JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE
(An Autonomous College of University of Mysuru)
Re-accredited by NAAC with 'A' grade Ooty road,
Mysuru-570 025, Karnataka

ESTD-1964

DEPARTMENT OF MICROBIOLOGY

SYLLABUS

NATIONAL EDUCATION POLICY
FOR

B.Sc. PROGRAMME

Microbiology & Biotechnology

Microbiology & Biochemistry

(W. E. F. 2023 – 2024)

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSURU-25DEPARTMENT OF MICROBIOLOGY
PROFORMA OF INSTRUCTIONS AND EXAMINATION FOR B.Sc. PROGRAMME IN MICROBIOLOGY (NEP)
DURATION OF THE COURSE: 4YEARS (8SEMESTER)
PROGRAMME: BSc Mb & Bt, (2023-24)PROGRAMME CODE: BScMbBt41
BSc Microbiology (Basic / Hons.)

Year	Semester	Course Category	Title of the paper	Lecture + Practicals hours per week	No. of credits L	T	P	Total credits	Total hours Th	Pr	Duration of Exam (Hrs.)	Maximum Marks in Exam/Assessment IA(Theory) C-1	C-2	C-3	Total
I B.Sc	I	**DSC-I :Theory-FSA500**	General Microbiology	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-I: Pract-I -FSA501P	General Microbiology	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		OE-I	Microbial Technology for human welfare	03	3:	0:	0	03	42	-	**2½**	20	20	60	100
	II	**DSC-II: TheoryFSB500**	Microbial biochemistry and physiology	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-II: Pract-II- FSB501P	Microbial biochemistry and physiology	04	0 :	0:	2	02		60	**3**	10	10+5(R)	25	50
		OE-II	Environmental and sanitary Microbiology	02	3:	0:	0	03	42		**2½**	20	20	60	100
II B.Sc	**III**	**DSC-III :TheoryFSC500**	Microbial Diversity	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-III:P ract-III-FSC501P	Microbial Diversity	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		OE-III	Microbial Entrepreneurship	03	3:	0:	0	03	42	-	**2½**	20	20	60	100
	IV	**DSC-IV: TheoryFSD500**	Microbial Enzymology and Metabolism	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-IV: Pract-IV-FSD501P	Microbial Enzymology and Metabolism	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		OE-IV	Human Microbiome	02	3:	0:	0	02	42		**2½**	10	10	30	50
	V	**DSC- V: TheoryFSE500**	Microbial Genetics	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-V: Pract-V-FSE501P	Microbial Genetics	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		DSC-VI: TheoryFSE502	Food Microbiology	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-VI: Pract-V-FSE503P	Food Microbiology	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		SEC-I :Theory	Microbial and Biochemical Techniques	02	2:	0:	0	02	30		**2½**	10	10	30	50
		SEC –I; Practicals	Microbial and Biochemical Techniques	02	0:	0:	1	01		30	**3**	10	10+5(R)	25	50
	VI	**DSC- VII: TheoryFSF500**	Immunology and Medical Microbiology	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-VII: Pract-V-FSF501P	Immunology and Medical Microbiology	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		DSC-VIII: TheoryFSF502	Industrial Microbiology	04	4:	0 :	0	04	60		**2½**	20	20	60	100
		DSC-VI: Pract-V-FSF503P	Industrial Microbiology	04	0:	0:	2	02		60	**3**	10	10+5(R)	25	50
		Internship	Internship	02				02	3-4weeks (Report& Viva)			25		25	50

JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE, OOTY ROAD, MYSURU-25DEPARTMENT OF MICROBIOLOGY
PROFORMA OF INSTRUCTIONS AND EXAMINATION FOR B.Sc. PROGRAMME IN MICROBIOLOGY (NEP)
DURATION OF THE COURSE: 4YEARS (8SEMESTER)
PROGRAMME: BSc Mb & Bc, (2023-24)PROGRAMME CODE: BScMbBc42
BSc Microbiology (Basic / Hons.)

