (definition, properties, examples), Adjuvant (definition, examples, function) Factors influencing antigenicity.
4. Immunoglobulins-Definition, structure types, properties and functions of Immunoglobulin Production of Polyclonal & Monoclonal antibodies & their application.
5. Antigen and Antibody Reactions-Agglutination, Precipitation, Complement fixation, test, neutralization, opsonization, Gel diffusion techniques, Immunoelectrophoresis, labeled antibodies –RIA, ELISA, Immunofluorescent techniques.

Unit 2 : (09 hrs)

1. Complement system-properties, components, pathway and functions.

2. Cells, tissues and organs involved in Immune system - Hematopoietic stem cells, stromal cells, hematopoietic growth factors, Lymphoid organs (primary and secondary) and cells, Mononuclear cells, Granulocytic cells, Mast cells, Dendritic cells- characteristics and functions.

3. Immune response- antigen processing and presentation, types and structures of Major histocompatibility complex molecules (MHC) and their role in antigen presentation, definition of cytokine, generation of humoral and cell mediated response by cellular interactions (general concept only). Immunological memory and immunological tolerance.

4. Hypersensitivity - definition, types, examples.

5. Cancer and immune system- Malignant Transformation of cells, oncogenes and cancer induction, Tumor Antigens, Immune surveillance theory, Cancer Immunotherapy.

6. Transplantation Immunology: Immunological basis of Graft Rejection, Mechanism of Graft rejection. Immunosuppressive therapy

7. Immunohematology- Blood grouping ABO & Rh

8. Vaccines – definition, types- Live attenuated vaccines – polio and BCG, Killed vaccines-pertussis, Toxoid-tetanus, Recombinant vaccines-hepatitis, DNA vaccines and Synthetic vaccines.

Unit 3: (09 hrs)

1. Infection-Definition, Types, stages of infection, process of infection, Koch postulates.

2. Microbial flora of human body, Pathogenicity and its virulence. Mechanism of Bacterial Pathogenicity: Entry, colonization, growth, mechanism of damage of host cell. Production of endo-and exo-toxins - definition and general properties (a) Neurotoxin: exotoxin & toxoid, botulinum toxin, tetanus toxin; (b) Enterotoxin: Cholera toxin, Salmonella toxin, Klebsiella toxin. (c) Cytotoxin: Shigella toxin, Diphtheria toxin.

3. Important groups of pathogenic Microorganism (classification culture, and biochemical characters, antigenic structure, pathogenic, pathogenesis and laboratory diagnosis, epidemiology prophylaxis and chemotherapy) of the following:

Bacterial diseases

a) Gonorrhoea

b) Syphilis
c) Diptheria
d) Typhoid
e) Tetanus
f) Shigellosis
g) Cholera
h) Leprosy
i) Tuberculosis

Unit 4: (09 hrs)

Viral Diseases

a) Polio
b) Measles
c) Mumps
d) Rabies
e) Hepatitis A.B
f) HIV
g) HINI, SARS, EBOLA and Chikungunya

Protozoan Diseases

a) Malaria
b) Giardiasis
c) Filiariasis

Fungal Diseases

a) Candidasis
b) Ring worm

Parasitology

a) Taenia solium
b) Fasciola hepatica

Unit 5 : (09 hrs)

1. Definition and classification of antibiotics.
2. Characteristics of antibiotics that qualify them as chemotherapeutic agents
3. Antimicrobial spectrum of antibiotics and mode of action of the following antibiotics

a) Antibacterial- Penicillins, Cephalosporins, Bacitracin, Polymyxins, Streptomycin, chloramphenicoles, tetracyclines and Vancomycin

b) Antifungal- Nystatin and cyclohexamide

c) Antiviral- Acrucloguanosine (nucleoside)

d) Synthetic Chemotherapeutic agents- Nalidixic acid

4. Development of Resistance to antibiotics- a brief account.

References:

1. Abbas Abul K. Lightman Andrew K. and Pober Jordan S. Cellular and Molecular immunology W.B Saunders Company, Philadelphia.
2. Anathanarayana and Paniker, Text Book of Microbiology Orient and Longman, New Delhi.
3. Gold by Richard A. Kindt Thomas J and Osborne Barbara A. Kuby Immunology, W.H. Freeman and Company, New York.
4. Jawetz Me hick, Adel berg Brooks, Butel and Orston, Medical Microbiology, Prentice Hail Incorporated London.
5. Pelczar M.J. Chan E.C.S and Krieg N.R. Microbiology McGraw Hill Book Company, New York.
6. Rcitt I.M. Essentials of Immunology, ELBS Blackwell scientific Publishers, London.

6.2 Industrial Microbiology and Microbial technology – Theory Paper

Unit 1: (09 hrs)

1. History, scope and development of industrial microbiology.
2. Isolation and screening of industrially important microorganisms.
3. Strain Improvement methods.
4. Industrial fermentation products and their producer Microorganisms
5. Concept and examples of Microorganisms classified as Generally Regarded As Safe (GRAS)
6. Culture Collections of industrially important microorganisms
7. Maintenance of Stock cultures, Patents and patent regulation,

Unit 2: (09 hrs)

1. Types of industrial fermentation processes: Batch continuous, surface, submerged, and SSF
2. Media components and formulation, crude media components, antifoam agents, precursors, inducer and inhibitors and buffering agents.

