

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:2026-27)

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	2	2
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	2	2
Skill	SEC-1: Practicals	Microbial and Molecular Techniques	2	4
SEMESTER – V				
Major-	DSE: Theory-V	Food Microbiology	3	3
	DSE: Theory-VI	Industrial Microbiology	3	3
	DSE: Practical-V	Food and Industrial Microbiology	2	4
	SEC- Theory-	-		
SEMESTER – VI				
Major-	DSE: Theory-VI	Immunology	3	3
	DSE: Theory-VII	Medical Microbiology	2	2
	DSE: Practical-VI	Immunology and Medical Microbiology	2	4
	SEC- Theory-	-	41	55

**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 QP246101	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 QP246201	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 QP246301	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	GMB311	Microbial Quality Control in Industries	03	3:0:0			03	48	-	3	10	10	80	100
	IV	DSC-IV: Theory-IV	GMB401 QP246401	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	GMB413 QP246413	Plant and Animal Microbiome	03	3:0:0			03	48	-	3	10	10	80	100
		SEC-1:Practicals	GMB412	Microbial and Molecular Techniques-SKILL	04	0:0:2			02	-	60	3	5	5	40	50
	III B.Sc	V	DSC- V Theory-	GMB501 QP246501	Food Microbiology	03	3:0:0			03	48	-	3	10	10	80
DSC -VI Theory-			GMB503 QP246503	Industrial Microbiology	03	3:0:0			03	48	-	3	10	10	80	100
DSC- Pract-V			GMB502	Food and Industrial Microbiology	04	0:0:2			02	-	60	3	5	5	40	50
VI		DSC- VII Theory-	GMB601 QP246601	Immunology	03	3:0:0			03	48	-	3	10	10	80	100
		DSC- VIII Theory-	GMB603 QP246601	Medical Microbiology	02	2:0:0			02	32	-	2	10	10	80	100
		DSC- Pract- VI	GMB602	Immunology and Medical Microbiology	04	0:0:2			02	-	60	3	5	5	40	50

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
ELE	5	-	5	-	40	-	50
SEC	-	5	-	5	-	40	50

NOTE;

1. IN CASE OF DSC, 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 ELE, C1 AND C2 WILL BE CONDUCTED FOR 10 MARKS WITH 30 MINUTES DURATION AND REDUCED TO ASSIGNED MARKS. C3 WILL BE CONDUCTED FOR 40 MARKS WITHIN 2 HOURS DURATION.
4. 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 WITHIN 3 HOURS DURATION.

PAPER CODE : GMB101

I SEMESTER

QPcode:246101

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.

A. 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.

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

C. 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.

A. 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).

B. 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.

A. Biodiversity: Definition and levels, Bergey's Manual of Systematic Bacteriology (Latest addition in brief upto sections). Comparison of bacteria, archaea and eukaryote (tabulation).

B. 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.

C. 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.**

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

B. 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, phytophagena-BCMV, zoophagena-Influenza. Subviral particles-viroids, virusoids and prions.

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 T4 phage, 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.

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.

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.

Text Books/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. ,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.,(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.

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.**

- A. 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.
- B. 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
- C. 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.**

- A. 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.
- B. 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.**

- A. 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).
- B. 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.**

- A. 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.

B. 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.

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.

ELE-1: MICROBIAL QUALITY CONTROL IN INDUSTRIES**ELECTIVE-1****32 (2hrs./week)****Unit I: Biohazards and Biosafety****16 hrs.**

- A. 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.
- B.** Biosafety levels- procedure and practices, safety equipment and laboratory facilities for BSL1, BSL-2, BSL-3 and BSL4. Discarding biohazardous waste- Methodology of disinfection, autoclaving and incineration.
- C.** Food Safety and Standards Act, 2006- scope, salient features and general principles. Food Safety Management Systems: GMP and GHP.

Unit II: Microbiological quality analysis of Air, Water and Food**16 hrs.**

- A. Analysis of air samples:** 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.
- B. Analysis of foods and 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 Saboraud agar.
- C.** Methods of analysis : Aerobic Plate Count (APC), Most Probable Number (MPN), Direct Microscopic Count (DMC). Immunological and molecular methods of detection of microbial contaminants in food and 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.

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.**

- A. 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.
- B. 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.**

- A. 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.
- B. 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.**

- A. 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.
- B. 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.**

- A. 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.
- B. 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.

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.