Year	Semester	Course Category	Title of the paper	Lecture + Practicals hours per week	No. of credits L	T	P	Total credits	Total hours Th	Pr	Duration of Exam (Hrs.)	Maximum Marks in Exam/Assessment IA(Theory) C-1	C-2	C-3	Total
I B.Sc	I	**DSC-I :Theory-FSA500**	General Microbiology	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-I: Pract-I -FSA501P	General Microbiology	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		OE-I	Microbial Technology for human welfare	03	3:	0:	0	03	42	-	$2^1/_2$	20	20	60	100
	II	**DSC-II: TheoryFSB500**	Microbial biochemistry and physiology	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-II: Pract-II- FSB501P	Microbial biochemistry and physiology	04	0 :	0:	2	02		60	3	10	10+5(R)	25	50
		OE-II	Environmental and sanitary Microbiology	02	3:	0:	0	03	42		$2^1/_2$	20	20	60	100
II B.Sc	III	**DSC-III :TheoryFSC500**	Microbial Diversity	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-III:P ract-III-FSC501P	Microbial Diversity	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		OE-III	Microbial Entrepreneurship	03	3:	0:	0	03	42	-	$2^1/_2$	20	20	60	100
	IV	**DSC-IV: TheoryFSD500**	Microbial Enzymology and Metabolism	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-IV: Pract-IV-FSD501P	Microbial Enzymology and Metabolism	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		OE-IV	Human Microbiome	02	3:	0:	0	02	42		$2^1/_2$	10	10	30	50
	V	**DSC- V: TheoryFSE500**	Microbial Genetics	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-V: Pract-V-FSE501P	Microbial Genetics	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		DSC-VI: TheoryFSE502	Food Microbiology	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-VI: Pract-V-FSE503P	Food Microbiology	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		SEC-I :Theory	Microbial and Biochemical Techniques	02	2:	0:	0	02	30		$2^1/_2$	10	10	30	50
		SEC –I; Practicals	Microbial and Biochemical Techniques	02	0:	0:	1	01		30	3	10	10+5(R)	25	50
	VI	**DSC- VII: TheoryFSF500**	Immunology and Medical Microbiology	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-VII: Pract-V-FSF501P	Immunology and Medical Microbiology	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		DSC-VIII: TheoryFSF502	Industrial Microbiology	04	4:	0 :	0	04	60		$2^1/_2$	20	20	60	100
		DSC-VI: Pract-V-FSF503P	Industrial Microbiology	04	0:	0:	2	02		60	3	10	10+5(R)	25	50
		Internship	Internship	02				02	3-4weeks (Report& Viva)			25		25	50

Name of the Degree Program: B. Sc.
(Basic/Hons.)Discipline Core: Microbiology

Total Credits for the Program: B. Sc. Basic - 136 and B. Sc. Hons. - 176
Starting year of implementation: 2021-22

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

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

1. Knowledge and understanding of concepts of microbiology and its application in pharma, food, agriculture, beverages, nutraceutical industries.
2. Understand the distribution, morphology and physiology of microorganisms and demonstrate the skills in aseptic handling of microbes including isolation, identification and maintenance.
3. Competent to apply the knowledge gained for conserving the environment and resolving the environmental related issues.
4. Learning and practicing professional skills in handling microbes and contaminants in laboratories and production sectors.
5. Exploring the microbial world and 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.

Assessment:

Weightage for assessments (in percentage)

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

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

Total Marks for each course = 100%
Formative Assessment (C1 + C2) = 40%
Semester End Examination (C3) = 60%

B. Sc. Microbiology 1st Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	I
Course Title	GENERAL MICROBIOLOGY (Theory)			
Course Code	DSC-1T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	2 1/2
Formative Assessment Marks	40		Summative Assessment Marks	60
Subject code	FSA500		QP code	11117

Course Outcomes (COs):

At the end of the course the student should be able to: (Write 3-7 course outcomes. Course outcomes are statements of observable student actions that serve as evidence of knowledge, skills and values acquired in this course)

1. Thorough knowledge and understanding of concepts of microbiology.
2. Learning and practicing professional skills in handling microbes.
3. Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.

