JSS MAHAVIDYAPEETA

JSS COLLEGE FOR WOMEN (Autonomous)

Saraswathipuram, Mysuru-570009

(Affiliated to **University of Mysore:** Reaccrediated by **NAAC** with **A+ Grade)**

CHOICE BASED CREDIT SYSTEM (CBCS)

&

CONTINUOUS ASSESSMENT AND GRADING PATTERN (CGPA)
Based

B. Sc. MICROBIOLOGY SYLLABUS

For

2024-25 onwards

CBCS based Undergraduate Microbiology Syllabus for 2024-25 onwards

Proposed Semester-wise distribution of the course structure

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week
SEMESTER – I				
	DSC: Theory-I	Introduction to Microbiology and Microbial Diversity	**3**	**3**
	DSC: Practical-I	Introduction to Microbiology and Microbial Diversity	**2**	**4**
SEMESTER – II				
	DSC: Theory-II	Microbial Physiology and Microbial Genetics	**3**	**3**
	DSC: Practical-II	Microbial Physiology and Microbial Genetics	**2**	**4**
SEMESTER – III				
	DSC: Theory-III	Molecular Biology and Recombinant DNA Technology	**3**	**3**
	DSC: Practical-III	Molecular Biology and Recombinant Technology	**2**	**4**
SEMESTER – IV				
	DSC: Theory-IV	Environmental and Agricultural Microbiology	**3**	**3**
	DSC: Practical-IV	Environmental and Agricultural Microbiology	**2**	**4**
SEMESTER – V (Any one of the DSE)				
	DSE: Theory-V	Food and Industrial Microbiology		
	DSE: Practical-V	Food and Industrial Microbiology		
	DSE- Theory-	-		
	DSE- Practical-	-		
	SEC- Theory-	-		
SEMESTER – VI (Any one of the DSE)				
	DSE: Theory-VI	Immunology and Medical Microbiology		
	DSE: Practical-VI	Immunology and Medical Microbiology		
	DSE- Theory-	-		
	DSE- Practical-	-		
	SEC- Theory-	-		

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

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 Hours (3 hrs./week)**

Unit I: History of Microbiology and Microscopy **12 hrs.**

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 **12 hrs.**

Staining techniques: Chemical nature and types of microbiological strains. 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, Incinerator), Moist Heat (Autoclave, Arnold sterilizer), Filtration: Filters (Depth Filters, Membrane Filters and HEPA Filter), Radiation: Cathode rays, UV rays.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 **12 hrs.**

Biodiversity: Definition and levels, Bergey's Manual of Systematic Bacteriology. Comparison of bacteria, archaea and eukarya (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 and economic importance of Rickettsiae, Chlamydia, Mycoplasma, Spirochaetes, Actinomycetes. Cyanobacteria: occurrence, structure, reproduction and importance of *Microcystis, Nostoc* and *Spirulina.*

Unit IV: Diversity of eukaryotes and viruses **12 hrs.**

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

Diversity of viruses: General characteristics of viruses. ICTV Classification, Structure & importance of viruses. Structure & replication of viruses: Bacteriophages-T4 phage, cyanophages-LPP-1, phytophagenae-TMV, zoophagenae- Rabies virus. Subviral particles-viroids, virusoids & prions.

I SEMESTER

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY

PRACTICAL-I **(4hrs/week)**

1. a. Microbiological laboratory standards and safety protocols. 1b.Study of contributions of microbiologists
2. Study and handling of simple and compound microscopes.
3. Working principle and operation of basic equipment of microbiological laboratory (Autoclave, Hot air Oven, Incubator, Laminar Air Flow System, Colony Counter, Membrane filter).
4. Applications of basic microbiological tools (Pipettes, Micropipette, Inoculation loop and needle).
5. Preparation of stains and mordant- Methylene Blue, Crystal Violet, Safranin, Nigrosin, Carbol Fuchsin, Malachite Green, Gram`s Iodine and Cotton Blue.
6. Simple (direct) staining of bacteria.
7. Simple (indirect) staining of bacteria.
8. Gram staining technique.
9. Endospore staining technique.
10. Determination of bacterial motility by Hanging Drop method.
11. Measurement of microbial cell size by micrometry
12. Study of cyanobacteria-*Microcystis, Nostoc* and *Spirulina.*
13. Study of Algae-*Oedogonium,* Diatoms and *Gracilaria.*
14. Study of Fungi-*Rhizopus, Penicillium Fusarium* and *Saccharomyces.*
15. a. Study of Protozoa-*Euglena* and *Paramecium* 15b.Study of T4 phage, TMV & Rabies virus.