**ELE-2: PLANT AND ANIMAL MICROBIOME
ELECTIVE-2****32 (2hrs./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: Fundamentals of Microbiome and Plant Microbiome**16 hrs.**

- A. Definition, scope and importance of microbiome. Host-associated microbiomes and microbes in early life. Microbial diversity in microbiome: bacteria, archaea, fungi, viruses and yeast. Methods to study microbiomes- Culturing microorganisms and genome extraction. Symbiosis between host and microorganisms.
- B. Concept and Basic structure of plant microbiome. Plant microbe interaction and their role in plant health. Microbe in nutrient uptake, nitrogen fixation, and soil health. Environmental applications – Pollutant degradation and carbon sequestration. Current and future research in plant microbiome.

Unit II: Animal Microbiome and Human Microbiome**16 hrs.**

- A. Diversity of microbiome in animals and ecological niches. Microbiome of livestock, reptiles, earthworm and honey bees. Rumen microbial diversity and factor influencing the rumen microbiota. Fermentation in rumen and methanogenesis.
- B. Introduction to the human microbiome and the holobiont theory of evolution. Pre and post-natal Microbiome development. Gut microbiome and dysbiosis. Effect of antibiotics and diet on human microbiome.
- C. 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.

SEC-1: MICROBIAL AND MOLECULAR TECHNIQUES

SKILL PAPER-1

PRACTICAL-IV

60 (4hrs/week)

1. Laboratory cleaning and safety practices: Introduction to lab safety- clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards.
2. SOP for various equipment in the QC Lab
3. Calibration and operation of basic laboratory instruments - weighing balance, micropipette, centrifuge, pH meter, water bath and colony counter.
4. Management of laboratory logbook maintenance and documentation procedures.
5. a. Sterility testing of media and consumable
b. Estimation of microbial load (Bio-Burden test)
6. Morphological characterization of bacteria- Gram's staining & Hanging drop method
7. Preparation of culture media-Sabouraud dextrose agar, Czapek dox agar and Algal medium
8. Isolation of microorganisms by- Spread plate, pour plate Streak plate and point inoculation method
9. Biochemical characterization of bacteria –Catalase test, Oxidase test & IMVIC.
10. Biochemical characterization of bacteria – TSI, Nitrate reduction and starch hydrolysis
11. Study of centrifugation and ultra centrifugation techniques and its applications.
12. Study of Partition, adsorption, ion exchange, exclusion and affinity chromatography- principle and applications.
13. Study of UV and visible spectrophotometric techniques- principle and application.
14. Study of Electrophoretic technique: agarose and polyacrylamide gel.
15. Study of Radiation safety and protection guidelines. GM counter.

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

Course Objectives

The main objectives of this course are:

1. To understand the role of microorganisms in food, including natural flora, contamination sources, and factors affecting microbial growth in foods.
2. To study food spoilage and food-borne diseases, their causative agents, symptoms, and preventive measures.
3. To learn the principles and techniques of food preservation, including physical and chemical preservation methods.
4. To understand microbiology of milk and dairy products, including contamination, biochemical changes, and microbiological analysis.
5. To study fermented foods and beverages, their production processes, microorganisms involved, and nutritional/therapeutic benefits.
6. To gain knowledge about food safety standards and quality control systems such as HACCP, TQM, BIS, FSSAI, and ISO.

COURSE OUTCOMES

After completing this course students will be able to:

- CO1: Explain the sources of microbial contamination in foods, factors influencing microbial growth, and mechanisms of food spoilage.
- CO2: Identify food-borne pathogens and toxins, describe food-borne infections and intoxications, and explain their detection methods.
- CO3: Describe and evaluate different food preservation techniques including physical and chemical methods used in food industries.
- CO4: Analyze the microbiology of milk, including starter cultures, contamination sources, biochemical changes, and microbiological quality tests.
- CO5: Explain the production and microbiology of fermented foods and beverages and evaluate the role of probiotics, prebiotics, synbiotics, and nutraceuticals in human health

Unit-1: Microbes and food**12Hrs**

- A.** Natural flora and sources of contamination of foods in general. Intrinsic and extrinsic factors affecting growth and survival of microbes in foods. Principles, spoilage of vegetables, fruits, meat, eggs, bread, and canned foods.
- B. Food borne infection and intoxication:** Food infections: *Salmonellosis*, *Bacillus cereus*, *Vibrio parahaemolyticus*, *Shigellosis*, *Listeria monocytogenes* and *Campylobacter jejuni*.
- C. Food intoxications:** *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins (aflatoxin, T2 toxin). Cultural and rapid detection methods of food borne pathogens in foods.