Content of Course 1: Theory: DSC-1T, General Microbiology	60 Hrs.
Unit 1: Historical development, origin of microorganisms, major contributions and microscopy	**15 Hrs.**
Historical development of microbiology -Theory of spontaneous generation, Biogenesis and Abiogenesis. Evolution of microorganisms. Fossil evidences of microorganisms. Contributions of Antony Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister and Edward Jenner, Alexander Fleming, Martinus Beijerinck, Sergei Winogrodsky, Elie Metechnikoff. Contributions of Indian scientists in the field of Microbiology. Microscopy: working principle, construction and operation of simple and compound microscopes. Phase contrast, Dark Field, Fluorescence, Confocal, Scanning and Transmission Electron Microscopy.	
Unit 2: Staining, sterilization, culturing and preservation of microorganisms	**15 Hrs.**
Staining: Nature of strains, principles, mechanism, methods and types of staining: Simple (Positive and Negative), Differential (Gram staining and Acid fast staining) and Structural (capsule, cell wall, endospore). **Sterilization:** Principles, types and techniques, Physical and chemical methods. Culture media and their types. Pure culture techniques and colony characteristics. Preservation of microorganisms: Methods of preservation of microorganisms; slant culture, stab culture, soil culture, mineral oil overlaying, glycerol preservation.	
Unit 3: Types, structure, organisation and reproduction of prokaryotic microorganism	**15 Hrs.**
Overview of Prokaryotic Cell Structure: Size, shape, arrangement. Diagram of Prokaryotic cell organisation, cell wall structure of Gram positive and negative bacteria, cell membrane; Bacterial and Archaeal, Cytoplasmic matrix- Composition and function of Cytoskeleton, ribosome and inclusion granules.Nuclear Materials: Bacterial chromosomes structure (its differences with the Eukaryotic chromosome); Extra Chromosomal materials. Components external to cell wall- capsule,	

slime, S layer, pilli, fimbriae, flagella-structure, motility, chemotaxis. Bacterial endospore: formation and function and types with example. Reproduction in bacteria and bacterial cell cycle.
Unit 4: Types, structure, organisation , reproduction and nomenclature of eukaryotic microorganisms **15 Hrs.**
Over view of eukaryotic cell structure: General structure and types of cells; External cell coverings and cell membrane. Structure and function of Cytoplasmic matrix-cytoskeleton. Single membrane organelles: Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles and Ribosomes. Double Membrane organelles: Nucleus, Mitochondrion and Chloroplast: Structure and Functions; Peroxisomes. Organelles of motility- Structure and movement of flagella and cilia.

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

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

Course Title	GENERAL MICROBIOLOGY (Practical)		
Course Code	DSC-2P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25
Subject code	FSA501P		

Course 1: Practical: DSC-2P, General Microbiology

1. Microbiological laboratory standards and safety protocols.
2. Standard aseptic conditions of Microbiological laboratory.
3. Operation and working principles of Simple and Compound microscope.
4. Working principles and operations of basic equipments of microbiological laboratory (Autoclave, Hot air Oven, Incubator, pH meter, Spectrophotometer, Colorimeter, Vortex, Magnetic stirrer).
5. Applications of basic microbiological tools (Pipettes, Micropipette, Bunsen burner, Inoculation loop and needle, Spreader).
6. Demonstration and observations of microorganisms from natural sources under light microscope (Algae, Yeast and Protozoa).
7. Demonstration of bacterial motility by hanging drop method.
8. Simple (Direct and Indirect) staining of bacteria.
9. Differential staining- Gram staining and Acid-fast staining.
10. Structural staining- Bacterial endospore and Capsule.
11. Staining of fungi by Lactophenol cotton blue.
12. Cleaning and sterilization of glassware. Preparation of media-nutrient broth, nutrient agar, potato dextrose agar and Mac Conkey's agar.
13. Cultivation of microorganisms on agar plate (point inoculation), broth and anaerobic cultivation (gaspak method).
14. Study of colony characteristics. Isolation of pure cultures of bacteria by streak plate method.
15. Maintenance and preservation of bacterial cultures on agar slants, overlaying with mineral oil and stab culture.

