

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(An Autonomous College of University of Mysuru)
Re-accredited by NAAC with 'A⁺' grade
Ooty road, Mysuru-570025, Karnataka



ESTD-1964

DEPARTMENT OF MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS)
&
CONTINUOUS ASSESSMENT AND GRADING PATTERN

SYLLABUS

FOR

B.Sc. PROGRAMME

Biochemistry, Biotechnology & Microbiology

Botany, Biochemistry & Microbiology

(W.E.F:2025-26)

Program Outcomes:

By the end of the program the students will be able to:

1. Knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.
2. Understand the distribution, morphology and physiology of microorganisms and demonstrate skills in aseptic handling of microbes including isolation, identification and maintenance.
3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. Exploring the microbial world and analysing the specific benefits and challenges.
6. Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyse outcomes by adopting scientific methods, thereby improving the employability.
12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

CBCS based Undergraduate Microbiology Syllabus for 2025-26 onwards

Semester-wise distribution of the course structure

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week
SEMESTER – I				
Major	DSC-1: Theory-I	Introduction to Microbiology and Microbial Diversity	3	3
	DSC-1: Practical-I	Introduction to Microbiology and Microbial Diversity	2	4
SEMESTER – II				
Major	DSC-2: Theory-II	Microbial Physiology and Genetics	3	3
	DSC-2: Practical-II	Microbial Physiology and Genetics	2	4
SEMESTER – III				
Major	DSC-3: Theory-III	Molecular Biology and Environmental Microbiology	3	3
	DSC-3: Practical-III	Molecular Biology and Environmental Microbiology	2	4
Elective	ELE-1: Theory	Microbial Quality Control in Industries	3	3
SEMESTER – IV				
Major	DSC-4: Theory-IV	Genetic Engineering and Agricultural Microbiology	3	3
	DSC-4: Practical-IV	Genetic Engineering and Agricultural Microbiology	2	4
Elective	ELE-2: Theory	Plant and Animal Microbiome	3	3
Skill	SEC-1: Theory	Microbial and Molecular Techniques	2	2
SEMESTER – V				
Major-	DSE: Theory-V	Food and Industrial Microbiology	3	3
	DSE: Practical-V	Food and Industrial Microbiology	2	4
	SEC- Theory-	-		
SEMESTER – VI				
Major-	DSE: Theory-VI	Immunology and Medical Microbiology	3	3
	DSE: Practical-VI	Immunology and Medical Microbiology	2	4
	SEC- Theory-	-		

**DSC - Discipline Specific Course, DSE- Discipline Specific Elective,
SEC- Skill Enhancement Course**

JSSCOLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSURU-25

DEPARTMENT OF MICROBIOLOGY

PROFORMA OF INSTRUCTIONS AND EXAMINATION FOR B.Sc. PROGRAMME IN MICROBIOLOGY(SEP)

DURATION OF THE COURSE: 3 YEARS (6 SEMESTER)

PROGRAMME: B Sc (BBtM) PROGRAMME CODE : B. Sc

Year	Semester	Course Category	Course code	Title of the paper	Lecture+ Practicals hours per week	No. of credits			Total credits	Total hours		Duration of Exam (Hrs.)	Maximum Marks in Exam/Assessment			Total
						L	T	P		Th	Pr		IA(Theory)			
													C-1	C-2	C-3	
I B.Sc	I	DSC-I:Theory-I	GMB101	Introduction to Microbiology and Microbial diversity	03	3:0:0			03	48	-	3	10	10	80	100
		DSC-I:Pract-I	GMB102	Introduction to Microbiology and Microbial diversity	04	0:0:2			02	-	60	3	5	5	40	50
	II	DSC-II: Theory-I	GMB201	Microbial biochemistry and physiology	03	3:0:0			03	48	-	3	10	10	80	100
		DSC-II : Pract -II-	GMB202	Microbial biochemistry and physiology	04	0:0:2			02	-	60	3	5	5	40	50
II B.Sc	III	DSC-III: Theory-III	GMB301	Molecular Biology and Environmental Microbiology	03	3:0:0			03	48	-	3	10	10	80	100
		DSC-III: Pract -III	GMB302	Molecular Biology and Environmental Microbiology	04	0:0:2			02	-	60	3	5	5	40	50
		ELE-1: Theory		Microbial Quality Control in Industries	03	3:0:0			03	48	-	3	10	10	80	100
	IV	DSC-IV: Theory-IV	GMB401	Genetic Engineering and Agricultural Microbiology	03	3:0:0			03	48	-	3	10	10	80	100
		DSC-IV: Pract –IV	GMB402	Genetic Engineering and Agricultural Microbiology	04	0:0:2			02	-	60	3	5	5	40	50
		ELE-1: Theory		Plant and Animal Microbiome	03	3:0:0			03	48	-	3	10	10	80	100

SCHEME OF VALUATION

MAXIMUM MARKS

COURSE TYPE	C1		C2		C3		TOTAL
	THEORY	LAB	THEORY	LAB	THEORY	LAB	
DSC	10	5	10	5	80	40	150
DSE	10	5	10	5	80	40	150
SEC	5	-	5	-	40		50

NOTE;

1. C1 AND C2 WILL BE CONDUCTED FOR 20 MARKS (THEORY) WITH 1 HOUR DURATION, 10 MARKS (LAB) WITH CONTINUOUS ASSESMENT THROUGH RECORD VALUATION AND MARKS REDUCED TO ASSIGNED MARKS.
2. C3 WILL BE CONDUCTED FOR 80 MARKS (THEORY) WITH 3 HOUR DURATION, 40 MARKS (LAB) WITH 3 HOUR DURATION.
3. IN CASE OF SEC, C1 AND C2 WILL BE CONDUCTED FOR 10 MARKS WITH 30 MINUTES DURATION AND REDUCE TO ASSIGNED MARKS. C3 WILL BE CONDUCTED FOR 40 MARKS.

I SEMESTER
DSC-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY
PAPER-I **48(3hrs./ week)**

Course Outcomes (COs):

- CO1. Thorough knowledge and understanding of concepts of microbiology.
- CO2. Thorough knowledge and application of good laboratory practices and learning practicing professional skills in handling microbes.
- CO3. Knowledge about microbes and their diversity.
- CO4. Study, characters, classification and economic importance of Prokaryotic and Eukaryotic microbes and also about viruses and their diversity.

Unit I: History of microbiology and microscopy **12hrs.**

History of microbiology: Scope and branches of Microbiology. Contributions of Anton Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner and E. J. Butler.

Systems of classification: Whittaker's five kingdom classification and Carl Woese's three domain classification. Classical and molecular characteristic used in microbial taxonomy.

Microscopy: Working principle, construction and application of compound microscope, dark field microscope, phase contrast microscope, fluorescent microscope and scanning & transmission electron microscope.

Unit II: Staining and sterilization techniques **12hrs.**

Staining techniques: Chemical nature and types of microbiological stains. Methods of staining: simple (positive and negative), differential (Gram staining and acid fast staining) and structural (capsule, endospore).

Sterilization techniques: Physical methods: dry heat (hot air oven, incineration), moist heat (autoclave), filtration: filters (membrane filters and HEPA filter), radiation: UV and gamma radiation. Chemical methods: definition of terms- disinfectants, antiseptics, sanitizers, microbicides, microbiostatic. Mode of action and uses of alcohols, aldehydes, halogens, phenols (tabulation).

Unit III: Microbial diversity **12hrs.**

Biodiversity: Definition and levels, Bergey's Manual of Systematic Bacteriology. Comparison of bacteria, archaea and eukaryote (tabulation).

Cell organization: Cell size, shape and arrangement, structure and functions of capsule, flagella, fimbriae, pili, cell wall, cell membrane, ribosomes, mesosomes, inclusion bodies, nucleoid and plasmids. Bacterial endospore- structure and formation.

Diversity of prokaryotes: General characteristics of Rickettsiae, Chlamydia, Mycoplasma, Spirochaetes, Actinomycetes. Cyanobacteria: occurrence, structure, reproduction and importance of *Microcystis*, *Anabaena* and *Spirulina*.

Unit IV: **Diversity of eukaryotes and viruses**

12hrs.

Diversity of eukaryotes: Structure, reproduction and importance of Algae (*Spirogyra*, Diatoms and *Gracilaria*), Fungi (*Rhizopus*, *Penicillium*, *Agaricus*) and Protozoa (*Euglena* and *Paramecium*)

Diversity of viruses: ICTV system of classification. General characteristics of viruses. Structure and Importance of viruses. Structure and replication of viruses: Bacteriophages-T4 phage, cyanophages- LLP-1, phytophagenae-BCMV, zoophagenae-Influenza. Subviral particles-viroids, virusoids and prions.

I SEMESTER

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

PRACTICAL-I

(4hrs/week)

1. Microbiological laboratory standards and safety protocols.
- 2-3. Working principle and operation of basic equipment of microbiological laboratory (Autoclave, Hot air Oven, Incubator, laminar air flow system, colony counter, pH meter, Spectrophotometer, Colorimeter, Vortex mixer, Magnetic stirrer).
4. Applications of basic microbiological tools (Pipettes, Micropipette, Inoculation loop and needle, Spreader).
5. Study of simple and compound microscopes.
6. Preparation of stains and mordant-methylene blue, crystal violet, safranin, nigrosin, carbol fuchsin, malachite green, Gram's iodine and cotton blue.
7. Simple (direct and indirect) staining of bacteria.
8. Gram staining and endospore staining.
9. Observation of bacterial motility by hanging drop method.
10. Measurement of microbial cell size by micrometry
11. Study of cyanobacteria- *Microcystis*, *Anabaena* and *Spirulina*.
12. Study of Algae-*Spirogyra*, Diatoms and *Gracilaria*.
13. Study of Fungi-*Rhizopus*, *Penicillium* and *Agaricus*.
14. Study of Protozoa-*Euglena* and *Paramecium*.
15. Study of T4phage, BCMV and Influenza virus.

Text Books/ References

1. Alexopoulos, C. J. and Mims, C.W., Introductory Mycology, Wile Eastern Limited, New Delhi.
2. Atlas, R. M.(1997).PrinciplesofMicrobiology.2ndedition.W.M.T.BrownPublishers.
3. Bold, H. C. and Wynne, M. J. Introduction to Algae, Prentice Hall of India Private Limited, New Delhi.
4. Brock, T. D. and Madigan, M. T. Biology of Microorganisms, Prentice Hall of India Private Ltd, New Delhi.
5. Cappucino. J. and Sherman, N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited.
6. Carter, J. and Saunders, V. (2007). Virology: Principles and Applications. John Wiley and Sons.
7. Dimmock, N. J., Easton, A. L and Leppard, K. N. (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
8. Dubey, R. C. and Maheshawari, D. K, (2013) Text book of Microbiology, S Chand and company limited, Ramnagar, New Delhi.
9. Flint, S. J., Enquist, L. W., Krug, R. M., Racaniello, V. R. and Skalka, A. M. (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
10. Lansing, M. Prescott, John, P. Harley, Donald A. Klein. (2002). Microbiology, 5th edition WCB Mc Graw Hill, New york.
11. Madigan, M. T.,Martinko,J.M.,Dunlap,P.V.andClark,D.P.(2014).BrockBiologyof Microorganisms. 14th edition. Pearson International Edition.
12. Michael, J. Pelczar,Jr.E.C.S.ChanandMoel(2001).Microbiology,McGrawHill Book Company, New york).
13. Pelczar, M. J., Chan, E. C. S. and Krieg,N.R.(1993).Microbiology. 5thedition. Mc Graw Hill Book Company.
14. Srivastava,S. and Srivastava,P.S.(2003).UnderstandingBacteria.KluwerAcademicPublishers, Dordrecht.
15. Stanier, R.Y., Ingraham,J.L.,Wheelis,M.L.andPainter,P.R.(2005).General Microbiology. 5th edition McMillan.
16. Tortora, G.J., Funke, B.R.andCase, C.L.(2008).Microbiology:AnIntroduction.9th edition. Pearson Education.
17. Versteeg,J.(1985).A Color Atlas of Virology. Wolfe Medical Publication.
18. Wagner, E.K., Hewlett, M.J.(2004). BasicVirology.2nd edition. Blackwell Publishing.

II SEMESTER
DSC-2: MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

PAPER-II

48(3hrs./week)

- CO1. Inculcate the knowledge regarding microbial growth, functions, physiology and metabolism.
CO2. Differentiating concepts of chemoheterotrophic metabolism and chemolithotrophic Metabolism.
CO3. Describing the enzyme kinetics, enzyme activity and regulation.
CO4. Differentiate various method of recombination in bacteria and compare gene interaction in viruses and fungi.