Text Books / References

1. Alexopoulas, C. J. and Mims, C.W., Introductory Mycology, Wile Eastern Limited, New Delhi.
2. Atlas, R. M. (1997). Principles of Microbiology. 2nd edition. W. M. T. Brown Publishers.
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. and Clark, D. P. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition.
12. Michael, J. Pelczar, Jr. E. C. S. Chan and Moel (2001). Microbiology, Mc Graw Hill Book Company, New york).
13. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
14. Srivastava, S. and Srivastava, P. S. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht.
15. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L. and Painter, P. R. (2005). General Microbiology. 5th edition McMillan.
16. Tortora, G. J., Funke, B. R. and Case, C. L. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
17. Versteeg, J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.
18. Wagner, E. K., Hewlett, M. J. (2004). Basic Virology. 2nd edition. Blackwell Publishing.

II SEMESTER
DSC-2: MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

Paper II **48 Hours (3 hrs./week)**

Unit I: Microbial nutrition **12 hrs.**

Bacterial nutrition: Bioenergetics. Nutritional requirements and Major nutritional types of microorganisms, Prototrophs and Auxotrophs, Uptake of nutrients-Passive Transport, Facilitated Diffusion, Active Transport, Group Translocation, Iron Uptake. 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 Preservation and Lyophilization.

Culture Collection Centers – ATCC and MTCC

Unit II: Microbial metabolism **12 hrs.**

Microbial enzymes: Enzymes: Definition**,** Nomenclature and Classification, Structure of enzyme, Mechanism of enzyme action. Lock and Key Model and Induced Fit Theory. Factors affecting enzyme activity, Enzyme inhibition and regulation. Microbial enzymes- Sources and Applications

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

Phototrophic metabolism: Photosynthetic microorganisms, Light harvesting pigments, Photophosphorylation, CO_2 fixation pathways: Calvin cycle.

Unit III: Genetic material and Bacterial genetics **12 hrs.**

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: Recombination in bacteria. 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 **12 hrs.**

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: Heterothallism and Parasexuality. Life cycle of *Neurospora*, ordered tetrad analysis in *Neurospora*, unorderedtetrad analysis in yeast,

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

SEMESTER-II

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. Cultivation of anaerobic bacteria by GasPak method.
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, pH meter, Spectrophotometer, Colorimeter, 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 Microoragnisms, Prentice hall of India Pvt. Ltd, New Delhi.
2. Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). Principles of Genetics. 8th Ed. Wiley-India.
3. Gottschalk, G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
4. Klug, W. S., Cummings, M. R., Spencer, C. and Palladino, M. (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.
5. Krebs, J., Goldstein. E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.
6. Lansing, M., Prescott, J., Ohn, P., Harley, Donald A. Klein, (2002) Microbiology,5th ed. WCB Mc Graw Hill, New york.
7. Madigan, M. T. and Martinko, J. M. (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
8. Maloy, S. R., Cronan, J. E. and Friefelder, D. (2004) Microbial Genetics 2nd edition. Jones and Barlett Pub.
9. Moat, A. G. and Foster, J. W. (2002). Microbial Physiology. 4th edition. John Wiley & Sons.
10. Nelson David, L and Cox Michael, M., Lehninger, (2008) Principles of Biochemistry, Macmillan Press, Worth Publishers, New Delhi.
11. Pierce, B. A. (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher 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- A Molecular Approach. 3rd Ed, Benjamin Cummings
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's Microbiology. 9th edition. McGraw Hill Higher Education.