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books / References

1. Alexopoulos, C. J., Mims, C.W., and Blackwell, M. (2002). Introductory Mycology. JohnWiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.
2. Atlas, R. M. (1984). Basic and practical microbiology. Mc Millan Publishers, USA. 987pp.
3. Black, J. G. (2008). Microbiology principles and explorations. 7th ed., John Wiley andSons Inc., New Jersey 846 pp.
4. Dubey, R. C. and Maheshwari, D. K. (1999). A Textbook of Microbiology. 1st ed., S. Chand& Company Ltd.
5. Jeffrey C .Pommerville (2011).Alcamo's Fundamentals of Microbiology,9 th Ed.Jonesand Bartlett publishers.
6. Lansing, M. Prescott, John, P. Harley, Donald A. Klein. (2002). Microbiology, 5th ed., WCBMc Graw Hill, New york.
7. Linda Bruslind, (2020). General Microbiology. 1st ed., Oregon State University
8. Madigan, M. T. Martinko, J. M. Dunlap, P. V. and Clark, D. P. (2009). Brock Biology ofMicroorganisms. 12th ed., Pearson International edition Pearson Benjamin Cummings.
9. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edition. McGrawHill Book Company.
10. Schlegel, H.G. (1995).General Microbiology. Cambridge University Press, Cambridge, 655 pp.
11. Seeley, H. W. and Demark, J. V. (1962) Microbes in Action-A laboratory Manual ofMicrobiology , Freeman Publisher.
12. Stanier and Ingraham et al, (1987). General Microbiology, 4th and 5th ed., Mc Millan education limited.
13. Sullia, S. B and Shantharam, S. (1998). General Microbiology. Oxford and IBM PublishingCompany Pvt Ltd,New Delhi.
14. Talaro, K. P. (2009). Foundations in Microbiology, 7th International edition, McGraw Hill.
15. Tortora, G. J. Funke, B. R. and Case, C. L. (2008). Microbiology-An Introduction, 10th ed.2008, Pearson Education.

Course 2: Theory: OE 1T, Microbial Technology for Human Welfare

Course 2 : OE 1T, Microbial Technology for Human Welfare	42 Hrs.
Unit 1: Food and Fermentation Microbial Technology	**14 Hrs.**
Fermented Foods– Types, Nutritional Values, Advantages and Health BenefitsPrebiotics, Probiotics, Symbiotics and Nutraceutical Foods Fermented Products– Alcoholic and non-alcoholic beverages, fermented dairy products,Fruit fermented drinks	
Unit 2: Agricultural Microbial Technology	**14 Hrs.**
Microbial Fertilizers Microbial Pesticides Mushroom Cultivation Biogas Production	
Unit 3: Pharmaceutical Microbial Technology	**14 Hrs.**
Microbial Drugs– Types and Development of Drug Resistance Antibiotics– Types, Functions and Antibiotic Therapy Vaccines– Types, Properties, Functions and Schedules	