Unit I: Microbial nutrition

12hrs.

Bacterial nutrition: Introduction to bioenergetics. Nutritional requirements and major nutritional types of microorganisms, Uptake of nutrients-passive transport, facilitated diffusion, active transport, group translocation and iron uptake. Prototrophs and auxotrophs. Bacterial growth curve- phases of growth and their significance, factors affecting microbial growth. Measurement of growth by cell number and cell mass.

Cultivation of bacteria: Culture media and their types. Pure culture techniques and colony characteristics of bacteria. Methods of preservation of microorganisms- slant culture, stab culture, mineral oil overlaying, glycerol stock preservation, cryopreservation and lyophilization.

Unit II: Microbial metabolism

12hrs.

Introduction to enzymes: Nomenclature and classification, structure of enzyme, mechanism of enzyme action. Lock and key model and induced fit theory. Enzyme inhibition and regulation.

Chemotrophic metabolism: Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway. Krebs cycle. Electron transport chain. Fermentation- Alcohol and lactose fermentation

Phototrophic metabolism: Photosynthetic microorganisms, light harvesting pigments, photophosphorylation, CO₂ fixation pathways: Calvin cycle. **Nitrogen metabolism:** Biological nitrogen fixation-nodulation in leguminous plants, nitrogenase, leghaemoglobin, ammonia assimilation. GOGAT cycle.

Unit III: DNA as genetic material and Bacterial genetics

12hrs.

DNA as a genetic material: Griffith experiment, Avery, MacLeod and McCarty experiment, Hershey and Chase experiment to prove DNA carries the genetic information. Fraenkel-Conrat experiment. Structure and organization of chromosomes in prokaryotes. Plasmid -types.

Bacterial genetics: Genome organization of *Escherichia coli*. Mechanism of genetic exchange in bacteria: Bacterial transformation- Principle and types of transformation mechanisms in prokaryotes. Bacterial Conjugation: U-tube experiment, F⁺ x F⁻ conjugation, F' x F⁻ conjugation, Hfr x F⁻ conjugation, Transduction: Generalized and specialized transduction.

Unit IV: Genetics of Viruses and Fungi

12hrs.

Genetics of viruses: Genetic recombination in phages, Heterozygosity in phages. Phenotypic mixing, Genotypic mixing. Genetic basis of lytic-lysogenic switch in phage lambda.

Genetics of fungi: Life cycle of *Neurospora*, ordered tetrad analysis in *Neurospora*, unordered tetrad analysis in yeast, two point and three point test cross.

Mutation: Nature and types, Mutagenic agents: physical and chemical mutagens, repair of mutated DNA: Photoreactivation and SOS repair. Transposable elements in prokaryotes.

II SEMESTER

MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

PRACTICAL-II

(4hrs/week)

1. Cleaning and sterilization of glassware and preparation of media-nutrient broth, nutrient agar and potato dextrose agar.
2. Preparation of physiological saline and serial dilution.
3. Estimation of CFU count by spread plate/pour plate method and study of colony characteristics of bacteria.
4. Cultivation of microorganisms on agar plate (point inoculation) and broth inoculation.
5. Isolation and preservation of bacterial cultures by streak plate, agar slants and stab culture.
6. Effect of temperature and pH on microbial growth.
7. Effect of salt and carbon source on microbial growth.
8. Measurement of growth by cell number using hemocytometer.
9. Microscopic examination of root nodules for bacteroids.
10. Demonstration of lactose fermentation.
11. Preparation of competent cells and demonstration of bacterial transformation.
12. Demonstration of bacterial conjugation by plate mating method.
13. Study of survival curve of bacteria after exposure to ultraviolet (UV) light.
14. Isolation of streptomycin resistant mutants of *Escherichia coli* by gradient plate method.
15. Study of culture media, hemocytometer, gaspak jar, Griffith experiment, plasmid, transformation, conjugation and transduction in bacteria, life cycle of *Neurospora* and transposable elements using photographs and model.

TextBooks/References

1. Brock, T. D. and Madigan, M.T.,(2012).Biology of Microorganisms, Prentice hall of India Pvt. Ltd, New Delhi.
2. Gardner,E. J.,Simmons,M.J.,Snustad,D.P.(2008).PrinciplesofGenetics.8thEd.Wiley-India.
3. Gottschalk, G.(1986).BacterialMetabolism.2ndedition.SpringerVerlag.
4. Klug, W. S.,Cummings,M.R.,Spencer,C.andPalladino,M.(2011).ConceptsofGenetics,10th Ed., Benjamin Cummings.
5. Krebs,J.,Goldstein.E.,Kilpatrick,S.(2013).Lewin'sEssentialGenes,3rdEd.,Jonesand Bartlett Learning.
6. Lansing,M.,Prescott,J.,Ohn,P.,Harley,DonaldA.Klein,(2002)Microbiology,5thed. WCB Mc Graw Hill, New york.
7. Madigan, M. T.and Martinko, J.M.(2014).BrockBiologyofMicroorganisms.14thedition. Prentice Hall International Inc.
8. Maloy,S.R.,Cronan,J.E.andFriefelder,D.(2004)MicrobialGenetics2ndedition.Jones and Barlett Pub.
9. Moat, A. G.and Foster, J.W.(2002).MicrobialPhysiology.4thedition.JohnWiley&Sons.
10. Nelson David , Land Cox Michael, M., Lehninger,(2008)Principles of Biochemistry, Macmillan Press, Worth Publishers, New Delhi.
11. Pierce,B.A.(2011)Genetics:AConceptualApproach,4thEd.,MacmillanHigher Education Learning.
12. Primrose, S. B. and Twyman, R.M.(2008).Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
13. Reddy, S. R. and Reddy, S.M.(2005).Microbial Physiology. Scientific Publishers India.
14. Russell,P.J.(2009).Genetics-AMolecularApproach.3rdEd,BenjaminCummings
15. Stanier, R. Y., Ingrahm ,J .I, Wheelis, M. L.and Painter, P.R.(1987).General Microbiology. 5th edition, McMillan Press.
16. Willey, J. M., Sherwood, L.M. and Woolverton, C.J.(2013).Prescott'sMicrobiology.9th edition. McGraw Hill Higher Education.

III SEMESTER

DSC-3:MOLECULAR BIOLOGY AND ENVIRONMENTAL MICROBIOLOGY

PAPER-III

48 (3hrs./week)

CO1. Understand concept involved in replication, transcription, translation in microbes.

CO2. Outline regulatory mechanisms in bacteria to control cellular processes.

CO3 Understand various plant microbes interactions and their applications .

CO4. Know the role of microorganisms in soil, air, water and waste water like various method to determine the Sanitary quality of water and sewage treatment methods .

Unit I: Genetic material and Transcription

12 hrs.

Genetic material: Chemical basis of heredity, Rosalind Franklin experiment. Chargaff's rules.

Watson and Crick model of DNA, DNA types. RNA-types, structure and importance.

Minor RNAs –RNAi, siRNA, miRNA and shRNA.

DNA replication: Definition and modes. Meselson-Stahl experiment. Enzymes and proteins involved in DNA replication. General mechanism of semi-conservative replication. Θ (theta) and rolling circle mode of replication.

Transcription: Transcription unit- concept of gene, promoter concept, Bacterial RNA polymerase, stages of transcription.

Unit II: Translation and regulation of gene expression

12 hrs.

Translation: Genetic code- features, Wobble hypothesis. Translation- steps in polypeptides synthesis in prokaryotes. Post-translational modifications of proteins- protein folding and targeting. Protein maturation and secretion- protein splicing and molecular chaperones. Comparative account of prokaryotic and eukaryotic translation.

Gene regulation: Operon concept, inducible and repressible operon. *lac* operon- structure, negative and positive control, catabolite repression. *Trp* operon-structure, regulation by repression and attenuation.

Unit III: Microbiology of Air and Soil

12 hrs.

Aeromicrobiology: Scope of aerobiology. Air microflora of indoor and outdoor environments.

Techniques to trap air-borne microorganisms: Passive (gravity slide, Petri plate exposure) and active spore traps (Andersen sampler, Rotorod sampler, Vertical cylinder and Hirst spore trap).

Microbiology of Soil: Soil types and soil profile. Microbial flora of soil. Role of microbes in soil processes: biodegradation of pectin, cellulose and lignin. Rhizosphere microorganisms: rhizosphere, rhizoplane and PGPR. Interaction among microorganisms. Plant microbe interaction- mycorrhizae and their types. Role of earthworm gut microflora in vermicomposting.

Unit IV: Microbiology of water and wastewater

12 hrs.

Aquatic Microbiology: Water as a microbial habitat. Microorganisms of freshwater, marine water and brackish water. Waterborne pathogens- types and source. Waterborne diseases- Cholera, Amoebic dysentery and Hepatitis. Microbiological analysis of water: SPC, MPN, IMViC reactions, membrane filter technique. Water purification in municipal water supply.

Sewage Microbiology: Sources of wastewater. Physical, chemical and microbiological characteristics of wastewater. BOD and COD. Wastewater treatment: septic tank, municipal wastewater treatment-primary, secondary and tertiary. Composting.

III SEMESTER

MOLECULAR BIOLOGY AND ENVIRONMENTAL MICROBIOLOGY

PRACTICAL-3

(4hrs/week)

1. Micropipeting: Moving very small volumes accurately.
2. Preparation of phosphate and citrate buffer.
3. Extraction of DNA by spooling method.
4. Isolation of genomic DNA from bacteria by heat lysis method.
5. Estimation of DNA by Diphenylamine method.
6. Determination of purity of DNA.
7. Isolation of airborne microorganisms (bacteria and fungi) by petriplate exposure method.
8. Trapping of microorganisms from air by gravity slide technique
9. Isolation and enumeration of bacteria and fungi from soil by serial dilution method.
10. Standard analysis of water and Determination of MPN
11. Biochemical differentiation of Enterobacteriaceae isolates by IMViC reactions.
12. Determination of bacteriological quality of water by H₂S paper strip test.
13. Estimation of total solids of sewage and Determination of BOD of sewage.
14. Study of Watson and Crick model of DNA, tRNA, semi-conservative replication of DNA, Transcription, translation, *lac* operon, air samplers, flocculator, clarifier, sand filter, chlorinometer, septic tank, trickling filter, oxidation pond and anaerobic digester through micrographs/schematic representations.
15. Visit to water treatment plant/sewage treatment plant/Virtual demonstration of water and waste water treatment/Submission of air borne fungi or bacterial culture

Text Books / References

1. Alberts Bruce, Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter ,P. (2014).Molecular Biology of the Cell.5th Edition, Taylor and Francis. New York, USA.
2. Alexander, A.M. 1987. Introduction to soil Microbiology, 5th ed., John Wiley and sons.
3. AllisonA. Elizabeth (2012).FundamentalMolecularBiology,2nd Edition. J Willey and Sons, Hoboken, New Jersey
4. Atlas, R. M. and Bartha, R. (1993). Microbial Ecology: Fundamentals and applications, 3rd ed., Benjamin and Cummings Pub.Co.New york.
5. Daniel Environmental Microbiology.
6. De Robertis, E. D. P. and De Robertis, E. M. F. (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia.
7. Frederick,M.,Ausubel,RogerBrent,Robert,E.,Kingston,David,D.,Moore, J. G.Seidman, John A. Smith,Kevin Struhl (2003).Current Protocols in Molecular Biology. John Wiley &Sons, New York, United States.
8. Freifelder's Essentials of MolecularBiology.GeorgeMMalacinski,4thed.2015
9. Grant, W.D. and P.E, Long: 1981 Environmental Microbiology, Thomson Litho ltd.
10. James,D.Watson,Tania A.Baker,StephenP. Bell,Alexander Gann,Michael Levine, Richard Losick.Molecular Biology of the Gene, 7th edition.2017
11. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
12. Krebs, J., Goldstein, E. and Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
13. Michael, J.Pelczar, Jr.E.C.S. Chan, Moel: Microbiology, Mc Graw Hill Book Company, New york).
14. Mitchell, R. (1992), Introduction to Environmental Microbiology, Prentice Hall Inc, Englewood Cliffs.
15. Powar and Daginwala (1996). General Microbiology, Vol 1. Himalaya Publishing House, Bombay.
16. Powar and Daginwala (1996). General Microbiology, Vol 2. Himalaya Publishing House, Bombay.
17. Rao, M.N. and Datta , A.K. (1987).Waste Water Treatment. Oxford and I.B.H.
18. Rheinhermer, G. (1986). Aquatic Microbiology Jhon Wiely and sons, New york.
19. Watson, J. D., Baker, T. A., Bell, S. P. et al., (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings.