Unit-2: Food preservation**12Hrs**

- A.** Principles. Physical methods of food preservation: temperature (low and high), canning, drying, irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging. Chemical methods of food preservation: salt, sugar, nitrites and nitrates, Organic acids, SO₂, ethylene oxide, antibiotics. Bacteriocins types, classification and applications.
- B. Food quality and control-** Total Quality Management (TQM): Concepts and approaches.

Hazard analysis critical control point (HACCP) for food safety. Indices of food quality: BIS, FSSAI standard, ISO certification.

Unit-3: Microbiology of milk

12Hrs

- A.** 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 (Phosphatase test, Alcohol Coagulation Test), SPC and Reduction tests (MBRT and Resazurin dye reduction test).
- B. Milk Preservation:** Preservation of milk and milk products-Sterilization, Pasteurization, HTST, UHT, dehydration.

Unit-4: Fermented foods

12Hrs

- A. Fermented foods:** Definition and characteristics. Starter culture-Salient features, types and role. Fermented dairy products: nutritional value, production and therapeutic values of cheese fresh, soft-ripened, semi-soft and hard, tofu, yoghurt and acidophilus milk.
- B.** Fermented non-dairy products: cereal (idli), vegetable (sauerkraut), meat (sausage) and fish (fish sauce). Fermented beverages- kombucha. Microbes as food. Prebiotics, probiotics, synbiotics.

Text Books/References

1. Adams, M.R. and Moss, M. O.(2016).Food Microbiology(4thed).Royal Society of Chemistry, Cambridge University Press.
2. Ananthanarayanan R., and Paniker, C.K.J. (2021). Textbook of Microbiology (12th ed.).Orient Longman.
3. Banwart, G.J. (1987.) Basic Food Microbiology. CBS Publishers and distributors, New Delhi.
4. Banwart,G.J.(2012).Basic Food Microbiology (3rded.). CBS Publishers and Distributors.
5. Frazier & Westhoff, D.C. (1995). Food Microbiology Tata McGraw Hill Pub. Company Ltd., New Dehli.
6. Frazier, W.C.,&Westhoff,D.C.(2018).FoodMicrobiology(5thed.).TataMcGrawHill.
7. Hammer, B. W.,& Babal, R.(2019).Dairy Microbiology(4thed.).Prentice Hall.
8. Hobbs, B. C.(2015).Food Microbiology(6thed.).Arnold-Heinemann.
9. Jay, J.M.(2019).Modern Food Microbiology(8thed.).Springer.
10. Robinson, R.K.(2018).Dairy Microbiology (3rded.).Elsevier.
11. Varnam, A.H.,&Evans,M.G.(2017).FoodbornePathogens(3rded.).Springer.

DSC-VI Industrial Microbiology**Paper VI****48hours (3hours/week)****Course Objectives**

The objectives of this course are to:

1. Understand the fundamentals of industrial microbiology, including its history, development, scope, and industrially important microorganisms.
2. Learn the principles of fermentation technology, including fermentation media, types of fermentation processes, and operation of bioreactors.
3. Study downstream processing techniques used for recovery and purification of microbial products.
4. Understand strain selection, improvement, preservation, and culture maintenance for industrial applications.
5. Explore the industrial production and applications of microbial products such as organic acids, solvents, antibiotics, enzymes, alcoholic beverages, amino acids, and microbial biomass.

COURSE OUTCOMES

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

1. Explain the scope and importance of industrial microbiology and identify microorganisms used in industrial production processes.
2. Describe fermentation processes and bioreactor systems and different fermentor designs.
3. Select appropriate fermentation media components and raw materials used in industrial fermentation.
4. Understand downstream processing methods and enzyme immobilization techniques.
5. Describe microbial production processes for important industrial products.
6. Understand concepts of scale-up, process control, and industrial applications of microbial biotechnology.

Unit 1: Introduction to Industrial Microbiology:**12Hrs**

- A. Definition, brief history, development and scope of industrial microbiology. Range of Microbial products with examples. Concept of primary and secondary metabolites.
- B. Microorganisms of industrial importance, Selection criteria for industrial strains, Primary and secondary screening. Stock cultures. Culture collection centers. Preservation and maintenance of industrial strains. Important methods of strain improvement.
- C. Components of a typical continuously stirred tank bioreactor (CSTR). Laboratory and pilot-scale fermentors in brief: (Airlift bioreactors, fluidized bed reactor, packed bed, tower bioreactors, Photobioreactors, anaerobic bioreactors).