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. 12 Marks

(Direct staining / Indirect staining / Gram staining /Endospore staining)

(Preparation-5 Marks, Principle-2 Marks, Procedure- 3 Marks and Result-2 marks)

II. Identify the materials B and C with labeled diagrams and reasons. 2x6=12 Marks

(One material from Cyanobacteria or Algae and One material from Fungi)

(Identification- 1 Mark, Labelled Diagram-2marks and Reasons- 3 Marks)

III. Measure the size of the microbial cell D using stage and ocular Micrometer. 06 Marks

(Calibration factor- 1 Marks, Principle-1 and procedure- 3 Marks and Result- 1 Mark)

IV. Write critical notes on E, F and G. 3x2=06 Marks

(Microbiologists / Microscopes / Stains / Disinfectants / Laboratory equipment)

(Identification- 1 Mark, Comments- 1 Mark)

V. Viva-voce 04 Marks

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 and interpret the result. 12 Marks

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

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

II. Demonstrate or perform the experiment B giving principle and procedure. Record and interpret the result. 12 Marks

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

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

III. Demonstrate or perform the experiment C. Record and interpret the result. 06 Marks

(Effect of temperature / pH / salt / carbon source on microbial growth / Study of colony characteristics / Demonstration of lactose fermentation/ Cultivation of anaerobic bacteria by GasPak method)

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

IV. Write critical notes on D, E and F. 3x2=06 Marks

(Culture media, pH meter, Spectrophotometer, Colorimeter, GasPak jar, 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- 1 Mark, Comments- 1 Mark)

V. Viva-voce 04 Marks

QUESTION PAPER PATTERN OF THEORY EXAMINATION

I and II SEMESTER B. Sc. MICROBIOLOGY
(For 2024-25 onwards)

Duration: 3 Hours **Max. Marks: 80**

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
} Question paper pattern-1

OR

3 questions from Unit 1
2 questions from Unit 2
3 questions from Unit 3
2 questions from Unit 3
} 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
} Question paper pattern-1

OR

2 questions from Unit 1
1 question from Unit 2
2 questions from Unit 3
1 question from Unit 4
} 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
} 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

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JSS COLLLEGE FOR WOMEN (Autonomous)

CHOICE BASED CREDIT SYSTEM (CBCS)

&

CONTINUOUS ASSESSMENT AND GRADING PATTERN (CAGP)
Based

III, IV, V & VI SEMESTER
B. Sc. MICROBIOLOGY SYLLABUS

Under

MODIFIED NEP SCHEME: 2024-25

Undergraduate Microbiology Syllabus for 2024-25

Semester-wise distribution of the course structure

Paper code	Paper type	Title of the paper	Credits Assigned	Instructional hours per week
SEMESTER – I				
DSC	Theory-I	Introduction to Microbiology and Microbial Diversity	**3**	**3**
DSC	Practical-I	Introduction to Microbiology and Microbial Diversity	**2**	**4**
SEMESTER – II				
DSC	Theory-II	Microbial Physiology and Genetics	**3**	**3**
DSC	Practical-II	Microbial Physiology and Genetics	**2**	**4**
SEMESTER – III				
DSC	Theory-III	Molecular Biology and Environmental Microbiology	**3**	**3**
DSC	Practical-III	Molecular Biology and Environmental Microbiology	**2**	**4**
ELE	Elective: Theory-1	Microbial Quality Control in Industries	**2**	**2**
SEMESTER – IV				
DSC	Theory-IV	Genetic Engineering and Agricultural Microbiology	**3**	**3**
DSC	Practical-IV	Genetic Engineering and Agricultural Microbiology	**2**	**4**
ELE	Elective: Theory-2	Plant and Animal Microbiome	**2**	**2**
SEC	Skill-Practical	Microbial and Molecular Techniques	**2**	**4**
SEMESTER – V				
DSC	Theory-V	Food Microbiology	**3**	**3**
DSC	Theory-VI	Industrial Microbiology	**3**	**3**
DSC	Practical-V	Food Microbiology and Industrial Microbiology	**2**	**4**
SEMESTER – VI				
DSC	Theory-VII	Immunology	**3**	**3**
DSC	Theory-VIII	Medical Microbiology	**2**	**2**
DSC	Practical-VI	Immunology and Medical Microbiology	**2**	**4**
		Total	**41**	**55**

DSC - Discipline Specific Course, ELE - Elective, SEC- Skill Enhancement Course

SCHEME OF VALUATION MAXIMUM MARKS

COURSE TYPE	C1		C2		C3		TOTAL
	THEORY	LAB	THEORY	LAB	THEORY	LAB	
DSC	5+5	5	5+5	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 60 minutes duration, 10 marks (lab) with continuous assessment through record valuation/test and marks reduced to assigned marks.
2. C3 will be conducted for 80 marks (theory) with 3 hours duration, 40 marks (lab) with 3 hours duration.
3. In case of ELE, 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 with 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 with 3 hours duration.