Text Books / References

1. Adams, M. R. and Moss, M. O.(1995). Food Microbiology. Royal Society of Chemistry,Cambridge University Press.
2. Ananthanarayan, R. and Paniker, C. K. J. (2009). Textbook of Microbiology. 8th ed.,University Press Publication.
3. Frazier and Westhoff, D. C. (1995). Food Microbiology. Tata McGraw Hill Pub. CompanyLtd., New Dehli.
4. Nandini Shetty (1993). Immunology: Introductory Textbook. NewAge International Ltd.
5. Rangaswamy, G. and Bagyaraj, D. J. (2001). Agricultural Microbiology, 2nd ed., Prenticehall of India Pvt. Ltd., New Delhi.
6. Stanbury, P. T. and Whitaker, (1984). Principles of Fermentation Technology, Pergamon Press, Newyork.
7. Subba Rao, N. S. (1988). Biofertilizers in Agricultural 2nd ed., Oxford and IBH Pub.Co., New Delhi.
8. Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. (2013) Prescott, Harley and Klein'sMicrobiology. 9th edition. McGraw Hill Higher Education.

B. Sc. Microbiology 2nd Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	II
Course Title	MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY (Theory)			
Course Code	DSC-3T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	2 1/2
Formative Assessment Marks	40		Summative Assessment Marks	60
Subject code	FSB500		QP code	11217

Content of Course 1: DSC-2T, Microbial Biochemistry and Physiology	60 Hrs.
Unit 1: Biochemical Concepts	**15 Hrs.**
Basic Biochemical Concepts: Major elements of life and their primary characteristics, atomic bonds and molecules-bonding properties of carbon, chemical bonds- covalent and non- covalent, Hydrogen bonds and Vander Waal Forces. Biological Solvents: Structure and properties of water molecule, Water as an universal solvent, polarity, hydrophilic and hydrophobic interactions, properties of water, Acids, bases, electrolytes, hydrogen ion concentration, pH, buffers and physiological buffer system.	
Unit 2: Macromolecules and Microbial nutrients	**15 Hrs.**
Definition, properties, classification and importance of carbohydrates, Amino acids, proteins, Lipids and Fats, Porphyrins and Vitamins. Microbial Nutrition: Microbial nutrients- Macro and micronutrients, Classification of organisms based on carbon source, energy source and electron source, Major nutritional classification of microorganisms. Cellular transport: Passive, Facilitated, Active, Group Translocation, Uptake of iron, Membrane bound and binding protein transport system- ATPase.	
Unit 3: Microbial Growth	**15 Hrs.**
Microbial Growth: Definition of growth, Mathematical expression, Growth curve, phases of growth, calculation of generation time and specific growth rate. Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth. Measurement of Growth: Direct Microscopic count - Haemocytometer; Viable count, Membrane filtration; Electronic Counting; Measurement of cell mass; Turbidity measurements- Nephelometer and spectrophotometer techniques; Measurements of cell constituents. Growth Yield (definition of terms). Influence of environmental factors on growth. Microbial growth in natural environments. Viable non-culturable organisms. Quorum sensing.	
Unit 4: Bioenergetics, Microbial Respiration, Microbial Photosynthesis	**15 Hrs.**
Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Laws of thermodynamics. Microbial Respiration: Structure, types and function of cytochrome, Respiratory electron transport chain in bacteria, oxidative and substrate level phosphorylation-inhibitors and mechanism, chemiosmotic coupling. Fermentation reactions (homo and hetero). Microbial Photosynthesis: Light reaction: Light harvesting pigments, structure of bacterial chlorophyll, Photophosphorylation, CO_2 fixation pathways: Calvin cycle and Reductive TCA pathway.	

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

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

Course Title	MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY (Practical)		
Course Code	DSC-4P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25
Subject code	FSB501P		

Course 1: Practical: DSC-2P, Microbial Biochemistry and Physiology

1. Preparation of Solution: Normal and Molar solutions.
2. Calibration of pH meter and determination of pH of natural samples.
3. Preparation of Buffer Solutions- Phosphate and Citrate buffer.
4. Qualitative determination and identification of Carbohydrates.
5. Qualitative determination and identification of Proteins.
6. Qualitative determination and identification of Amino Acids.
7. Qualitative determination and identification of Fatty Acids.
8. Quantitative estimation of Reducing Sugar by DNS method.
9. Quantitative estimation of Proteins by Biuret and Lowry's method.
10. Determination of bacterial growth by spectrophotometric method & calculation of generation time.
11. Measurement of cell number using Haemocytometer.
12. Effect of pH and Temperature on bacterial growth.
13. Effect of salt concentration on bacterial growth.
14. Effect of carbon source on microbial growth.
15. Demonstration of aerobic (catalase) and anaerobic respiration (Kuhne`s fermentation)in microbes.