Unit 2: Fermentation media and process:**12Hrs**

- A.** Fermentation media: A brief account of - Production medium, Inoculum medium; Raw materials: Carbon and nitrogen sources used in fermentation medium: molasses and its types, corn steep liquor, Sulphite waste liquor; and whey. Buffers, Precursors, Inhibitors and Antifoam agents.
- B.** Types of Fermentation: batch, fed-batch and continuous. Types of fermentation processes: solid state, and Submerged. Kinetics of fermentation.

Unit 3: Downstream processing:**12Hrs**

- A.** Downstream processing: Definition and stages. Methods of downstream processing: Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying and crystallization.
- B.** Enzyme immobilization :Definition and methods-reversible immobilization (adsorption), irreversible immobilization (covalent coupling, entrapment, copolymerization). Support materials: Characteristics and types (organic and inorganic). Applications of enzyme immobilization. Immobilized enzymes: Advantages and disadvantages. Intellectual property rights (IPR)

Unit 4: Microbial production of industrially important products:**12Hrs**

- A.** Industrial production and uses of 1) Organic acids: Citric acid and acetic acid 2) Organic Solvent: Ethanol 3) Antibiotic: Penicillin. 4) Enzymes: amylases, proteases, lipases. 5) Alcoholic beverages: Beer and wine. 6) Amino acid: L-Glutamic acid, L-lysine
- B.** Microorganisms as Food: Cultivation and Nutritional properties of Single cell protein and Mushroom.
- C.** Microbial bioactive compounds for industrial applications (Bacteria and Mushroom).

Text Books/References

1. Arindam Kuila and Vinay Sharma (2018). Principles and Applications of Fermentation Technology, Wiley.
2. Casida L E.(2016).Industrial Microbiology,2nd edition, New Age International Publisher.
3. Casida, L.E.(2018).Industrial Microbiology(3rded.).New Age International Publishers.
4. Michael,J.W.,Neil L.Morgan(2013).Industrial Microbiology: an Introduction. Black well science
5. Nduka Okafor, Benedict Okeke (2017).Modern Industrial Microbiology and Biotechnology. 2nd Edition :CRC Press Publishers
6. Reed, G.(2017).Industrial Microbiology (4thed.).Mac Millan Publications.
7. Sherwood L. M. and Woolverton C.J.(2008).Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education.
8. Stanbury P.F.,W. Whitaker and S. J. Hall(2016).Principles of Fermentation Technology. 3rd edition. Elsevier publication
9. Stanbury, P .T. and Whitaker,(1984)Principles of Fermentation Technology, Pergamomg Press, Newyork.
10. Stanier,R. Y.,Ingraham,J.L.,Wheelis,M.L.,andPainter,P.R.(2019).General Microbiology (6th ed.). Prentice Hall of India.

FOOD MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY**Practica IV****4hours/week**

1. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
2. Methylene blue and Resazurin reduction test for assessing the raw milk quality.
3. Standard plate count to raw and pasteurized milk
4. Isolation of spoilage fungi from spoiled vegetables, fruits and bread
5. Determination of thermal death point of microorganisms.
6. Preparation of wine from grapes.
7. Preparation of alcohol using jaggery/molasses.
8. Estimation of citric acid produced from *Aspergillus niger* by titrimetric method
9. Estimation of percentage alcohol in a given sample by specific gravity bottle method
10. Cultivation and processing of edible Mushroom
11. Preservation of industrial important microbes with glycerol/soil.
12. Microbial production and estimation of amylase enzymes.
13. Screening and isolation of antibiotic producing microbes from soil sample.
14. Demonstration of lipolytic activity of soil microbes
15. Display of Microbial industrial products: Organic Solvent: Ethyl Alcohol; Alcoholic Beverages: Wine, Beer, Organic acids:-Vinegar and Citric acid, Microbes as food SCP:-*Spirulina* and Mushroom: Antibiotic: Penicillin; Microbial Enzymes: Amylase, protease and lipases. Amino acid; L-Glutamic acid. Display of photographs-Bread, *Penicillium* on citrus, cheese, butter, probiotic foods

DSC-VII Immunology**Paper VII****48hours (3hours/week)****Course Objectives**

1. To introduce the fundamentals of the immune system, including innate and adaptive immunity, immune cells, lymphoid organs, and mechanisms of antigen recognition.
2. To explain the mechanisms of immune responses, including humoral and cell-mediated immunity.
3. To understand immunoprophylaxis and vaccination strategies, including different vaccine types and national immunization programs.
4. To familiarize students with antigen–antibody interactions and immunological techniques used in diagnosis and research.
5. To develop conceptual understanding of immune disorders, such as hypersensitivity reactions and autoimmune diseases.