III SEMESTER

ELE-1: MICROBIAL QUALITY CONTROL IN INDUSTRIES

CO1. Understand concept of Biohazards and biosafety levels

CO2. Understand microbiological quality of air

CO3. Know the role of microorganisms in food, water

CO4. Know the food safety & standards.

ELECTIVE-1

48 (3hrs./week)

Unit I: Biohazards and Biosafety

12 hrs.

Biohazards- definition, sources, types, risk group. Risk assessment of biohazardous agents. Good laboratory practices and Good microbiological practices. Biosafety cabinets: working of biosafety cabinets, using protective clothing. Biosafety levels- procedures and practices, safety equipment and laboratory facilities for BSL1, BSL-2, BSL-3 and BSL4. Discarding biohazardous waste- Methodology of disinfection, autoclaving and incineration.

Unit II :Microbiological quality analysis of Air

12 hrs.

Microflora of Air: Bioaerosols. Airborne microorganisms (bacteria, viruses, fungi) and their impact on human health and environment. Significance air microflora in food and pharma industries and operation theatres. Aeroallergens.

Collection of air sample and analysis: Bioaerosol sampling, air samplers and methods of analysis. Identification characteristics of bioaerosols. Bioaerosols inactivation mechanisms- UV light, desiccation, incineration.

Unit III: Microbiological quality analysis of Food and Water

12 hrs.

Pathogenic Microorganisms of Importance in Food & Water: SOP for water and food sampling. Culture media to detect specific microorganisms- XLD agar, Salmonella Shigella agar, Manitol salt agar, EMB agar, McConkey agar and Sabouraud agar.

Methods of analysis for foods and water: Aerobic Plate Count (APC), Most Probable Numbers (MPN), Direct Microscopic Counts (DMC). Immunological and molecular methods of detection of microbial contaminants in food and water.

Unit IV: Food safety and standards

12 hrs.

Introduction to food safety. Role of microbiologist in food industries. Food Safety and Standards Act, 2006- scope, salient features and general principles. Food Safety Management Systems: GMP and GHP. HACCP- principles, flow diagrams, applications. FSSAI- structure, statutory power, initiatives, functions, landmark cases and challenges. FDA and BIS. BIS standards for common foods and drinking water.

Text Books / References

1. Atlas, R. M. and Bartha, R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Baird, R. M., Hodges, N. A. and Denyer, S. P. (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
3. da Silva, N., Taniwaki, M. H., Junqueira, V. C., Silveira, N., Nascimento, M. S. and Gomes, R. A. R. (2012) Microbiological Examination Methods of Food and WaterA Laboratory Manual, CRC Press.
4. Food Safety and Standards Authority of India (FSSAI) Food Safety and Standards Authority of India, Government of India. Retrieved 2 April 2012.
5. Garg, N., Garg, K. L. and Mukerji, K. G. (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
6. Harrigan, W. F. (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press.
7. Hurst, C. J, Crawford, R. L., Garland, J. L. and Lipson, D. A. (2007) Manual of Environmental Microbiology, 3rd edition, ASM press.
8. Jay, J. M., Loessner, M. J., Golden, D. A. (2005) Modern Food Microbiology, 7th edition. Springer.
9. Maier, R. M., Pepper, I. L. and Gerba, C. P. (2009). Environmental Microbiology. 2nd edition, Academic Press.

IV SEMESTER

DSC-4: GENETIC ENGINEERING AND AGRICULTURAL MICROBIOLOGY

PAPER-IV

48 (3hrs./week)

After the successful completion of the course, the student will be able to:

CO1.Understand the molecular tools in gene cloning.

CO2.Learn about the molecular cloning methods

CO3.Understand concepts of microbes in sustainable agriculture

CO4. Understand the plant pathology aspects.

Unit I: Introduction to Genetic Engineering

12 hrs.

Molecular tools in gene cloning: Milestones in genetic engineering. Steps involved in gene cloning. Cloning tools: restriction enzymes- nomenclature, types, mode of action and applications. DNA modifying enzymes and their applications: DNA polymerases, methylases, terminal deoxynucleotidyl transferase, kinases and phosphatases and DNA ligases.

Cloning Vectors: Definition and Properties. Plasmid vectors: pBR322 and pUC18. Bacteriophage lambda and M13 vectors. Cosmids, BACs, YACs. Expression vectors: Baculovirus vectors, mammalian SV40 vectors. Cloning host- *Escherichia coli*

Unit II: Methods in molecular cloning

12 hrs.

Gene screening: Isolation of DNA. Separation of DNA by agarose gel electrophoresis. DNA transfer methods. Blotting techniques, DNA Hybridisation methods-Colony and Plaque hybridization. Sanger's method of DNA sequencing and Next Generation sequencing. PCR-types and applications.

Applications of Recombinant DNA Technology: Genomic and cDNA libraries: construction and uses. Products of recombinant DNA technology: recombinant insulin, hGH, recombinant vaccines and Bt Cotton. Gene therapy and RFLP, DNA finger printing

Unit III: Microbes in sustainable agriculture

12 hrs.

Biofertilization: Biofertilizers-definition, types-Nitrogen fixing and Phosphate solubilizing. Mass production, mode of application, advantages and limitations of bacterial inoculants (*Rhizobium*, *Azotobacter*, *Azospirillum*) and cyanobacterial inoculants. Role of *Frankia* and VAM in soil fertility.

Biological control: Biopesticides: definition. Mode of action, factors influencing, target pests, advantages and limitations of bacterial, viral and fungal pesticides-. Microbial herbicides. Secondary agriculture biotechnology- silage, biomanure and biofuels.

Unit IV: Plant pathology

12 hrs.

Introduction to plant pathology: Historical perspectives. Classification and spread of plant diseases. Virulence factors of pathogens in disease development. Defense mechanisms in plants- structural and biochemical. Horizontal and vertical resistance.

Plant diseases: Study of symptoms, etiology, epidemiology and management of diseases caused by fungi (tikka disease of Groundnut, blast disease of Paddy, powdery mildew of Mulberry), bacteria (citrus canker, angular leaf spot of Cotton, Sandalwood spike), viruses (bunchy top of Banana, Papaya ring spot) and viroid (Potato spindle tuber disease). Post harvest pathology.

IV SEMESTER

GENETIC ENGINEERING AND AGRICULTURAL MICROBIOLOGY

PRACTICAL-IV

(4hrs/week)

1. Visualization of DNA by agarose gel electrophoresis.
2. Isolation of plasmid DNA
3. Preparation of master and replica plate.
4. Designing of primers for DNA amplification.
5. Demonstration of amplification of DNA by PCR.
6. Interpretation of sequencing gel electropherogram.
7. Demonstration of blue-white screening of recombinants.
8. Study of antagonism between microorganisms.
9. Seed health testing by standard blotter method.
10. Isolation and characterization of *Rhizobium* from root nodules
11. Study of *Anabaena* from *Azolla*
12. Study of VAM, biofertilizers and biopesticides.
13. Gram staining of citrus canker specimen
14. Mounting of fungal disease specimens- powdery mildew of Mulberry and tikka disease of Groundnut.
15. Study of pBR322, agarose gel electrophoresis, Microinjection, Southern blotting, PCR, colony hybridization products of recombinant DNA technology and plant diseases through micrographs / schematic representations.

Text Books / References

1. Brown, T. A. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark, D. P. and Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA.
3. Gardner, E. J., Simmons, M. J. and Snustad, D. P. (2008). Principles of Genetics. 8th Ed. Wiley-India.
4. Krebs, J., Goldstein, E. and Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
5. Mehrotra, R.S., Plant Pathology, Tata Mc Graw Hill Publications Limited, New Delhi.
6. Michael, J. Pelczar, Jr. E.C.S. Chan, Moel: Microbiology, Mc Graw Hill Book Company, New York).
7. Powar and Dagainwala (1996). General Microbiology, Vol 1. Himalaya Publishing House, Bombay.
8. Powar and Dagainwala (1996). General Microbiology, Vol 2. Himalaya Publishing House, Bombay.
9. Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Black well Publishing, Oxford, U.K.
10. Primrose, S. B. and Twyman, R. M. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
11. Rangaswamy, G. and Bagyaraj, D.J.(2001), Agricultural Microbiology, 2nd ed. Prentice hall of India pvt.ltd., New Delhi.
12. Sambrook, J. and Russell, D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
13. Subba Rao, N.S.(2002) Soil Microorganisms and Plant Growth 4th ed., Oxford and IBH Pub.Co.Pvt.ltd., New Delhi.
14. Subha Rao, N.S., 1988. Biofertilizers in Agricultural 2nd ed.Oxford and IBH Pub.Co., New Delhi.
15. Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.

IV SEMESTER

ELE-2: PLANT AND ANIMAL MICROBIOME

ELECTIVE-2

48 (3hrs./week)

After the successful completion of the course, the student will be able to;

CO1. Understand the concepts of microbiome.

CO2. Learn about dynamic relationships between plant and microorganisms

CO3. Understand concepts of diversity of microbiome across different animal species, ecological niches and developmental stages.

CO4. Understand the aspects of human microbiome.

Unit I: Introduction to Microbiome

12 hrs.

Microbiome- Definition and scope. Microbiome in early life. Host-associated microbiomes. Anatomical locations of microbiome in animals and plants. Culturing organisms of interest from the microbiome: bacterial, archaeal, fungal, viral and yeast. Extracting whole genomes from the microbiome to study microbial diversity. Symbiosis host-bacteria. Normal human microbiota and their role in health. Microbiome other than digestive system.

Unit II: Plant Microbiome

12 hrs.

Basics of plant microbiome. Dynamic relationships between plant and microorganisms. Plant microbiome and plant health. Use of plant microbiome interaction for nutrients uptake, nitrogen fixation, pollutants cleaning and soils/plants health improvement. Microorganisms for carbon sequestration. Plant microbiome in practice. Current techniques related to plant microbiome research. Future research about plant microbiome.

Unit III: Animal Microbiome

12 hrs.

Diversity of microbiome across different animal species, ecological niches and developmental stages. Gut microbiome of livestock, skin microbiome of reptiles, microbiome of earthworm and microbiome of honeybees. Rumen microbiome- Diversity and factor influencing the rumen microbiota. Establishment of rumen microbiota at birth. Fermentation in rumen. Rumen microbiome and methanogenesis. Molecular techniques and 'omic' approaches to understand rumen microbial function.

Unit IV: Human Microbiome

12 hrs.

Introduction to the human microbiome. The holobiont theory of evolution. Pre and post-natal microbiome. The gut microbiome. Dysbiosis and the gut microbiome. Antibiotics and the human microbiome. Diet and the human microbiome. Behavior and the microbiome (the gut brain axis). Probiotics, prebiotics synbiotics and the human microbiome. Drug metabolism by the microbiome. Human Microbiome Project. Fecal microbiota transplantation.

Text Books / References

1. Angela E Douglas, (2018). Fundamentals of Microbiome Science: How Microbes Shape Animal Biology. Princeton University Press. 248pp.
2. Cieslak, A., M. Szumacher-Strabel, A, Stochmal & W. Oleszek. 2013. Plant components with specific activities against rumen methanogens. – *Animal*, 7(s2): 253-265.
3. Edward Ishiguro, Natasha Haskey and Kristina Campbell, (2018). Gut Microbiota. 1st edition. 2008pp.
4. Emeran Mayer, (2018). The Mind-Gut Connection: How the Hidden Conversation within our bodies impacts our mood, our choices, and our overall Health. Harper Wave, 336pp.
5. Giulia Enders and Jill Enders, (2018). Gut: The Inside Story of Our Body's Most Underrated Organ (Revised Edition). Greystone Books, 304pp.
6. Hart, K. J., D. R. Yañez-Ruiz, S. M. Duval, N. R. McEwan & C. J. Newbold. 2008. Plant extracts to manipulate the rumen. – *Animal Feed Science and Technology*, 147(1-3): 8-35
7. Hungate, R. E. 1966. The rumen and its microbes. – Academic Press, New York, USA, 533 pp
8. Natalia V Beloborodova, (2021). Human Microbiome. IntechOpen, 166pp. Gregory, P. H. (1961). The Microbiology of the atmosphere. Interscience Publishers, New York.
9. Tille, P. (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby.

IV SEMESTER

SEC-1: MICROBIAL AND MOLECULAR TECHNIQUES

SKILL PAPER-1

32 (2hrs./week)

After the successful completion of the course, the student will be able to:

CO1. Understand the microbial techniques

CO2. Know about molecular techniques

Unit I: Microbial Techniques

16 hrs.

Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards. SOP for various equipment in the QC Lab. Sterility check, Bio-burden and Logbook maintenance.