Practical Examination I-VI semesters Duration: 3 Hrs

- Experimentation (Major & Minor/Spotters) - 35 Marks
- Viva voce - 05 Marks

Total **- 40 Marks**

Internal Assessment for Practical Paper I-VI semesters

- Attendance/ Internal Assessment test - 05 Marks
- Record - 05 Marks

Total **- 10 Marks**

V Semester

DSC-V Food Microbiology

Paper Code V: **48 (3 hours/week)**

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.

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: **12 Hrs**

a. Sources of contamination of foods. Intrinsic and extrinsic factors affecting growth and survival of microbes in foods. Principles of spoilage. 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*. **Food intoxications:** *Staphylococcus aureus*, *Clostridium botulinum* and Mycotoxins (Aflatoxins, T2 toxin).

c. Cultural & rapid detection methods of food borne pathogens in foods.

Unit-2: Microbes as food and Food Preservation Techniques: **12 Hrs**

a. Microbes as Food: Cultivation and Nutritional properties of Single Cell Protein (*Spirulina*, *Chlorella* and Mushroom).

b. Food preservation Techniques: Principles of food preservation. 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, SO_2, Ethylene Oxide, antibiotics. Bacteriocins types, classification and applications.

Unit-3: Microbiology of milk: **12 Hrs**

a. Composition of milk. Sources of contamination of milk. Biochemical changes of milk- Souring, Gassy Fermentation, Proteolysis, Lipolysis, Ropiness, **Colour and Flavour**. Microbiological analysis of milk- Rapid platform tests (Phosphatase test, Alcohol Coagulation Test), SPC and Reduction tests (MBRT test and Resazurin test).

b. Milk Preservation: Preservation of milk and milk products- Sterilization, Pasteurization-**LTLT**, HTST, UHT, Dehydration.

Unit-4: Fermented foods: **12 Hrs**

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. Fermented non-dairy products: cereal (idli), vegetable (sauerkraut), meat (sausage) and fish (fish sauce). Fermented beverages- kombucha. Prebiotics, probiotics, synbiotics.

V Semester

DSC-VI Industrial Microbiology

Paper code VI: **48 hours (3 hours/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: **12 Hrs**

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. Important methods of strain improvement. Primary and secondary screening. Stock cultures. Culture collection centers. Preservation and maintenance of industrial strains.

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: **12 Hrs**

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: **12 Hrs**

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.

c. Intellectual Property Rights (IPR)

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

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
7) Microbial bioactive compounds for industrial applications

V SEMESTER

PRACTICAL V

FOOD MICROBIOLOGY AND INDUSTRIAL MICROBIOLOGY

4 hours/week

1. Isolation of microorganisms from food utensils.
2. Microscopic examination of Idli batter.
3. Isolation of spoilage causing fungi from spoiled vegetables, fruits and bread
4. Dye Reduction Test: MBRT test and Resazurin test for assessing the quality given milk sample.
5. Isolation of bacteria from raw and pasteurized milk by Standard Plate Count.
6. Casein hydrolysis test.
7. Estimation of percentage of lactic acid present in a given fermented dairy product.
8. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
9. Preparation of wine from grapes.
10. Estimation of citric acid produced from *Aspergillus niger* by titrimetric method.
11. Estimation of percentage alcohol in a given sample by specific gravity bottle method.
12. Immobilization of enzymes.
13. Microbial production of amylase enzymes by Solid Substrate Fermentation.
14. Screening and isolation of antibiotic producing microbes from soil sample.
15. Study 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.

    Fermented foods: Bread, cheese, Yogurt, Acidophilus milk, Probiotic Foods

Sixth semester DSC-VII

Immunology

Paper VII **48 hours (3 hours/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:

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

UNIT 1: Immune system **12 Hrs**

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. 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. Complement system - Classical, Lectin, and Alternative pathway.

Antigen-Properties and types; Antibodies -Types, Nature and their functions.