COURSE OUTCOMES (CO)

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

- CO1: Explain the structure and functions of the immune system, including lymphoid organs, immune cells, and antigen-presenting mechanisms.
- CO2: Describe the molecular and cellular mechanisms involved in innate and adaptive immune responses.
- CO3: Classify and explain hypersensitivity reactions, complement pathways and autoimmune diseases.
- CO4: Identify different types of vaccines and explain their role in immunoprophylaxis and national immunization programs.
- CO5: Analyze antigen–antibody interactions and apply immunological techniques immunofluorescence in diagnostics and research.

UNIT1: Immune system**12Hrs**

- A. Innate and acquired immunity. Cells and organs of the immune system: Lymphoid organs-Thymus, Bone marrow, Spleen, Mucosa associated lymphoid tissue(MALT) and lymph node.
- B. Hematopoiesis: Lymphoid cells – Myeloid cells, Null cells and phagocytic cells. Toll-like receptors, Major histocompatibility complex (MHC)- types and functions (exogenous pathway and Endocytic Pathway of antigen processing) and Dendritic cells.
- C. Antigen-Properties and types; Antibodies -Types, Structure and their functions.

UNIT 2: Antigen-antibody reactions**12Hrs**

- A. Salient features-antibody affinity and avidity, cross reaction. Agglutination reactions: Hemagglutination- blood grouping, complement fixation test, WIDAL (slide and Tube method).
- B. Immunodiffusion: Radial (Mancini) and double (Ouchterlony) Immunoelectrophoresis-rocket electrophoresis, ELISA (Direct, Indirect, Sandwich and Competitive), Radioimmunoassay and Immunofluorescence (Direct and Indirect methods).

UNIT 3: Immune response and Hypersensitivity reaction**12Hrs**

- A. Cell mediated and humoral mechanism of immune response.
- B. Hypersensitive reactions: Classification of hypersensitivity. Type I (IgE Anaphylaxis and Atopic reactions), Type II (IgG and IgM-ADCC Blood group and Rh factor complications), Type III (Serum sickness, IgA vasculitis), Type IV (Contact Dermatitis).
- C. Complement system - Classical, Lectin, and Alternative. Autoimmune Diseases- Systemic Autoimmune Diseases (Rheumatoid Arthritis), Classification by Pathogenic Mechanism (Graves' disease stimulation)

UNIT 4: Immunoprophylaxis**12Hrs**

- A. Definition and advancements in Immunoprophylaxis: Attenuated (MMR, Chickenpox, BCG, OPV, Flumist), killed (Salk polio vaccine (IPV), hepatitis A vaccine, rabies vaccine, and influenza shots), Subunit Hepatitis B Vaccine, Human Papillomavirus (HPV) Vaccine, Shingles Vaccine, COVID-19 Vaccine), Conjugate (*Haemophilus influenzae* type b and pneumococcal (PCV) vaccines) recombinant vaccines (HPV) and Toxoid (tetanus, diphtheria). mRNA (Zika Vaccine).
- B. National immunization Schedule.

Text Books/References

1. Abbas, A.K., Lichtman, A.H., and Pillai, S. (2022). *Cellular and Molecular Immunology* (10th ed.). Elsevier.
2. Ananthanarayan, R. and Paniker, C.K.J. (2021). *Textbook of Microbiology* (12th ed.). Orient Longman.
3. Delves P., Martin S., Burton D. and Roitt I.M. (2006). *Roitt's Essential Immunology*. 11th edition Wiley-Blackwell Scientific Publication, Oxford.
4. Goldsby, R.A., Kindt, T.J., Osborne, B.A., and Kuby, J. (2021). *Kuby Immunology* (8th ed.). W.H. Freeman.
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. Murphy, K, Travers, P. and Walport, M. (2008). *Janeway's Immunobiology*. 7th edition Garland Science, Publishers, New York.
7. Peakman, M. and Vergani D. (2009). *Basic and Clinical Immunology*, 2nd edition Churchill, Livingstone Publishers, Edinburgh.
8. Pelczar, M. J., Chan, E. C. S., and Krieg, N. R. (2020). *Microbiology* (7th ed.). McGraw Hill.
9. Richard, C. and Geffrey, S. (2009). *Immunology*. 6th edition. Wiley Blackwell Publication.
10. Roitt, I.M. (2017). *Essential of Immunology* (12th ed.). Blackwell Scientific Publishers.
11. Willey, J.M., Sherwood, L.M., and Woolverton, C.J. (2013). *Prescott, Harley and Klein's Microbiology*. 9th edition. McGraw Hill Higher Education

DSC-VIII Medical Microbiology**Paper VIII****32hours(2hours/week)****Course Objectives (COB)**

1. To introduce the concept of the human microbiome and normal microflora, and their role in maintaining human health.
2. To explain host–pathogen interactions, including infection, virulence, transmission, and mechanisms of disease development.
3. To provide knowledge of major bacterial, viral, protozoan and fungal diseases, including their etiology, pathogenesis, clinical manifestations, and epidemiology.
4. To familiarize students with laboratory diagnosis, prevention, and treatment strategies for medically important infectious diseases.
5. To understand antimicrobial agents and mechanisms of drug action, as well as the emergence of antibiotic resistance in pathogens.