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books / References

1. Boyer, R. (2002), Concepts in Biochemistry 2nd Edition, Brook/ Cole, Australia.
2. Caldwell, D. R. (1995). Microbial Physiology and Metabolism. Brown Publishers.
3. Cohen and Georges, N. (2014). Microbial Biochemistry. Springer, Netherlands.
4. Felix Franks, (1993). Protein Biotechnology. Humana Press, New Jersey.
5. Harper (1999). Biochemistry, McGraw Hill, New York.
6. Lodish H, T. Baltimore, A. Berck B.L. Zipursky, P. Mastsydaire and Darnell, J. (2004). Molecular Cell Biology. Scientific American Books, Inc. Newyork.
7. Moat A. G., Foster J.W. Spector, (2004). Microbial Physiology. 4th ed., Panama Book Distributors.
8. Nelson and Cox, (2000). Lehninger Principles of Biochemistry, Elsevier Publ.
9. Palmer, T. (2001), Biochemistry, Biotechnology and Clinical Chemistry. Harwood Publication, Chichester.
10. Stryer, L. (1995). Biochemistry. Freeman and Company, New York.
11. Voet and Voet, (1995). Biochemistry. John Wiley and Sons, New York.

Course 2: Theory: OE- 2T, Environmental and Sanitary Microbiology

Course 2: Theory: OE- 2T, Environmental and Sanitary Microbiology	**42 Hrs.**
Unit 1: Soil and Air Microbiology	**14 Hrs.**
Soil and Air as a major component of environment.Types, properties and uses of soil and air. Distribution of microorganisms in soil and air. Major types of beneficial microorganisms in soil. Major types of harmful microorganisms in soil	
Unit 2: Water Microbiology	**14 Hrs.**
Water as a major component of environment.Types, properties and uses of water. Microorganisms of different water bodies.Standard qualities of drinking water	
Unit 3: Sanitary Microbiology	**14 Hrs.**
Public health hygiene and communicable diseases.Survey and surveillance of microbial infections.Airborne microbial infections, waterborne microbial infections, Food borne microbial infections. Epidemiology of microbial infections, their detection and control.	

Text Books / References

1. Dubey, R. C. and Maheshwari, D. K. (1999). A Textbook of Microbiology. 1st ed., S. Chand& Company Ltd.
2. Jeffrey C. Pommerville (2011).Alcamo's Fundamentals of Microbiology,9 th Ed.Jonesand Bartlett publishers.
3. Lansing, M. Prescott, John, P. Harley, Donald A. Klein. (2002). Microbiology, 5th ed., WCBMc Graw Hill, New york.
4. Madigan, M. T. Martinko, J. M. Dunlap, P. V. and Clark, D. P. (2009). Brock Biology ofMicroorganisms. 12th ed., Pearson International edition Pearson Benjamin Cummings.
5. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edition. McGrawHill Book Company.
6. Seeley, H. W. and Demark, J. V. (1962) Microbes in Action-A laboratory Manual ofMicrobiology , Freeman Publisher.
7. Stanier and Ingraham et al, (1987). General Microbiology, 4th and 5th ed., Mc Millan education limited.
8. Sullia, S. B and Shantharam, S. (1998). General Microbiology. Oxford and IBM PublishingCompany Pvt Ltd,New Delhi.
9. Tortora, G. J. Funke, B. R. and Case, C. L. (2008). Microbiology-An Introduction, 10th ed.2008, Pearson Education.
10. Gregory, P. H. (1961). The Microbiology of the atmosphere. Interscience Publishers,NewYork.
11. Subba Rao, N. S. (2002). Soil Microorganisms and Plant Growth 4th ed., Oxford and IBHPub. Co. Pvt. Ltd., New Delhi.