3. Sterilization of media and raw materials and maintenance of sterility at critical points during fermentation.
4. Inoculum preparation.
5. Process parameters-aeration, agitation, temperature regulation, foam regulation and pH regulation.
6. Fermentor: Basic structure, construction and various types-typical stirred aerated fermentor, tower fermentor, airlift ferment or and bubble cap fermentor.

Unit 3: (09 hrs)

1. Role and importance of downstream processing in industrial Microbiological processes. Problems and requirements of bio product purification.
2. Physico-chemical basis of bio separation processes. Cell disruption methods for intracellular products removal (flocculation, sedimentation, centrifugation and filtration methods. Membrane based separations (Micro & ultra filtration) theory, design, and configuration of membrane. precipitation methods (with salts, organic solvents and polymers, extractive separations, aqueous two phase extraction, integrated bio processing.
3. Purification and concentration methods of byproduct chromatographic techniques affinity column, HPLC, ion exchange and GLC. Electrophoresis of proteins and nucleic acids, 1D, 2D gels, chromatofocusing electrophoretic separations, Distillation, Dialysis, crystallization, evaporation.

Unit 4: (09 hrs)

1. Production of chemicals-Fermentative production of Alcohol-Industrial alcohol and alcoholic beverages-beer-wine and whiskey.
2. Organic acids – citric acid,
3. Vitamins- B 12
4. Amino acid – Glutamic acid
5. Antibiotics-Penicillin
6. Enzymes- amylase.

Unit 5: (09 hrs)

1. Biofuels: Methane and hydrogen gas production types of substrate process, mechanism by Producers.
2. Production of vaccines- hepatitis B and hormones – human insulin.
3. Production and use of biofertilizers and biopesticides
4. Biotransformation of steroids

5. Mushroom cultivation
6. Immobilization of enzymes and cells and its applications
7. Ethical issues against microbial technologies.

References:

1. Casida L.E. Industrial Microbiology, Wiley Eastern Limited, New Delhi.
2. Prescott S.C. and Dunn C.C. Industrial Microbiology, Tata McGraw-Hill Publishing Company limited, New Delhi.
3. Stanbury, P.F. Whitaker A and Hall S.J. Principles of Fermentation Technology, Elsevier Science limited Aditya Books Private Limited, New Delhi.
4. Waites Michael J. Morgan Neil L. Rockey John S. And Gray Higton, Industrial Microbiology- An Introduction, Blackwell | Science. Delhi.
5. McNell B and Harve/ L.M. Fermentation-A Practical Approach, IRL Press, New York.

6.3 Microbiology Practical's VII/VIII

Immunology and Medical Microbiology

1. Isolation and identification of microorganisms from Ear, nose, throat and sputum.(Growth on Blood Agar. Chocolate agar, Braid Parker, Mac-Conkey Agar, Nutrient Agar)
2. Isolation and identification of microorganisms from clinical samples –urine (Growth in Alkaline peptone water, Growth on Blood Agar)
3. Determination of sugar and protein in urine samples
4. Blood grouping
5. Differential count of WBC
6. Coagulase test
7. WIDAL test
8. VDRL test
9. Spot Elisa
10. ODD-Ouchterlony Double diffusion
11. RID-Radial Immune Diffusion
12. Study of AFB –slide
13. Study of pathogenic microorganisms-*Shigella, Clostridium, Staphylococcus, Streptococcus, Entamoeba, Plasmodium,* and *Candidaia* (Slides)

14. Study of *Taenia solium* and *Fasciola hepatica.*

Industrial Microbiology and Microbial technology

1. Production of wine from grapes
2. Estimation of alcohol content by specific gravity method
3. Production of Citric acid from fungi.
4. Production and Estimation of Citric acid by Titrimetric method
5. Production and estimation of amylase from fungi
6. Production and estimation of Lactic acid from milk
7. Role of yeasts in bread making and bromothymol test
8. Mushroom Cultivation.
9. Immobilization of cells.
10. Isolation of Lipase producing microorganisms.
11. Charts on the different types of fomenters
    a) Typical stirred aerated fomenters
    b) Tower fermentor
    c) Air lift fermentor
    d) Bubble cap fermentor
12. Visit to an Food/ Dairy/ Pharmaceutical/ Beverage industry.

B.Sc MICROBIOLOGY QUESTION PAPER PATTERN – THEORY

MAXIMUM MARKS: 90 **TIME: 3 HOURS**

PART – A

Answer any ten questions in one or two sentences **10x2=20**

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

PART – B

Answer any six questions. Short note type **6x5=30**

13.
14.
15.
16.
17 a)
b)
18 a)
b)
19.
20.

PART - C

Answer any four questions. Essay Type **4X10=40**

21.
22.
23.
24.
25.

Note: Equal weightage should be given to all the units while preparing the question paper.

B.Sc MICROBIOLOGY QUESTION PAPER PATTERN – PRACTICAL

MAXIMUM MARKS: 50 **TIME: 3 HOURS**

1. Major Experiment: 12 Marks

2. Minor Experiment: 08 Marks

3. Spotters/Demonstrations: 20 Marks

4. Record Submission: 05 Marks

5. Viva-Voce: 05 Marks

Note: Scheme of valuation specific to each semester has to be prepared by the BOE for each examination separately

Internal Assessment:

Average of two Internal tests:	05 Marks
Average of two assignments: (Frontier areas of microbiology)	05 Marks

TOTAL: 10 Marks

Note: Students should be given a choice of picking a topic of their interest for assignment and the teachers should guide them in making an informed choice. The choice of the assignments and the due date of submission not less than one week from the date of notification should be displayed on the notice board of the department.