Course Outcomes(CO)

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

- CO1: Describe the human microbiome and normal microflora of different body sites and explain their significance in health and disease.
- CO2: Explain host–pathogen interactions, modes of infection transmission, types of infections, and the role of carriers in disease spread.
- CO3: Identify the etiology, pathogenesis, symptoms, epidemiology, diagnosis, prevention, and treatment of major bacterial, viral, protozoan, and fungal diseases.
- CO4: Explain the principles of antimicrobial therapy, including the mechanisms of action of antibacterial, antifungal, and antiviral drugs.
- CO5: Evaluate the causes and implications of antimicrobial resistance, including MDR, XDR, MRSA, and NDM-1.

UNIT 1: Introduction to Medical Microbiology and Bacterial diseases**16Hrs**

- A. Human microbiome, Normal micro flora of human Skin, Oral cavity, Gastrointestinal tract, Genitourinary tract and their importance. Gnotobiotic animals.
- B. Host pathogen interaction: Definitions-Infection, Invasion, Pathogenicity, Virulence, and Inflammation. Types of Infection, Modes of transmission of infection, Carriers and their types.
- C. **Bacterial diseases:** Etiology, Pathogenesis, Clinical symptoms, Laboratory diagnosis, Epidemiology, Prophylaxis and Treatment of the diseases caused by :*Staphylococcus aureus*, *Streptococcus pyogenes*, *Mycobacterium tuberculosis*, *Clostridium tetani*, *Salmonella typhi*, *Vibrio cholerae*, *Haemophilus influenzae*, and *Treponema pallidum*.

UNIT 2: Medical Virology, Parasitology, Mycology and Chemotherapy 16Hrs

- A. Etiology, pathogenesis, epidemiology, diagnosis, prophylaxis and treatment of Viral infections: Polio, Hepatitis-B, Rabies, Dengue, HIV, and Corona.
- B. Protozoan disease- Malaria, Trichomoniasis, Amoebic dysentery.
- C. Fungal infections: Cutaneous mycoses-Tinea infections, Systemic mycoses-Histoplasmosis and Opportunistic mycoses- Candidiasis.
- D. General characteristics and mode of action of Antibacterial agents (Penicillin, Streptomycin), antifungalagents: Amphotericin B, Griseofulvin; Antiviral agents: Acyclovir, Azidothymidine. Antibiotic resistance: MDR, XDR, MRSA, NDM-1.

Text Books/References

1. Ananthanarayan R. and Paniker C.K.J (2009). Text book of Microbiology, 8th Edition, University Press, Publication.
2. Bhatra, R. (2021). *Essentials of Medical Microbiology* (2nd ed.). Jaypee Brothers Medical Publishers.
3. 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
4. Douglas, J.W., & Sleight, J.D. (2019). *Medical Bacteriology* (4th ed.). Churchill Livingstone.
5. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier
6. Goldsby, R. A., Kindt, T. J., Osborne, B. A., & Kuby, J. (2021). *Kuby Immunology* (8th ed.). W.H. Freeman.
7. Gupte, S. (2019). *The Short Text book of Medical Microbiology* (10th ed.). Jaypee Brothers Medical Publishers.
8. Hughes, W.T., and Moffet, H.L. (2018). *Clinical Microbiology* (5th ed.). J.B. Lippincott.
9. Jawetz, E., Melnick, J. L., and Adelberg, E. A. (2020). *Medical Microbiology* (28th ed.). McGraw Hill.
10. Kenneth, J. R. (2019). *Medical Microbiology: Introduction to Infectious Diseases* (6th ed.). Prentice Hall International.
11. Madigan M.T., Martinko J.M., Dunlap P.V. and Clark D.P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
12. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (2020). *Microbiology* (7th ed.). McGraw Hill.
13. Willey J.M., Sherwood L.M., and Woolverton C.J. (2013). Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education