Handling and calibration of lab equipment- weighing balance, micropipette, centrifuge, pH meter, water bath and colony counter. Preparation of normality, molarity and buffer solutions.

Types of culture media and maintenance of culture: Preparation of various culture media.

Cultivation of bacteria, fungi, actinomycetes and algae. Isolation and preservation of pure culture. Morphological and biochemical characterization of bacteria.

Unit II: Molecular Techniques

16 hrs.

Centrifugation and Chromatography: Principles of centrifugation and ultracentrifugation techniques and its applications. Partition, adsorption, ion exchange, exclusion and affinity chromatography- principle and applications.

Spectrophotometry and Electrophoresis: UV and visible spectrophotometric techniques principle and application. Electrophoretic technique: agarose and polyacrylamide gel electrophoresis- components, working principle and applications.

Radiobiology: Radioactivity, radioisotopes. Radioisotope dilution technique. Radioisotope technique: Autoradiography-.working principle and uses. Radiation safety and protection.

Text Books / References

1. Aurora Blair. Laboratory Techniques & Experiments in Biology. Intelliz Press
2. Beckner, W. M., Kleinsmith, L. J. and Hardin, J. (2000). The world of cell. IV edition Benjamin/Cummings
3. Black J. G. (2002). Microbiology- Principles and Explorations. JohnWiley&SonsInc. NewYork,
4. Cambridge University Press.
5. Colin A. Ramsden (2014). "Analytical Molecular Biology". Oxford University Press.
6. Cowan and Steel's Manual for the Identification of Medical Bacteria. G. I. Barrow (Editor), R. K. A. Feltham (Editor) 3rd Edition. 2004
7. John M. Walker and Ralph Rapley (2014). "Molecular Biomethods Handbook". HumanaPress.
8. Maheswari, D. K. (2010). Practical Microbiology. S Chand publications
9. Michael Lufaso (2016). "Laboratory Skills for Science and Medicine: An Introduction". CRCPress.
10. Murphy, D. B. (2001). Fundamental of Light Microscopy &Electron Imaging.1st Edition. Wiley-Liss.
11. Murphy, D. B. (2001). Fundamental of Light Microscopy &Electron Imaging.1st Edition. Wiley-Liss.
12. Plummer, D. T. (1987). An Introduction to Practical Biochemistry. McGraw Hill Publication
13. Pranav Kumar (2016). Fundamentals and Techniques of Biophysics and Molecular Biology
14. Prescott, M. J., Harley, J. P. and Klein, D. A. (2002). Microbiology. 5th Edition WCB Mc GrawHill, New York,
15. Wilson and Walker(2000). Principles and Techniques in Practical Biochemistry. 5th Edition

JSS COLLEGE OF ARTS,COMMERCE AND SCIENCE
(An Autonomous College of University of Mysuru)
Re-accredited by NAAC with 'A⁺' grade Ooty road,
Mysuru-570025,Karnataka



ESTD-1964

DEPARTMENT OF MICROBIOLOGY

SYLLABUS

**NATIONAL EDUCATION POLICY
FOR
B.Sc. PROGRAMME**

Microbiology & Biotechnology

Microbiology & Biochemistry

(W.E.F.2025–2026)

JSSCOLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSURU-25 DEPARTMENT OF MICROBIOLOGY
PROFORMA OF INSTRUCTIONS AND EXAMINATION FOR B.Sc. PROGRAMME IN MICROBIOLOGY (NEP)

DURATION OF THE COURSE: 4 YEARS (8 SEMESTER)

PROGRAMME: B Sc Mb & Bt, (2025-26) PROGRAMME CODE: BScMbBt41

BSc Microbiology (Basic/ Hons.)

Year	Semester	Course Category	Title of the paper	Lecture+ Practicals hours per week	No. of credits			Total credits	Total hours		Duration of Exam (Hrs.)	Maximum Marks in Exam/Assessment			Total
					L	T	P		Th	Pr		IA(Theory)			
												C-1	C-2	C-3	
III BSc	V	DSC-V:TheoryFSE500	Microbial Genetics	04	4:0:0			04	60		2½	20	20	60	100
		DSC-V:Pract-V-FSE501P	Microbial Genetics	04	0:0:2			02		60	3	10	10+5(R)	25	50
		DSC-VI:TheoryFSE502	Food Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VI: Pract-V-FSE503P	Food Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
		SEC-I:Theory	Microbial and Biochemical Techniques	02	2:0:0			02	30		2½	10	10	30	50
		SEC-I; Practicals	Microbial and Biochemical Techniques	02	0:0:1			01		30	3	10	10+5(R)	25	50
	VI	DSC-VII: TheoryFSF500	Immunology and Medical Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VII: Pract-V-FSF501P	Immunology and Medical Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
		DSC-VIII:TheoryFSF502	Industrial Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VI: Pract-V-FSF503P	Industrial Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
		Internship	Internship	02				02	3-4weeks (Report & Viva)			25		25	50

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSURU-25 DEPARTMENT OF MICROBIOLOGY
PROFORMA OF INSTRUCTIONS AND EXAMINATION FOR B.Sc. PROGRAMME IN MICROBIOLOGY (NEP)
DURATION OF THE COURSE: 4 YEARS (8 SEMESTER)
PROGRAMME: BSc Mb & Bc, (2025-26) PROGRAMME CODE: BScMbBc42
BSc Microbiology (Basic/ Hons.)

Year	Semester	Course Category	Title of the paper	Lecture+ Practicals hours per week	No. of credits			Total credits	Total hours		Durationof Exam (Hrs.)	Maximum Marks in Exam/Assessment			Total
					L	T	P		Th	Pr		IA(Theory)			
												C-1	C-2	C-3	
III BSc	V	DSC-V:TheoryFSE500	Microbial Genetics	04	4:0:0			04	60		2½	20	20	60	100
		DSC-V:Pract-V-FSE501P	Microbial Genetics	04	0:0:2			02		60	3	10	10+5(R)	25	50
		DSC-VI:TheoryFSE502	Food Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VI: Pract-V-FSE503P	Food Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
		SEC-I:Theory	Microbial and Biochemical Techniques	02	2:0:0			02	30		2½	10	10	30	50
		SEC-I; Practicals	Microbial and Biochemical Techniques	02	0:0:1			01		30	3	10	10+5(R)	25	50
	VI	DSC-VII: TheoryFSF500	Immunology and Medical Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VII: Pract-V-FSF501P	Immunology and Medical Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
		DSC-VIII:TheoryFSF502	Industrial Microbiology	04	4:0:0			04	60		2½	20	20	60	100
		DSC-VI: Pract-V-FSF503P	Industrial Microbiology	04	0:0:2			02		60	3	10	10+5(R)	25	50
Internship		Internship	02				02	3-4weeks (Report & Viva)			25		25	50	

Name of the Degree Program: B. Sc.
Discipline Core: Microbiology
Starting year of implementation: 2021-22

Program Outcomes: Competencies need to be acquired by the candidate securing B.Sc. (Basic) or B. Sc. (Hons.)

By the end of the program the students will be able to:

1. Knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.
2. Understand the distribution, morphology and physiology of microorganisms and Demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. Exploring the microbial world and analyzing the specific benefits and challenges.
6. Applying the knowledge acquired to undertake studies and identify specific remedial measures for the challenges in health, agriculture, and food sectors.
7. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
8. Understanding biochemical and physiological aspects of microbes and developing broader perspective to identify innovative solutions for present and future challenges posed by microbes.
9. Understanding and application of microbial principles in forensic and working knowledge about clinical microbiology.
10. Demonstrate the ability to identify ethical issues related to recombinant DNA technology, GMOs, intellectual property rights, biosafety and biohazards.
11. Demonstrate the ability to identify key questions in microbiological research, optimize research methods, and analyse outcomes by adopting scientific methods, thereby improving the employability.
12. Enhance and demonstrate analytical skills and apply basic computational and statistical techniques in the field of microbiology.

Assessment:

Weight age for assessments (in percentage)

Type of Course	Formative Assessment/ IA	Summative Assessment
Theory	40%	60%
Practical	50%	50%
Projects	40%	60%
Experiential Learning (Internships/MOOC/Swayametc.)	30%	70%

FormativeAssessment:40%	
Assessment Occasion/type	Weightage in Marks
C1=IA -1+Assignments/Visits	10%+ 10%= 20%:20Marks
C2=IA-2+Assignment/Group Discussion	10%+ 10= 20%:20Marks
Total	40%:40Marks

Total Marks for each course = 100%

Formative Assessment (C1+C2)=40%

Semester End Examination (C3)= 60%

MICROBIAL GENETICS

60 (4hrs./week)

Course Outcomes (COs):

After the successful completion of the course, the student will be able to;

CO1. Understand the experimental evidences to prove DNA as genetic material.

CO2. Differentiate various method of recombination in bacteria.

CO3. Compare gene interaction in viruses and fungi.

CO4. Understand concepts involved in replication, transcription, translation in bacteria and Outline regulatory mechanisms in bacteria to control cellular processes

Content of Course 5 : Theory : Microbial Genetics**60Hrs.****Unit 1: DNA as genetic material and Bacterial genetics****15Hrs.**

DNA as a genetic material : Griffith experiment of Transformation ,Avery, MacLeod and McCarty experiment, Hershey and Chase experiment to prove DNA carries the genetic information. Fraenkel-Conrat experiment to prove RNA as genetic material. Structure and organization of chromosomes in prokaryotes. Plasmid-types, Transposons in Prokaryotes. **Bacterial genetics:** Mechanism of genetic exchange in bacteria: Bacterial transformation- Principle and Types of transformation mechanisms found in prokaryotes. Bacterial Conjugation :U- tube experiment, properties of the F plasmid, $F^+ \times F^-$ conjugation, $F' \times F^-$ conjugation, $Hfr \times F^-$ conjugation, Transduction :Generalized and specialized transduction.

Unit 2 : Genetic Material and Replication and Transcription of DNA**15Hrs.**

Genetic Material: Chemical basis of heredity, Watson and Crick model of DNA, DNA types, RNA-types, structure, importance. Modern concept of gene-cistron, muton, recon. **DNA Replication:** Replicon, Enzymes and proteins involved in DNA replication; DNA polymerases, DNA ligase, primase, telomerase. General mechanism of replication. Models of DNA replication including rolling circle, Θ (theta) mode of replication.

Transcription: Structure of bacterial RNA polymerase, Promoter concept, Recognition of Promoters and DNA melting, Transcription bubble ,Stages of transcription-initiation elongation and termination. Transcriptional attenuation.

Unit 3 : Gene expression and Regulation**15Hrs.**

Gene expression: Genetic code- features, Wobble hypothesis. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in prokaryotes. Post translational modifications of proteins. Protein maturation and secretion-protein splicing ,molecular chaperones.

Gene regulation: Regulatory mechanisms in bacteria. Operon concept, polycistronic mRNA. *lac* operon- negative inducible, allolactose, structure of *lac* repressor, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon. Regulation by *lac* repressor and CAP.*trp* operon regulation–repressor control and attenuator control.

15Hrs.

Unit 4 : Genetics of Viruses and Fungi and Mutation

Genetics of Viruses : Genetic recombination in phages, Heterozygosity in phages. Temperate phage and prophage, Non-genetic interaction of viral gene products- Complementation, Phenotypic mixing, Genotypic mixing and interference.

Genetics of Fungi: Life cycle of *Neurospora*, Tetrad analysis, unordered tetrad analysis in yeast, ordered tetrad analysis in *Neurospora*, two point and three point test cross.

Mutation : Nature and types, Mutagenic agents: physical and chemical mutagens. Damage and repair of DNA : Photoreactivation and SOS repair, Ames test.