B. Sc. Microbiology 3rd Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	III
Course Title	MICROBIAL DIVERSITY (Theory)			
Course Code	DSC-5T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	2 1/2
Formative Assessment Marks		40	Summative Assessment Marks	60
Subject code		FSC500	QP code	11317

Course Outcomes (COs): At the end of the course the student should be able to;

1. Knowledge about microbes and their diversity.
2. Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes.
3. Knowledge about viruses and their diversity.

Content of Course 3: Theory: DSC-5T, Microbial Diversity	60 Hrs.
Unit 1: Biodiversity and Microbial Diversity	**15 Hrs.**
Concept, definition, and levels of biodiversity. Study and measures of microbial diversity. Major classification systems: Whittaker's five kingdom classification and Carl Woese's three domain classification. Biosystematics: Taxonomic ranks, Nomenclature – ICNP rules. Phenotypic and phylogenetic classification. Classical and molecular characteristic used in microbial taxonomy. Assessing microbial phylogeny- Molecular chronometer and Phylogenetic tree. Numerical and Chemotaxonomy. Ribotyping. Economic values of microbial diversity.	
Unit 2: Diversity of Prokaryotic Microorganisms	**15 Hrs.**
An overview of Bergey's Manual of Systematic Bacteriology. General characteristics and economic importance; Bacteria- *Escherichia coli, Bacillus subtilis, Staphylococcus aureus* Archea- Thermophiles- *Thermus aquaticus* and Halophiles- *Halobacteria salinarium* Cyanobacteria- *Nostoc, Microcystis, Spirulina* Actinomycetes: *Streptomyces, Nocordia, Frankia* Rickettsiae- *Rickettsia rickettsi* Chlamydiae- *Chlamydia trachomatis* Spirochaetes- *Treponema pallidum*	
Unit 3: Diversity of Eukaryotic Microorganisms	**15 Hrs.**
Fungi: Alexopoulos and Mim's classification. General characteristics, Structure, reproduction and economic importance- *Rhizopus, Aspergillus, Agaricus, Fusarium, Saccharomyces*. Algae: Fritsch's classification. Occurrence, thallus organization and economic importance *Chlorella, Cosmarium,* Diatoms, *Gracilaraia*, Lichen-thallus organization and types. Protozoa: Salient features, Classification up to the level of classes. Type study- *Euglena,Paramoecium, Trypanosoma*	
Unit 4: Diversity of Virus	**15 Hrs.**

General properties and structure, Isolation and purification of virus. Principles of Viral taxonomy- Baltimore and ICTV classification.
Capsid symmetry- Icosahedral, helical, complex. Structure,
Replication and Significance of the following:
Human and Animal viruses: HIV, Corona, Oncogenic virus and H1N1.
Plants viruses: TMV, Ring spot virus in Tomato
Microbial viruses: T4 phage, Lambda phage, Cyanophages and Mycophages. Subviral particles: Viroids, Virusoids, Satellite virus and Prions.

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

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

Course 3: Practical: DSC-6P, Microbial Diversity

Course Title	MICROBIAL DIVERSITY (Practical)		
Course Code	DSC-6P	No. of Credits	02
Contact Hours	60 (4 Hrs. per session)	Duration of SEA/Exam (Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25
Subject code	FSC501P		