IMMUNOLOGY AND MEDICAL MICROBIOLOGY**Practical Paper VI****(4hrs/Week)**

1. Determination of blood group, Rhfactor
2. Differential leucocyte count
3. Experiment on hand hygiene.
4. Demonstration of precipitation reaction-Ouchterlony double diffusion test.
5. Demonstration of hemolytic activity of pathogenic bacteria.
6. Demonstration of antistreptolysin O.
7. Antibiotic sensitivity test (Disc diffusion method).
8. Detection of antimicrobial activity of fungi (e.g., penicillin).
9. Perform total leucocyte count of the given blood sample using haemocytometer.
10. Demonstration of Single Radial Immuno Diffusion.
11. WIDAL test and RPR test
12. Study of composition and use of important differential media for identification of pathogenic bacteria: EMB Agar, McConkey agar, Mannitol salt agar, TCBS agar, Deoxycholate citrate agar.
13. Study of bacterial flora of skin by swab method
14. Identification of bacteria (*E. coli*, *Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics; TSI, nitrate reduction, urease production and catalase tests.
15. Microscopic observation / display of photographs of human pathogens *Staphylococcus*, *Streptococcus*, *Clostridium*, *Salmonella*, *Vibrio*, *Mycobacterium*, Polio virus, Hepatitis B virus, HIV, Rabies virus, Tinea, *Candida*, *Entamoeba* and *Plasmodium*.

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.

I. 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

II. 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

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

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

(Microscopes/Stains/Disinfectants/Laboratory equipment)

(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 | { | Question paper pattern-1 |
| 3 questions from Unit 2 | | |
| 2 questions from Unit 3 | | |
| 3 questions from Unit 4 | | |
| OR | | |
| 3 questions from Unit 1 | { | Question paper pattern-2 |
| 2 questions from Unit 2 | | |
| 3 questions from Unit 3 | | |
| 2 questions from Unit 3 | | |

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

6 ×4=24

- | | | |
|-------------------------|---|--------------------------|
| 1 question from Unit 1 | { | Question paper pattern-1 |
| 2 questions from Unit 2 | | |
| 1 question from Unit 3 | | |
| 2 questions from Unit 4 | | |
| OR | | |
| 2 questions from Unit 1 | { | Question paper pattern-2 |
| 1 question from Unit 2 | | |
| 2 questions from Unit 3 | | |
| 1 question from Unit 4 | | |

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

10×4=40

- | | | |
|-------------------------|---|--------------------------|
| 2 questions from Unit 1 | { | Question paper pattern-1 |
| 1 question from Unit 2 | | |
| 2 questions from Unit 3 | | |
| 1 question from Unit 4 | | |
| OR | | |
| 1 question from Unit 1 | { | Question paper pattern-2 |
| 2 questions from Unit 2 | | |
| 1 question from Unit 3 | | |
| 2 questions from Unit 4 | | |

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. 10 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. 10 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 04 Marks

VI. Record 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. 10 Marks**
(Visualization of DNA by agarose gel electrophoresis / Preparation of master and replica plate / Blue-white screening of recombinants)
(Demonstration- 4 Marks, Principle and Procedure- 4 Marks and Result- 2 Marks)
- II. Perform or demonstrate the experiment B giving principle and procedure. Record the result. 10 Marks**
(Antagonism between microorganisms / Seed health testing by standard blotter method / Gram staining of citrus canker specimen)
(Demonstration- 4 Marks, Principle and Procedure- 4 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 04 Marks**
- VI. Record 05 Marks**

SCHEME OF PRACTICAL EXAMINATION

IV SEMESTER

SEC-PRACTICAL: MICROBIAL AND MOLECULAR TECHNIQUES

Duration: 3 hours

Max.Marks:40

- I. Demonstrate the experiment A, giving the principle and procedure. Record the result. 15Marks**
(Sterility check, Bio-burden testing, Calibration of micropipette, Calibration of pH meter/
pure culture techniques).
(Demonstration-5marks, Procedure-5marks,Result/observation-5marks)
- II. Demonstrate the experiment B, giving the principle and procedure. Record the result. 10Marks**
Gram staining, motility determination, catalase test, oxidase test, IMViC, TSI,
nitrate reduction and starch hydrolysis
(Demonstration-4marks,Principle-2marks,Procedure-2marks,Result-2marks)
- III. Write the SOP for the equipment C 04Marks**
SOP for various equipments in QC Lab.
- IV. Write critical notes on D, E and F. 3x2=06Marks**
Lab symbols, culture media, pure culture techniques centrifugation techniques,
chromatographic techniques, spectrophotometer, GM counter
- V. Viva voce/Hands-on entry of mock lab data in logbooks 05marks**