Pedagogy : Lectures, Seminars, Industry/ Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion / type	Marks
C-1 Theory test	10
Assignments / Visits	10
C-2 Theory test	10
Assignments / Group Discussion	10
Total	40
Formative Assessment as per guidelines are compulsory	

Course Code: FSE501P

**V SEMESTER
Microbial Genetics**

PRACTICAL-V

(4hrs/week)

1. Micropipeting: Moving very small volumes very accurately.
2. Isolation of DNA from microbial source.
3. Estimation of DNA by Diphenylamine method.
4. Isolation of coliphages from sewage.
5. Isolation of antibiotic resistant mutant by gradient plate method.
6. Demonstration of Ames test.
7. Preparation of master and replica plates.
8. Study survival curve of bacteria after exposure to ultraviolet (UV) light.
9. Preparation of competent cells for bacterial transformation.
10. Demonstration of bacterial conjugation by plate mating method.
11. Determination of purity of DNA.
12. Visualization of genomic DNA by agarose gel electrophoresis.
13. β -galactosidase activity assay in Yeast.
14. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
15. Study of Griffith's experiment, conjugation, transduction, plasmid DNA, T4 phage, ordered tetrad analysis in *Neurospora*, Watson and Crick model of DNA, tRNA, semi-conservative replication of DNA, bacterial RNA polymerase, transcription, translation and *lac* operon through micrographs / schematic representations

Pedagogy : Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion / type	Marks
Class Records	05
C-1Test	10
C-2 Test / Attendance	10
Total	25
Formative Assessment as per guide lines are compulsory	

TextBooks/ References

1. Maloyetal.,1994 .Microbial Genetics by Jones and Bartlett Publishers.
2. J.W.Dale,1994. Molecular Genetics of Bacteria by John Wiley and Sons.
3. Streip sand Yasbin,1991. Modern Microbial Genetics by Niley Ltd.
4. J. D. Watson, N. H. Hoppkins, J. W. Roberts, J. A. Steitz and A. M. Weiner. 1987. Molecular Biology of the Gene 4th Edition by, Benjamin / Cummings Publications Co.Inc. California.
5. Lewin ,2000.GeneVII by Oxford University Press.
6. Bacterial and Bacteriophage Genetics.4th Editions by Birge.
7. Microbial Genetics by Frefielder. 4thEdition.
8. Organization of Prokayotic Genome.1999byRobertL.Charlebois,ASM Publications.
9. Molecular Genetics of Bacteria,1997byLarry,Snyder and Wendy,Champness,ASM
10. James,D.Watson,Tania A .Baker,StephenP.Bell, AlexanderGann ,Michael Levine, Richard Losick. Molecular Biology of the Gene, 7th edition. 2017
11. Freifelder's Essentials of Molecular Biology.George M Malacinski,4thed.2015
12. Alberts Bruce, Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell.5th Edition, Taylor and Francis.NewYork,USA.
13. Tropp,B.E.(2012)Molecular Biology: Genesto Proteins.4rdEdition, Jones&Bartlett, Learning, Burlington, MA
14. Allison A .Elizabeth (2012) Fundamental Molecular Biology,2ndEdition.J Willeyand Sons, Hoboken, New Jersey
15. Frederick, M., Ausubel, Roger Brent, Robert, E., Kingston, David, D., Moore, J. G. Seidman, John A.Smith, Kevin Struhl (2003). Current Protocols in Molecular Biology. John Wiley & Sons, New York, United States.
16. Sambrook, J. F. and Russell, D. W. (2001). Molecular Cloning: a Laboratory Manual.3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
17. Yilmaz, M., Ozic, C., Gok, İ. (2012). Principles of Nucleic Acid Separation by Agarose Gel Electrophoresis. Gel Electrophoresis - Principles and Basics, Dr. Magdeldin S (Ed.), ISBN: 978-953-51-0458-2, InTech.

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1. Understand the association of microbes in food and the quality testing of food

CO2. Understand the preservation and food safety protocols

CO3 .Understand the methods of spoilage of food and the diseases associated with it.

CO4. Learn the properties of milk and the types of preservation of milk.

CO5.Learn the types of fermented food and dairy products and its significance

Content of Course 6: Theory: Food Microbiology**60Hrs.****Unit1 : Production of food crops and their diseases****15Hrs.**

Role of microbes in food crops production: Biofertilizers : Definition, Mass production, mode of applications, advantages and limitations of *Rhizobium* , *Azotobacter*, *Azospirillum*, cyanobacterial fertilizers. Role of *Frankia* and VAM in soil fertility. Biopesticides: Definition, types- bacterial, viral and fungal-mode of action, factors influencing, target pests. Microbial herbicides.

Diseases of food crops: Study of symptoms, etiology, epidemiology and management of diseases caused by fungi (Tikka disease of groundnut, blast disease of paddy, Red rot of sugarcane), bacteria (Citrus canker ,Bacterial blight of rice),viruses (Bean mosaic ,Papaya ring spot) and viroid (Potato spindle tuber disease).Post-harvest diseases.

Unit 2 : Microbial quality of air and water for food processing and disposal of waste water**15Hrs.**

Bio aerosols in food: Air borne microbes and their impact on food. Bioaerosol sampling: Vertical clinder spore trap, Hirst spore trap, Rotorod sampler, Andersen sampler, impingers and filtration. Control of bioaerosols- UV light, HEPA filters, desiccation, Incineration.

Water quality in food safety : Water sample collection, methods to detect potability of water samples :presumptive /MPN tests ,confirmed and completed tests for faecal coliforms, SPC, IMViC reactions, membrane filter technique .Water borne pathogens, Control of water borne pathogens –Precipitation ,filtration ,chemical disinfection ,UV light. **Disposal of waste water in food industries:** Microbiological characteristics of wastewater. Waste water treatment- primary (screening, coagulation and sedimentation), secondary (trickling filter ,oxidation pond) tertiary (reverse osmosis,ion exchange). Methods of solid waste disposal (composting and biogas).BOD and COD.

Unit 3: Food spoilage, Infection and Preservation**15Hrs.**

Microbes and food: Food as a substrate for microorganisms- Intrinsic and extrinsic parameters affecting the growth of microbes. **Spoilage:** Sources of food contamination, Principles of food spoilage, Spoilage of meat and poultry, Fish and sea foods. Spoilage cereals, fruits and vegetables. Spoilage of canned food. Food borne infection and intoxication- Salmonellosis, Listeriosis, Botulism and Aflatoxicosis.

Food preservation: Principles of food Preservation. Methods of preservation-Physical (temperature, drying, irradiation, HPP), chemical (Class I and Class II). Bio preservation. Canning. Food Packaging- Types of packaging materials, properties and benefits. Food sanitation and control-Good Hygiene practices, GLP, GMP, HACCP, FSSAI, FDA and BIS in brief.

Unit4: Microbiology of milk and fermented food products**15Hrs.**

Dairy Microbiology: Composition of milk. Sources of contamination of milk. Biochemical changes of milk- souring, gassy fermentation, proteolysis, lipolysis, ropiness. Microbiological analysis of milk- Rapid platform tests (COB, Phosphatase test, DMC), SPC and Reduction tests. Preservation of milk and milk products- Pasteurization, dehydration, sterilization. Packing of milk and dairy products. Starter culture- types and role.

Fermented foods: Fermented milk (Cheese- types and production of Cheddar, Tofu, Yoghurt, Acidophilus milk), vegetable (sauerkraut, pickles) Meat (sausage) and fish (fish sauce). Beverages-kombucha. Microbes as food-SCP, SCO. Prebiotics, Probiotics, Synbiotics and Neutraceuticals

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/type	Marks
C-1 Theory test	10
Assignments/ Visits	10
C-2Theorytest	10
Assignments/Group Discussion	10
Total	40
Formative Assessment as per guidelines are compulsory	

PRACTICAL-VI

1. Isolation and characterization of *Rhizobium* spp. Associated with root nodules.
2. Microscopic observation of diseased specimen of food crops: Citrus canker, Downy mildew of grapes, Tikka disease of groundnut and Potato spindle tuber disease
3. Determination of microbial contamination of air by passive sampling method.
4. Standard analysis of water samples and Determination of MPN.
5. Biochemical differentiation of *Enterobacteriaceae* isolates by IMViC reactions.
6. Determination of bacteriological quality of water by H₂S paper strip test.
7. Measurement of Biochemical Oxygen Demand (BOD) of food processing wastewater.
8. Estimation of total solids of waste water from food processing unit.
9. Isolation and identification of indigenous wine yeast and its use in alcohol fermentation
10. Determination of mesophilic aerobic count in foods and expression of count in log CFU/g
11. Turbidity index for the detection of efficiency of sterilization of milk.
12. Methylene blue and Resazurin reduction test for assessing the raw milk quality.
13. Laboratory scale production of yogurt and its sensory evaluation.
14. Culturing of *Spirulina* sp. as single cell protein.
15. Demonstration of air samplers, display of photographs of water purification process and wastewater treatment.

Note: Visit to agriculture research station, water/sewage treatment plant & food industry

Pedagogy : Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/type	Marks
Class Records	05
C-1 Test	10
C-2 Test/Attendance	10
Total	25
Formative Assessment as per guidelines are compulsory	

Text Books/ References

1. Rangaswamy, G. and Bagyaraj, D.J.(2001),AgriculturalMicrobiology,2nded.Prentice hall of India pvt.ltd., New Delhi.
2. Rao,M.N. and Datta,A.K.(1987).Waste Water Treatment .Oxford and I.B.H.
3. Rheinhermer,G.(1986).AquaticMicrobiologyJhonWielyandsons,Newyork.
4. SubhaRao,N.S.,1988.Biofertilizers in Agricultural2nded.OxfordandIBHPub.Co.,New Delhi.
5. Daniel Environmental Microbiology.
6. Grant, W. D. and P.E,Long:1981 Environmental Microbiology,T homson Litholtd.
7. Mehrotra, R.S., PlantPathalogy, Tata McGraw Hill Publications Limited, New Delhi.
8. Michael, J.Pelczar, Jr.E. C. S. Chan, Moel: Microbiology, Mc Graw Hill Book Company ,New 40ork).
9. Mitchell, R.(1992),Introduction to Environmental Microbiology,Prentice HallInc, Englewood Cliffs.
10. Adams, M. R. and Moss, M. O. (1995)Food Microbiology. Royal Society of Chemistry ,Cambridge University Press.
11. Frazier&Westhoff,D.C.(1995)FoodMicrobiologyTataMcGrawHillPub.Company Ltd.,New Dehli.
12. Jay, J.M.(1985).Modern Food Microbiology. CBS Publishers and distributors, New Delhi.
13. DoyleM.P.andBeuchatL.R.(2007).FoodMicrobiology-Fundamentals.Frontiers,ASM Press.
14. GarbuttJ.(1997).Essentials of Food Microbiology, Arnold-International Students edition, London. 8. Marriott N. G. and Gravani R. B. (2006).
15. ThomasJ.,Matthews, Karl;Kniel,KalmiaE(2017),FoodMicrobiology:AnIntroduction, American Society for (ASM).
16. DeakT. and Beuchat L.R.(1996).Hand Book of Food Spoilage Yeasts, CRC Press, New York.

V SEMESTER

After the successful completion of the course, the student will be able to:

CO2: Understand principles which underlie sterilization of culture media, glassware and plastic ware to be used for microbiological work.

CO4: Handle several separation techniques which may be required to be handled later as microbiologists.

Unit1:MicrobialTechniques

Handling and calibration of lab equipment- weighing balance, Micropipette Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions.

Cultivation of Bacteria, Fungi, Actinomycetes and Algae. Isolation and preservation of pure culture. Morphological and biochemical characterization of bacteria.

Centrifugation: Principles of Centrifugation and Ultracentrifugation techniques and its applications. **Chromatography:** Principle and techniques with applications (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Electrophoretic technique (agarose and polyacrylamide gel) its components, working and applications.

Spectrophotometry and Radiobiology: Principle, mechanism and application of instruments used in Spectrophotometric techniques (UV and visible). Radiobiological techniques – characters of radioisotopes, autoradiography, Radioisotope dilution technique and pulse chase experiments. Basic principles & Law of absorption and radiation and its application.

V SEMESTER

SEC- Microbial and Biochemical Techniques (4hrs/week)

PRACTICAL-V

1. Usage and maintenance of basic equipment of microbiology lab: Principles, calibrations, and SOPs of balances, pH meter, Autoclaves, Laminar flows, Biosafety cabinets, Microscopes, Homogenizers and Magnetic stirrers.
2. Cultivation of microorganisms: (i) Bacterial cultivation: (a) Streak-plate method (*E.coli*, *Staphylococcus aureus*) Streaking with inoculation loop. Streaking with toothpick. (b) Pour-plate method (*E.coli*).
3. Maintenance of microorganisms (slant culture, stab culture, glycerol stocks) (ii) Fungal cultivation (a) Yeast (*Saccharomyces cerevisiae*) Moulds (*Penicillium notatum*, *Aspergillus niger*)
4. Estimation of CFU count by serial dilution-spread plate method/pour plate method.
5. Study of colony characteristics on nutrient agar
6. Biochemical characterization of bacteria:
 - a. Sugar utilization test(minimal medium + sugar)
 - b. Sugar fermentation test (peptone water method,Ammonium salts ugar method
 - c. IMViC reactions
 - d. Enzyme detection–Amylase ,Gelatinase ,lipase, caseinase, Catalase ,and Oxidase
 - e. Oxidative-fermentative test,arginine hydrolysis,ornithine,lysine decarboxylase, nitrate, nitrite reduction
7. Separation of mixtures by paper/thin layer chromatography.
8. Demonstration of column packing in any form of column chromatography.
9. Separation of protein mixtures by any form of chromatography.
10. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis(PAGE).
11. Determination of absorption max for an unknown sample and calculation of extinction coefficient.
12. Separation of components of a given mixture using a laboratory scale centrifuge.