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

Salient features Antigen-Antibody Reactions, Agglutination reactions: Hemagglutination- blood grouping, Complement Fixation Test, Widal Test**, RPR Test**. Immunodiffusion: **Oudin, Oklay-Fulthorpe,** Mancini and Ouchterlony procedure, Immunoelectrophoresis- Rocket Electrophoresis, ELISA (Direct, Indirect, Sandwich and Competitive), Radioimmunoassay and Immunofluorescence (Direct and Indirect methods).

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

Cell mediated and humoral mechanism of immune response. 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). Autoimmune Diseases- Salient features, Examples for Autoimmune Diseases- Rheumatoid Arthritis, Graves' disease

UNIT 4: Immunoprophylaxis **12 Hrs**

Definition and advancements in Immunoprophylaxis: Attenuated (MMR, Chicken pox, 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). National immunization Schedule. **Mission Indradhanush.**

Sixth semester

DSC-VIII Medical Microbiology

Paper VIII **32 hours (2 hours/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:

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

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

Human microbiome, Normal micro flora of human Skin, Oral cavity, Gastrointestinal tract, Genito-urinary tract and their importance. Gnotobiotic animals. Host pathogen interaction: Definitions-Infection, Invasion, Pathogenicity, Virulence, and Inflammation. Types of Infection, Modes of transmission of infection, Carriers and their types.

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 **16 Hrs**

Etiology, pathogenesis, epidemiology, diagnosis, prophylaxis and treatment of Viral infections: Polio, Hepatitis-B, Rabies, Dengue, HIV, and Corona. Protozoan disease- Malaria, Trichomoniasis, Amoebic dysentery. Fungal infections: Cutaneous mycoses-Tinea infections, Systemic mycoses- Histoplasmosis and Opportunistic mycoses- Candidiasis.

VI SEMESTER

IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Practical Paper **4 hours/week**

1. Agglutination test: Determination of Blood Group and Rh factor.
2. Precipitation test: a) Oklay- Fulthorpe procedure b) Radial immunodiffusion test.
3. Precipitation test: c) Ouchterlony Double diffusion test
4. Enumeration of WBC.
5. Differential leucocyte count.
6. Widal test and RPR test
7. Study of normal microflora of human skin.
8. Detection of bacteruria by Urine dip slide method.
9. Peripheral blood smear test for detection of malarial parasite
10. Examination of stool sample for identification of *Entamoeba histolytica* cyst by Saline method.
11. Detection of ringworm infection by KOH test.
12. Antibiotic sensitivity test (Disc diffusion method).
13. Isolation and Identification of *E. coli*
14. Isolation and Identification of *Staphylococcus spp.*
15. Microscopic observation / display of photographs of human pathogens – *Staphylococcus, Streptococcus, Clostridium, Salmonella, Vibrio, Mycobacterium* I, Polio virus, Hepatitis B virus, HIV, Rabies virus, Tinea*, Candida, Entamoeba* and *Plasmodium*.

III SEMESTER

ELECTIVE PAPER-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 bio-hazardous agents. Good Laboratory Practices and Good Microbiological Practices.

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

c. 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: **Food safety and standards** **16 hrs.**

a. Importance of Pathogenic microorganisms in Food & Water: SOP for water and food sampling.

b. 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.

IV SEMESTER

SEC-1 MICROBIAL AND MOLECULAR TECHNIQUES

SKILL PAPER-1

Practical Paper **[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 log book maintenance and documentation procedure.
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's Dextrose Agar, Czapek dox agar, EMB Agar, McConkey agar, Mannitol salt agar and Algal medium.
8. Isolation of microorganisms by Pour plate and Spread plate method.
9. Isolation of microorganisms by Streak plate & Point inoculation method
10. Biochemical characterization of bacteria – Catalase test, Oxidase test, IMVIC Reactions, TSI test,
11. Biochemical characterization of bacteria -Nitrate reduction and starch hydrolysis.
12. Study of centrifugation and ultra centrifugation techniques and its application.
13. Study of partition, adsorption, ion exchange, exclusion & affinity chromatography- principle and applications.
14. Study of UV and Visible spectrophotometric techniques – principle and applications.
15. Study of Electophoretic technique: Agarose and Polyacrylamide Gel Electrophoresis.