SCHEME OF PRACTICAL EXAMINATION V
SEMESTER
PRACTICAL-V: FOOD MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY

Duration: 3 hours

Max.Marks:40

I. Demonstrate or perform the experiment A giving principle and procedure. Record the result.10Marks

Isolation of fungi from spoiled vegetables, fruits and bread /

Determination of thermal death point of microorganisms/ SPC)

(Demonstration-5 Marks, Principle and Procedure-4 Marks and Result-1Mark)

II. Perform or demonstrate the experiment B giving principle and procedure .Record the result.10 Marks

(Estimation of amylase enzymes/ Screening and isolation of antibiotic producing microbes from soil

sample/ Estimation of citric acid produced from *Aspergillus niger* by titrimetric method).

(Demonstration-5Marks, Principle and Procedure-4 Marks and Result-1 Mark)

III. Conduct or identify the test C. Record and interpret the result.

05 Marks

(Alkaline Phosphatase/MBRT/Resazurin/Estimation of percentage alcohol in a given sample by specific gravity bottle method/Lipolytic activity)

(Conduct/Identification-2Marks, Result-1Mark, Interpretation-2Marks)

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

3x2=06 Marks

(Bread, *Penicillium* on citrus, cheese, butter, probiotic foods/Organic acids:-Vinegar and

Citric acid, Microbes as food SCP:-*Spirulina* and Mushroom: Antibiotic: Penicillin; Microbial Enzymes:

Amylase, protease and lipases. Amino acid; L-Glutamic acid)

(Identification-1 Mark and Critical comments-2 mark)

V. Viva-voce

04 Marks

VI. Record

05 Marks

SCHEME OF PRACTICAL EXAMINATION
VI Semester
Practical-VI: Immunology and Medical Microbiology

Duration: 3 hours

Max.Marks:40

I. Demonstrate or perform the experiment A giving principle and procedure. Record the result.10Marks

(Determination of blood group and Rh factor / Ouchterlony double diffusion test / Widal test /
Demonstration of hemolytic activity of pathogenic bacteria)
(Demonstration-5 Marks, Principle and Procedure-4 Marks and Result-1Mark)

II. Perform or demonstrate the experiment B giving principle and procedure. Record the result.10Marks

(Detection of antimicrobial activity of penicillin /Microbial flora of human skin /
Antibiotic sensitivity by Kirby-Bauer method/ Differential Leucocyte count)
(Demonstration-5 Marks, Principle and Procedure-4 Marks and Result-1 Mark)

III. Conduct or identify the test C. Record and interpret the result.

05 Marks

(RPR test/ TSI test /Nitrate reduction /Urease production / Catalase test/Antistreptolysin O Test)
(Conduct/Identification-2 Marks, Result-1 Mark, Interpretation-2 Marks)

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

3x2=06 Marks

(Display of photographs of human pathogens–*Staphylococcus*,*Streptococcus*, *Clostridium*, *Salmonella*,
Vibrio, *Mycobacterium* I, Polio virus, Hepatitis virus,HIV, Rabies virus, Tinea, *Candida*, *Entamoeba* and
Plasmodium/EMB agar/McConkey agar, Mannitol salt agar, TCBS agar, Deoxycholate citrate agar)
(Identification-1MarkandCriticalcomments-2marks)

V. Viva-voce

04 Marks

VI. Record

05 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. Santhosh	Associate Prof& HOD Dept.of Microbiology Yuvaraja'scollege Mysore.
4	Dr. Girish K	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	Associate professor Dept .of Microbiology Maharani's Science College, Mysore
12	Dr.M.S.Shobha	Professor Dept.of Microbiology Maharani's Science College, Mysore
13	Sri. G.S.Siddegowda	Associate professor Dept.of Microbiology Sir M V Government Science College Bhadravathi

14	Nataraju	Associate professor Dept. of Microbiology Maharani's Science College, Mysore
15	Syeda Farahna Parveen	Assistant professor Dept.of Microbiology St.Philomina's College, Mysore
16	Dr. Suresh M G	Associate Professor, Dept. of Microbiology Maharani's Science College, Mysore
17	Mahadevaprasad G	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's College, Mysore
21	Athiya sultan	Assistant professor Dept.of Microbiology SDM College JLBRoad, Mysuru
22	C.Poornima Devi	Assistant professor Dept.of Microbiology Yuvaraja's college, 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
26	Spandhana	Assistant professor Dept.of Microbiology SBRR Mahajana's College, Mysuru
27	Dr.Kiran B	Assistant professor Dept.of Microbiology SBRR Mahajana's College, Mysuru