Text Books/ References

1. Michael Lufaso(2016)."Laboratory Skills for Science and Medicine:An Introduction". CRCPress.
2. ColinA. Ramsden(2014)."Analytical MolecularBiology".OxfordUniversityPress.
3. JohnM. Walker and Ralph Rapley (2014)."Molecular Bio methods Handbook". Humana Press.
4. WilsonandWalke,r(2000).PrinciplesandTechniquesinPracticalBiochemistry.5thEdition
5. Cambridge University Press.
6. Murphy, D.B.(2001).Fundamental of Light Microscopy&ElectronImaging.1st Edition. Wiley-Liss.
7. Murphy, D.B.(2001).Fundamental of Light Microscopy&ElectronImaging.1st Edition. Wiley-Liss.
8. PranavKumar,(2016).FundamentalsandTechniquesofBiophysicsandMolecularBiology
9. AuroraBlair.LaboratoryTechniques&ExperimentsinBiology.IntellizPress
10. Plummer,D.T.(1987).AnIntroductiontoPracticalBiochemistry.McGrawHillPublication
11. Beckner,W.M.,Kleinsmith,L.J.andHardin,J.(2000).Theworldofcell.IVedition Benjamin/Cummings
12. Prescott,M.J.,Harley,J.P.andKlein,D.A.(2002).Microbiology.5thEditionWCB McGraw Hill, New York,
13. Black J.G.(2002). Microbiology-Principles and Explorations. John Wiley & Sons Inc. New York,
14. Maheswari, D.K.(2010).Practical Microbiology. S Chand publications
15. CowanandSteel'sManualfortheIdentificationofMedicalBacteria.G.I.Barrow(Editor), R.K.A. Feltham(Editor)3rdEdition.2004

Course Outcomes (COs):

After the successful completion of the course, the student will be able to:

CO1: Gain a preliminary understanding about various immune mechanisms.

CO2: Familiarize with immunological techniques and sero-diagnosis of infectious diseases

CO3: Understand pathogenic bacterial infections, symptoms, diagnosis and treatment

Content of Course 7: Immunology and Medical Microbiology**60Hrs.****Unit1:Introduction to Immune system****15Hrs.**

Immune system: Historical perspective of immunology. Immunity-Definition and types. Cells and organs of immune system: B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoid organs-Bone marrow and Thymus. Secondary lymphoid organs-Spleen and Lymphnodes. Lymphoid tissues-MALT and GALT.

Antigen and Antibody: Antigen-Definition, properties and types. Immunogenicity and antigenicity, epitopes, haptens. Degree of foreignness, molecular weight, degradability. Adjuvants and their importance. Antibody: Definition, Basic structure of antibody, Structure and functions of different types of antibodies (IgG, IgA, IgM, IgD and IgE). Antigenic Determinants on immunoglobulins: Isotype, allotype and idiotype.

Unit2:Antigen-antibody interactions and Hypersensitive reactions**15Hrs.**

Antigen-antibody reactions: Definition, salient features, antibody affinity and avidity, cross reaction. Agglutination reactions: Hemagglutination-blood grouping, Immunoprecipitation: Radial (Mancini) and double (Ouchterlony) immunodiffusion and Immunoelectrophoresis. Complement mediated opsonization, complement fixation test. Immunotechniques: ELISA, Radio immunoassay and Immunofluorescence.

Hypersensitive reactions: Classification, antibody mediated hypersensitivity; Type I (Ig E), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity Type IV (DTH). Auto immune diseases and Transplantation Immunology in brief. Immuno prophylaxis –Vaccines –Types –Killed, Live attenuated and Toxoid with an example each. National Immunization Schedule and Mission Indradhanush.

Unit3 : Host-pathogen interaction and Medical Bacteriology**15Hrs.**

Pathogen interaction: Normal microflora of human skin, oral cavity, gastrointestinal tract, urogenital tract and their importance. Host pathogen interaction: Definitions-Infection, Invasion, Pathogenicity, Virulence, Attenuation, Exaltation,

Toxigenicity, Carriers and their types. Infection-types of infection, modes of transmission of infection, portal of entry of pathogen. Sample collection, transport and diagnosis.

Medical Bacteriology: Symptoms, mode of transmission, prophylaxis and control of the following- respiratory diseases caused by *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*. Gastrointestinal Diseases caused by: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, Others: *Treponema pallidum*, *Staphylococcus aureus*, *Clostridium tetani*.

Unit4 : Medical Virology, Parasitology and Mycology and Chemotherapy 15Hrs.

Medical Virology Parasitology and Mycology: Symptoms, mode of transmission, prophylaxis and control of Polio, Hepatitis-B, Rabies, Dengue, AIDS, Corona and Chikungunya. Malaria, Kala-azar, Amoebic dysentery. Fungal infections: Cutaneous mycoses- Tinea infections, Systemic mycoses- Histoplasmosis and Opportunistic mycoses- Candidiasis.

Antimicrobial agents: General characteristics and mode of action Antibacterial agents: Inhibitor of nucleic acid synthesis; Inhibitor of cellwall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Mechanism of action of antifungal agents: Amphotericin B, Griseofulvin; Antiviral agents: Acyclovir, Azidothymidine . Antibiotic resistance, MDR, XDR, MRSA, NDM-1

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/type	Marks
C-1Theorytest	10
Assignments/ Visits	10
C-2Theorytest	10
Assignments/Group Discussion	10
Total	40
Formative Assessment as per guidelines are compulsory	

Course Code: FSF501P

VI SEMESTER

IMMUNOLOGY AND MEDICAL MICROBIOLOGY (4hrs/week)

PRACTICAL-VII

1. Identification of human blood groups.
2. Perform WBC of the given blood sample using haemocytometer.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Demonstration: separate serum from the blood sample.
5. Perform immune diffusion by Ouchterlony method.
6. Demonstration of Single Radial Immuno Diffusion.
7. Widal test/ HCG test
8. RPR test/ VDRL test.
9. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, Mac Conkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS agar.
10. Study of bacterial flora of skin by swab method
11. Identify bacteria (*E. coli*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
12. Cultural, morphological and biochemical characteristics of *Staphylococcus*.
13. Study of various stages of Malarial parasite in RBCs using permanent mounts
14. Perform antibiotic sensitivity by Kirby-Bauer method
15. Study symptoms of the diseases with the help of photographs : Polio, Rabies, Chikungunya , AIDS, Histoplasmosis , Candidiasis and Athlete's foot.

Note: Visit to pharmaceutical and pathology laboratory(Optional).

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/type	Marks
Class Records	05
C-1Test	10
C-2 Test/Attendance	10
Total	25
Formative Assessment as per guidelines are compulsory	

Text Books/ References

1. Ananthanarayan, R. and Paniker C.K.J. (2009). Textbook of Microbiology, 8th Edition, University Press, Publication.
2. Brooks, G.F., Carroll, K.C., Butel, J.S., Morse, S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
6. Delves, P., Martin, S., Burton, D., Roitt, I.M. (2006). Roitt's Essential Immunology. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
7. Goldsby, R.A., Kindt, T. J., Osborne, B.A. (2007). Kuby's Immunology. 6th edition W. H. Freeman and Company, New York.
8. Murphy, K., Travers, P., Walport, M. (2008). Janeway's Immunobiology. 7th edition Garland Science, Publishers, New York.
9. Peakman, M. and Vergani, D. (2009) Basic and Clinical Immunology, 2nd edition Churchill, Livingstone Publishers, Edinburgh.
10. Richard, C. and Geffrey, S. (2009). Immunology. 6th edition. Wiley Black well Publication.

Course Outcomes (Cos):

After the successful completion of the course, the student will be able to:

CO1 .Learn the over view of scope and importance of industrially important microbes.

CO2. Acquaint with different types of fermentation processes and equipment.

CO3. Acquire the knowledge of purification of value-added products.

CO4. Acquire knowledge on the concepts and terminology in genetic engineering.

CO5. Learn about principles involved in manipulating genes and DNA.

CO6. Familiar with various techniques used in genetic engineering.

Content of Course : Industrial Microbiology and Genetic Engineering **60Hrs.**

Unit1:Introduction to Industrial Microbiology **15Hrs.**

Introduction to Industrial Microbiology: Scope and concepts. Microorganisms of industrial importance: Selection criteria, Strain improvement and Preservation. Fermentor: Design and components of a bioreactor. Specialized bioreactors: Airlift bioreactors, fluidized bed reactor, packed bed reactors, Photo-bioreactors and membrane bioreactors .Sterilization of fermentor. Control of air, temperature and pH. Aseptic inoculation and sampling methods.

Fermentation media and process: Strategies formed in formulation, Natural and synthetic media. Production medium and Inoculum medium. Raw materials (Molasses and its types, corn steep liquor, sulphite waste liquor and whey). Buffers, Precursors, Inhibitors and Antifoamagents.Types of fermentation process: Submerged fermentation, Solidstate fermentation (Koji), Batch fermentation and continuous fermentation.

Unit2 : Downstream processing, General production strategies of microbial Products and Enzyme immobilization **15Hrs.**

Downstream processing- Definition, Stages in downstream processing. Methods of downstream processing: Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying and crystallization.

Microbial production of industrial products: Industrial production and uses of Ethyl alcohol, wine, Penicillin, Lactic acid, Citric acid, Amylase. Oyster mushroom cultivation.

Enzyme immobilization : Immobilized enzymes, Reversible immobilization-Adsorption, Irreversible immobilization –covalent coupling, entrapment, and copolymerization. Applications of Enzyme immobilization, Advantages and disadvantages of immobilized enzymes

Unit3:Genetic Engineering tools used in Strain improvement of microbes of Industrial importance **15Hrs.**

Introduction to genetic engineering: Definition, milestones in genetic engineering. Tools in genetic engineering: Restriction enzymes- Types, Mode of action, nomenclature, applications. DNA modifying enzymes and their applications: DNA polymerases, Methylases, Terminal deoxynucleotidyl transferase, Kinases, Phosphatases and Ligases.

Cloning Vectors and Cloning host: Cloning Vectors- Definition and Properties. Characteristics of cloning vectors. Plasmid vectors: pBR and pUC series. Bacteriophage lambda, Cosmids, BACs, YACs. Use of linkers and adaptors. Expression vectors: Baculovirus based vectors, mammalian SV40-based expression vectors. Cloning host-Cloning in *Escherichia coli* and *Saccharomyces cerevisiae*

Unit4: Genetic engineering techniques in industrial production of recombinant products **15hrs**

Techniques in genetic engineering: Isolation of DNA, restriction digestion and ligation of DNA, Agarose gel electrophoresis, Blotting techniques, DNA sequencing-Sanger's method. PCR techniques and applications. DNA transfer methods: Microinjection, Biolistic, Electroporation, Calcium phosphate mediated NA transfer. Identification and selection of recombinants: DNA hybridization, blue white selection, colony and plaque hybridization. Industrial production of recombinant products: Products of human therapeutic interest – insulin, hGH, antisense molecules. Bt Cotton, Bt Brinjal. Gene therapy, recombinant vaccines. Biological, ethical and social issues of gene cloning and IPR. Gene Library: Construction and application of cDNA and genomic libraries. Application of recombinant Microorganisms in basic research, industry, medicine, agriculture, environment.

Pedagogy: Lectures, Seminars, Industry/Institute Visits, Debates, Quiz, Project and Assignments

Formative Assessment for Theory	
Assessment Occasion/type	Marks
C-1 Theory test	10
Assignments/ Visits	10
C-2 Theory test	10
Assignments/ Group Discussion	10
Total	40
Formative Assessment as per guidelines are compulsory	

PRACTICAL-VIII

1. Preparation of natural and synthetic media used in industry.
2. Production of amylase by solid substrate fermentation.
3. Preservation of industrial important microbes with glycerol/soil.
Preparation of wine from grapes.
4. Preparation of alcohol using jiggery /molasses.
5. Estimation of citric acid produced from *Aspergillus niger* by titrimetric method
6. Estimation of % alcohol in a given sample by specific gravity bottle method
7. Cultivation and processing of edible Mushroom.
8. Preparation of buffers-TE, TAE and Lysis buffer.
9. Isolation of plasmid DNA from *Escherichia coli*.
10. Digestion of DNA with restriction enzymes.
11. Demonstration of amplification of DNA by PCR.
12. Demonstration of Southern blotting.
13. Demonstration of cloning of DNA inserts and Blue white screening of recombinants.
14. Study of specialized bioreactors, Microbial production of industrial products,
Cloning vectors, Techniques in genetic engineering and recombinant products as per theory.

Note: Visit to distilleries and molecular biology laboratory.

Pedagogy: Experiential learning, Problem solving, Project

Formative Assessment for Practical	
Assessment Occasion/type	Marks
Class Records	05
C-1Test	10
C-2 Test/Attendance	10
Total	25
Formative Assessment as per guidelines are compulsory	

Text Books/ References

1. Arindam Kuila and Vinay Sharma (2018). Principle and Applications of Fermentation Technology, Wiley.
2. Casida, L. (2016). Industrial Microbiology, 2nd edition, New Age International Publisher.
3. Crueger, W. and A Crueger. (2017). Cruegers Biotechnology: A Text Book of Industrial Microbiology. Edited by K. R. Aneja. Panima Publishing Corporation.
4. Michael, J. W., Neil, L. Morgan. (2013). Industrial Microbiology: an Introduction. Blackwell science
5. Nduka Okafor and Benedict Okeke (2017). Modern Industrial Microbiology and Biotechnology. 2nd Edition : CRC Press Publishers
6. Stanbury P. F., W. Whitaker and S. J. Hall (2016). Principles of Fermentation Technology. 3rd edition. Elsevier publication
7. Alexander, N. Glazer, Hiroshi Nikaido (2014). Microbial Biotechnology: Fundamental of applied Microbiology, 2nd Edition, Cambridge University Press
8. Brown, T. A. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
9. Clark, D. P. and Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
10. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
11. Primrose, S. B. and Twyman, R. M. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
12. Primrose, S. B. and Twyman, R. M. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
13. Russell, P. J. (2009). Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings
14. Sambrook, J. and Russell, D. (2001). Molecular Cloning - A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
15. Sambrook, J. and Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
16. Watson, J. D., Baker, T. A., Bell, S. P. et al. (2008). Molecular Biology of the Gene, 6th Ed., Benjamin Cummings Wiley
17. Sherwood, L. M. and Woolverton, C. J. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.

B.Sc. Microbiology 6th Semester Internship for Graduate Programme

Course title	Internship Discipline specific
No of contact hours	90
No of credits	2
Method of evaluation	Presentations/ Report submission/ Both

Project Assessment			
Formative Assessment		Summative Assessment	Total Marks
Assessment Occasion/Type	Weightage in Marks	Practical Exams	50
Data maintenance	10	Presentation/ Report/ Both 25	
Assessment	10		
Attendance	05		
Total	25	25	

- Internship shall be Discipline Specific of 90hours (2credits) with duration 4-6weeks.
- Internship may be full-time/part-time(full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship)to the mentor for completion of the internship.
- The detailed guide lines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

QUESTION PAPER PATTERN OF THEORY EXAMINATION

I and II SEMESTER B.Sc. MICROBIOLOGY (For 2025-26 onwards)

Duration: 3 Hours

Max.Marks:80

Instructions: *Answer all questions.*

Draw neat labeled diagrams wherever necessary.

II. Answer any eight of the following (10questionstobeasked):

2×8=16

2 questions from Unit 1

3 questions from Unit 2

2 questions from Unit 3

3 questions from Unit 4

OR

3 questions from Unit 1

2 questions from Unit 2

3 questions from Unit 3

2 questions from Unit 4

Question paper pattern-1

Question paper pattern-2

III. Answer any four of the following (6questionstobeasked):

6×4=24

1 question from Unit 1

2 questions from Unit 2

1 question from Unit 3

2 questions from Unit 4

OR

2 questions from Unit 1

1 question from Unit 2

2 questions from Unit3

1 question from Unit 4

Question paper pattern-1

Question paper pattern-2

IV. Answer any four of the following (6 questions to be asked):

10×4=40

2 questions from Unit 1

1 question from Unit 2

2 questions from Unit 3

1question from Unit 4

Question paper pattern-1

OR

1 question from Unit 1

2 questions from Unit 2

1 question from Unit 3

2 questions from Unit 4

Question paper pattern-2

Note: Weightage given to each unit is 29±1 Marks

SCHEME OF PRACTICAL EXAMINATION

I SEMESTER

PRACTICAL I: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

Duration: 3 hours

Max.Marks:40

- I. Stain the given material A by.....method. Write the principle and Procedure. Leave the preparation for evaluation. 10Marks**
(Direct staining / Indirect staining / Gram staining /Endospore staining)
(Preparation-5Marks, Principle-2Marks, Procedure-3MarksandResult-2marks)
- II. Identify the materials B, C and D with labeled diagrams and reasons. 3x4=10Marks**
(One material each from Cyanobacteria, Algae and Fungi)
(Identification- 1 Mark, Diagram and Reasons- 3 Marks)
- III . Measure the size of the microbial cell E using stage and ocular Micrometer. 05Marks**
(Calibration factor-1Marks, Principle and procedure-3Marks and Result- 1Mark)
- IV. Write critical notes on F, G and H. 3x2=06Marks**
(Microbiologists/Microscopes/Stains/Disinfectants/Laboratoryequipment)
(Identification- 1 Mark, Comments- 1 Mark)
- V. Viva-voce 04Marks**
- VI. Record 05Marks**

SCHEME OF PRACTICAL EXAMINATION II

SEMESTER

PRACTICAL-II: MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

Duration: 3 hours

Max.Marks:40

I. Demonstrate or perform the experiment A giving principle and procedure. Record the result.

10Marks

(Serial dilution/ Pour plate/Spread plate/Streak plate/Point inoculation/Measurement of growth by cell number using haemocytometer)

(Demonstration-5Marks, Principle and Procedure-5MarksandResult-2Marks)

II. Perform or demonstrate the experiment B giving principle and procedure. Record the result.

10Marks

(Demonstration of bacterial conjugation by plate mating method/UV survival curve of bacteria/ Gradient plate method)

(Demonstration-5Marks, Principle and Procedure-5MarksandResult-2Marks)

III. Conduct the experiment C. Record and interpret the result.

05 Marks (Effect

of temperature / pH / salt / carbon source on microbial growth / Study of colony characteristics / Microscopic examination of root nodules for bacteroids / Demonstration of lactose fermentation)

(Performance-2Marks,Principle and Procedure-2 Marks and Result-1Mark)

IV. Write critical notes on D, E and F.

3x2=06Marks

(Culture media, Griffith experiment, Hershey and Chase experiment, plasmid, transformation, conjugation and transduction in bacteria, life cycle of *Neurospora*, transposable elements and result of the experiments)

(Identification-1Mark,Comments-1Mark)

V. Viva-voce

04Marks

VI Record

05Marks

QUESTION PAPER PATTERN OF THEORY EXAMINATION (DSC & ELECTIVE)

**III and IV SEMESTER B. Sc. MICROBIOLOGY
(Under SEP Scheme 2024-25)**

Duration: 3 Hours

Max. Marks: 80

Instructions: *Answer all questions.*

Draw neat labeled diagrams wherever necessary.

I. Answer any eight of the following (10 questions to be asked):

2×8=16

2 questions from Unit 1

3 questions from Unit 2

2 questions from Unit 3

3 questions from Unit 4

OR

3 questions from Unit 1

2 questions from Unit 2

3 questions from Unit 3

2 questions from Unit 3

Question paper pattern-1

Question paper pattern-2

II. Answer any four of the following (6 questions to be asked):

6 ×4=24

1 question from Unit 1

2 questions from Unit 2

1 question from Unit 3

2 questions from Unit 4

OR

2 questions from Unit 1

1 question from Unit 2

2 questions from Unit 3

1 question from Unit 4

Question paper pattern-1

Question paper pattern-2

III. Answer any four of the following (6 questions to be asked):

10×4=40

2 questions from Unit 1

1 question from Unit 2

2 questions from Unit 3

1 question from Unit 4

OR

1 question from Unit 1

2 questions from Unit 2

1 question from Unit 3

2 questions from Unit 4

Question paper pattern-1

Question paper pattern-2

Note: Weightage given to each unit is 29±1 Marks

QUESTION PAPER PATTERN OF SKILL PAPER EXAMINATION

**IV SEMESTER B. Sc. MICROBIOLOGY
(Under SEP Scheme 2024-25)**

Duration: 2 Hours

Max. Marks: 40

Instructions: *Answer all questions.*

Draw neat labeled diagrams wherever necessary

I. Answer any four of the following (6 questions to be asked): **2×4=08**

3 questions from Unit 1

3 questions from Unit 2

II. Answer any three of the following (4 questions to be asked): **4×3=12**

2 questions from Unit 1

2 questions from Unit 2

III. Answer the following (2 questions to be asked with internal choice): **10×2=20**

2 questions from Unit 1

2 questions from Unit 2

Note: Weightage given to each unit is 34 Marks

SCHEME OF PRACTICAL EXAMINATION

III SEMESTER

PRACTICAL-III: MOLECULAR BIOLOGY AND ENVIRONMENTAL MICROBIOLOGY

Duration: 3 hours

Max. Marks: 40

- I. Demonstrate or perform the experiment A giving principle and procedure. Record the result. 12 Marks**
(Extraction of DNA by spooling method / Isolation of DNA by heat lysis method / Estimation of DNA by Diphenylamine method / Determination of purity of DNA)
(Demonstration- 5 Marks, Principle and Procedure- 5 Marks and Result- 2 Marks)
- II. Perform/ demonstrate the experiment B giving principle and procedure. Record the result. 12 Marks**
(Petriplate exposure method, Isolation and enumeration of microorganisms from soil / Determination of MPN / Determination of BOD of sewage / Estimation of total solids of sewage)
(Demonstration- 5 Marks, Principle and Procedure- 5 Marks and Result- 2 Marks)
- III. Conduct or identify the test C. Record and interpret the result. 05 Marks**
(Presumptive test / Confirmed test / Indole production test / MR test / VP test / Citrate utilization test / H₂S strip test)
(Conduct / Identification- 2 Marks, Result- 1 Mark, Interpretation- 1 Mark)
- IV. Write critical notes on D, E and F. 3x2=06 Marks**
(Micropipette, Watson and Crick model of DNA, t RNA, semi-conservative replication of DNA, transcription, translation, *lac* operon, Air samplers, flocculator, clarifier, sand filter, chlorinometer, septic tank, trickling filter, oxidation pond, anaerobic digester)
(Identification- 1 Mark and Critical comment- 1 mark)
- V. Viva-voce 05 Marks**

SCHEME OF PRACTICAL EXAMINATION

IV SEMESTER

PRACTICAL-IV:GENETIC ENGINEERING AND AGRICULTURAL MICROBIOLOGY

Duration: 3 hours

Max. Marks: 40

- I. Demonstrate or perform the experiment A giving principle and procedure. Record the result. 12 Marks**
(Visualization of DNA by agarose gel electrophoresis / Preparation of master and replica plate / Blue-white screening of recombinants)
(Demonstration- 5 Marks, Principle and Procedure- 5 Marks and Result- 2 Marks)
- II. Perform or demonstrate the experiment B giving principle and procedure. Record the result. 12 Marks**
(Antagonism between microorganisms / Seed health testing by standard blotter method / Gram staining of citrus canker specimen)
(Demonstration- 5 Marks, Principle and Procedure- 5 Marks and Result- 2 Marks)
- III. Identify the organism in the materials C with labeled diagrams and reasons.05 Marks**
(*Anabaena* from *Azolla* / Tikka disease of Groundnut / Powdery mildew of mulberry)
(Identification- 1 Mark and Labelled diagram with reasons- 4 Marks)
- IV. Write critical notes on D, E and F. 3x2=06 Marks**
(pBR322, agarose gel electrophoresis, microinjection, PCR, colony hybridization, products of recombinant DNA technology, specimens of plant disease, biofertilizers and biopesticides)
(Identification- 1 Mark and Critical comment- 1 mark)
- V. Viva-voce 05 Marks**

GENERAL PATTERN OF THEORY EXAMINATION

B.Sc MICROBIOLOGY (V –VI Semester)

Duration : 02 & ½ Hours

Maximum: 60Marks

Note : All questions are compulsory

Draw neat labeled diagrams wherever necessary

Q No. I Answer any EIGHT of the following:

2X8=16

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.
- 8.
- 9.
- 10.

Q No. II Answer any SIX of the following:

4X6=24

- 11.
- 12.
- 13.
- 14.
- 15
- 16
- 17
- 18

Q No. III Answer any TWO of the following:

10X2=20

- 19.
- 20.
- 21.
- 22.

PATTERN OF PRACTICAL EXAMINATION

Practical examination – B.Sc MICROBIOLOGY

Duration: 3 hours

Max.Marks:25

Q.1	Major question	08 Marks
Q.2	Minor question	05 Marks
Q.3	Identify and comment	2X4=08Marks
Q.4	Viva-voce	04 Marks

PATTERN OF FORMATIVE ASSESMENT-PRACTICALS

Max.Marks:25

1	IA1 (Assesment)	10Marks
2	IA2 (Test+Record)	15Marks

SCHEME OF THEORY EXAMINATION
III B.Sc., V SEMESTER
DSC-V: Microbial Genetics

Times: 2hrs

Max Marks: 60

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit-1: DNA as genetic material and Bacterial genetics	2	2	1	22
Unit-2: Genetic Material and Replication and Transcription of DNA	2	2	1	22
Unit-3: Gene expression and Regulation	3	2	1	24
Unit-4: Genetics of Viruses and Fungi and Mutation	3	2	1	24

Question Paper to be set for total of 92 marks including choices

I Main:2x10=20Marks

II Main:4x8=32Marks

III Main:4x10=40Marks

SCHEME OF PRACTICAL EXAMINATION IV SEMESTER (NEP)
PRACTICALV: MICROBIAL GENETICS

Time: 3 hrs.

Max.Marks:25

I Demonstrate the experiment A giving principle and procedure. Record the result. **8 marks**
 (Estimation of DNA by Diphenylamine method, Isolation of antibiotic resistant mutant by gradient plate method., Demonstration of Ames test, Preparation of master and replica plates, Study survival curve of bacteria after exposure to ultraviolet(UV) light)(Demonstration–2M,Principle–2M,Procedure–2M, Result –2M)

II Conduct the given biochemical test B giving principle and procedure. Write the significance 05 marks. (Isolation of antibiotic resistant mutant by gradient plate method., Demonstration of Ames test , Preparation of master and replica plates. Study survival curve of bacteria after exposure to ultraviolet(UV)light) (Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on C, D, E and F 4x2 = 08 marks

(Preparation of competent cells for bacterial transformation, Demonstration of bacterial conjugation by plate mating method , Determination of purity of DNA ,Visualization of genomic DNA by agarose gel electrophoresis,

β-Galactosidase activity assay in Yeast. Resolution and visualization of proteins by PolyacrylamideGel

Electrophoresis(SDS-PAGE).Study of Griffith`s experiment, conjugation, transduction, plasmidDNA,T4phage, ordered tetrad analysis in *Neurospora*, Watson and Crick model of DNA, tRNA, semi-conservative replication of DNA, bacterial RNA polymerase, transcription, translation and *lac* operon)

IV Viva-voce

04marks

SCHEME OF THE THEORY EXAMINATION
III B.Sc., V SEMESTER
DSC-VI: FOOD MICROBIOLOGY

Times: 2 hrs

Max Marks: 60

UNITS	2 mark questions	4 mark questions	10 mark questions	Total Marks
Unit-1: Production of food crops and their diseases	2	2	1	22
Unit-2: Microbial quality of air and water for food processing and disposal of Waste water	2	2	1	22
Unit - 3 : Food spoilage, Infection and Preservation	3	2	1	24
Unit-4: Microbiology of milk and Fermented food products	3	2	1	24

Question Paper to be set for total of 92 marks including choices

I Main: 2x10=20 Marks

II Main: 4x8= 32 Marks

III Main: 4x10=40 Marks

SCHEME OF PRACTICAL EXAMINATION IV SEMESTER (NEP)
PRACTICAL VI: FOOD MICROBIOLOGY

Time: 3 hrs.

Max. Marks: 25

I Demonstrate the experiment A giving principle and procedure. Record the result. **08 marks**

(Determination of microbial contamination of air by passive sampling method, Standard analysis of water samples and Determination of MPN, IMViC reactions, Determination of mesophilic aerobic count in foods and expression of counting log CFU/g)

(Demonstration-2M, Principle -2M, Procedure-2M, Result-2M)

II Conduct the given biochemical test B giving principle and procedure. Write the significance.

05 marks

(Turbidity test, resazurin test, MBRT test, Estimation of % of alcohol in a given sample by specific gravity bottle method, IMViC reactions, H₂S test)

(Demonstration-2M, Principle and Procedure-2M, Significance-1M)

III Write critical notes on C, D, E and F

4x2 = 08 marks

(Demonstration of air samplers, display of photographs of water purification process and wastewater treatment, Plant diseases).

IV Viva-voce

04 marks

SCHEME OF THE THEORY EXAMINATION
III B.Sc., VI SEMESTER
DSC-VII: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Times: 2 hrs

Max Marks: 60

UNITS	2 mark questions	4 mark questions	10 mark questions	Total Marks
Unit-1: Introduction to Immune system	2	2	1	22
Unit-2: Antigen-antibody interactions and Hypersensitive reactions	2	2	1	22
Unit-3: Host-pathogen Interaction and Medical Bacteriology	3	2	1	24
Unit-4: Medical Virology, Parasitology And Mycology and Chemotherapy	3	2	1	24

Question Paper to be set for total of 92 marks including choices

I Main: 2x10=20 Marks

II Main: 4x8= 32 Marks

III Main: 4x10=40 Marks

SCHEME OF PRACTICAL EXAMINATION IV SEMESTER (NEP)
PRACTICAL VII: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Time: 3 hrs.

Max. Marks: 25

I Demonstrate the experiment A giving principle and procedure. Record the result. **08 marks**

(Determination of blood group and Rh factor/Demonstration of precipitation reaction-ODD, Demonstration of Single Radial ImmunoDiffusion)

(Demonstration-2M, Principle-2M, Procedure-2M, Result-2M)

II Conduct the given biochemical test B giving principle and procedure. Write the significance.

05 marks

(IMViC, TSI, nitrate reduction, urease production and catalase tests, Study of bacterial flora of skin by swab method, Kirby-Bauer method)(Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on C, D, E and F

4x2=08 marks

(Polio, Rabies, Chikungunya, AIDS, Histoplasmosis, Candidiasis and Athlete's foot,

Widal test / HCG test, RPR test/VDRL test)

IV Viva-voce

04 marks

SCHEME OF THE THEORY EXAMINATION
III B.Sc., VI SEMESTER
DSC-VII: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Times: 2 and 1/2hrs

Max Marks: 60

UNITS	2 mark questions	4 mark questions	10 mark questions	Total Marks
Unit-1: Introduction to Immune system	2	2	1	22
Unit-2: Antigen-antibody interactions and Hypersensitive reactions	2	2	1	22
Unit -3: Host-pathogen Interaction and Medical Bacteriology	3	2	1	24
Unit-4: Medical Virology, Parasitology And Mycology and Chemotherapy	3	2	1	24

Question Paper to be set for total of 92 marks including choices

I Main: 2x10=20 Marks

II Main: 4x8= 32 Marks

III Main: 4x10=40 Marks

SCHEME OF PRACTICAL EXAMINATION IV SEMESTER (NEP)
PRACTICAL VII: IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Time: 3 hrs.

Max. Marks: 25

I Demonstrate the experiment A giving principle and procedure. Record the result. **08 marks**

(Determination of blood group and Rh factor/ Demonstration of precipitation reaction-ODD, Demonstration of Single Radial Immuno Diffusion)

(Demonstration-2M, Principle-2M, Procedure-2M, Result-2M)

II Conduct the given biochemical test B giving principle and procedure. Write the significance.

05 marks

(IMViC, TSI, nitrate reduction, urease production and catalase tests, Study of bacterial flora of skin by swab method, Kirby-Bauer method) (Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on C, D, E and F

4x2=08 marks

(Polio, Rabies, Chikungunya, AIDS, Histoplasmosis, Candidiasis and Athlete's foot, Widal test/ HCG test, RPR test/ VDRL test)

IV Viva-voce

04 marks

**SCHEME OF THEORY EXAMINATION
III B.Sc., VI SEMESTER**

Times: 2 and 1/2hrs

DSC-VIII: INDUSTRIAL MICROBIOLOGY

Max Marks: 60

UNITS	2 mark questions	4 mark questions	10 mark questions	Total Marks
Unit-1: Introduction to Industrial Microbiology	2	2	1	22
Unit – 2 : Downstream processing, General production strategies of microbial Products and Enzyme immobilization	2	2	1	22
Unit – 3 : Genetic Engineering tools used in Strain improvement of microbes of Industrial importance	3	2	1	24
Unit – 4: Genetic engineering techniques in industrial production of recombinant products	3	2	1	24

Question Paper to be set for total of 92 marks including choices

I Main: 2x10=20 Marks

II Main: 4x8= 32 Marks

III Main: 4x10=40 Marks

**SCHEME OF PRACTICAL EXAMINATION IV SEMESTER (NEP)
PRACTICAL VII: INDUSTRIAL MICROBIOLOGY**

Time : 3 hrs.

Max. Marks: 25

I Demonstrate the experiment A giving principle and procedure. Record the result. **08 marks**

(Estimation of citric acid produced from *Aspergillus niger* by titrimetric method,
Estimation of % alcohol in a given sample by specific gravity bottle method)

(Demonstration–2M, Principle–2M, Procedure–2M, Result–2M)

II Conduct the given biochemical test B giving principle and procedure. Write the significance. (Preparation of buffers-TE, TAE and Lysis buffer)

(Demonstration–2M, Principle and Procedure–2M, Significance–1M)

05 marks

III Write critical notes on C, D, E and F

4x2=08 marks

(Study of specialized bioreactors, Microbial production of industrial products, Cloning vectors, cloning of DNA inserts and Blue white screening of recombinants, Mushroom cultivation,
Amplification of DNA by PCR, Southern blotting, Wine, Isolation of plasmid DNA from *Escherichia coli*, Media used in industries, Production of amylase)

IV Viva-voce

04 marks

Annexure-1**Approved list of Paper setters and Valuers**

Sl No.	Name	College address
1	Dr.M.Seema	Assistant professor & Chairperson Dept. of Microbiology JSS College ,Ooty road, Mysore
2	Dr. H.P.Spoorthy	Assistant professor Dept.of Microbiology JSS College, Ooty road,Mysore
3	Dr.S.Mahadevamurthy	Associate Prof& HOD Dept.of Microbiology Yuvaraja'scollege Mysore.
4	Dr.Syeda Kauser Fathima	Associate Prof. of Microbiology Government College for women,Mandya.
5	Dr.H.S.Jayanth.	Asso.Prof.of Microbiology Dept. of Microbiology Yuvaraja's college Mysore.
6	Dr.Uma Maheshwari	Assistant professor JSS University, JSS AHER, Mysuru
7	Sri.M. Girish	Assistant professor Dept .of Microbiology Government Women College ,Kolar
8	Dr.P.K. Maheshwar	Professor Dept. of Microbiology Yuvaraja's college, Mysore.
9	Smt. M.S.Shobha	Associate professor Dept.ofMicrobiology Government Science College, Chintamani
10	Sri.R.A. Manjunath	Assistant professor. Dept .of Microbiology Sarada vilas College, Mysore
11	Dr.M.P.Ragavendra	Assistant professor Dept .of Microbiology Maharani's Science College, Mysore
12	Dr.K.Girish	Assistant professor. Dept.of Microbiology Maharani's Science College, Mysore
13	Sri. G.S.Siddegowda	Assistant professor Dept.of Microbiology Sir M V Government Science College Bhadravathi

14	Dr.N.S.Devaki	Professor Dept. of Molecular Biology Yuvaraja's College,Mysore
15	Syeda Farahna Parveen	Assistant professor Dept.of Microbiology St.Philomina's College, Mysore
16	Smt. Vanitha	Assistant professor Dept.of Microbiology Maharani's Science College,Mysore
17	Mahadeva prasad	Assistant professor. Dept. of Microbiology JSS College for Women Saraswathipuram,Mysore
18	Dr.Nagalambika	Assistant professor JSS University, JSSAHER,Mysuru
19	Raja Rajeshwari.R	Assistant professor Dept.of Microbiology SDM College JLBRoad,Mysuru
20	Uzma Bathool	Assistant professor Dept.of Microbiology St.Philomina'sCollege, Mysore
21	Athiyasultan	Assistant professor Dept.of Microbiology SDM College JLBRoad,Mysuru
22	C.PoornimaDevi	Assistant professor Dept.of Microbiology Yuvaraja'scollege,Mysore
23	Vasundara Devi R	Assistant professor Dept.of Microbiology Maharani's Science College, Mysore
24	Niveditha Prakash	Assistant professor Dept. of Microbiology JSS College for Women Saraswathipuram, Mysore
25	Dr.K.Sumana	Associate professor JSS University,JSS AHER,Mysuru