Practical Content

1. Isolation and enumeration of bacteria from soil
2. Isolation and identification of fungi from soil
3. Isolation and characterization of bacteria from air
4. Isolation and identification of fungi from air
5. Isolation and enumeration of bacteria from water
6. Microscopic observation of pond and lake water for cyanobacteria and algae
7. Cultivation of cyanobacteria
8. Cultivation of Actinomycetes
9. Measurement of microbial cell size by Micrometry
10. Study of cyanobacteria –*Nostoc*, *Microcyctis, Spirulina*
11. Study of Algae –*Chlorella*, Diatoms, Gracilaria
12. Study of Fungi – *Rhizopus, Aspergillus, Saccharomyces, Agaricus*
13. Study of Protozoa – *Paramoecium, Euglena*
14. Study of HIV, Corona virus and Oncogenic viruses
15. Study of TMV, T4 Phage and Viroids

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books / References

1. Brock, T. D. and Madigan, M. T. (1988). Biology of Microorganisms, V Edition. PrenticeHall. New Jersey
2. Vashishta, B. R, Sinha A.K and Singh V. P. (2005). Botany – Fungi, S. Chand andCompany Limited, NewDelhi
3. Black, J. G. (2002). Microbiology-Principles and Explorations. John Wiley and Sons, Inc.New York
4. Dimmock, N. J., Easton, A. J., and Leppard, K. N. (2001). Introduction to Modern Virology. 5th edn. Blackwell publishing, USA
5. Flint, S. J., Enquist, L. W., Drug, R. M., Racaniello, V. R. and Skalka, A. M. (2000). Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington,D.C
6. Prescott, Harley, Klein's Microbiology, J. M. Willey, L. M. Sherwood, C. J. Woolverton, (2008) 7th edition, McGraw Hill
7. Kotpal R. L (2008). Protozoa, 5th edn. Rastogi Publications, Meerut, New Delhi.
8. Tortora, G. J. Funke, B. R. Case, C. L. (2008). Microbiology – An Introduction, 10thedn., PearsonEducation
9. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edn. McGraw HillBook Company.
10. Vashishta, B. R Sinha A. K and Singh V. P. (2005). Botany - Algae S. Chand andCompany Limited, NewDelhi
11. Alexopoulos, C. J., Mims, C. W., and Blackwell, M. (2002). Introductory Mycology.John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869pp

Course 3: Theory: OE 3T, Microbial Entrepreneurship

Course Outcomes (COs): At the end of the course the student should be able to:

1. Demonstrate Entrepreneurial skills
2. Acquire knowledge industrial Entrepreneurship
3. Acquire knowledge about Healthcare Entrepreneurship

Course 3: Theory: OE 3T, Microbial Entrepreneurship	**42Hrs**
Unit 1: General Entrepreneurship	**14Hrs**
Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Bio-safety and Bioethics, IPR and patenting, Government organization/ institutions/ schemes, Opportunities and challenges.	
Unit 2: Industrial Entrepreneurship	**14Hrs**
Microbiological industries – Types, processes and products, Dairy products, Fermented foods, Bakery and Confectionery, Alcoholic products and Beverages, Enzymes – Industrial production and applications. Biofertilizers and Biopesticides, SCP (Mushroom and *Spirulina*) etc.	
Unit 3: Healthcare Entrepreneurship	**14Hrs**
Production and applications: Sanitizers, Antiseptic solutions, Polyphenols (Flavonoids), Alkaloids, Cosmetics, Biopigments and Bioplastics, vaccines, Diagnostic tools and kits.	

Text Books / References

1. Srilakshmi B, (2007). Dietetics. New Age International publishers. New Delhi
2. Srilakshmi B, (2002). Nutrition Science. New Age International publishers. New Delhi
3. Swaminathan M. (2002). Advanced text book on food and Nutrition. Volume I. Bappco
4. Gopalan.C., Ramasastry, B.V., and Balasubramanian, S.C.(2009). Nutritive value ofIndianFoods. NIN. ICMR. Hyderabad.
5. Mudambi, S. R. and Rajagopal, M. V. (2008. Fundamentals of Foods, Nutrition &diet therapy by NewAge International Publishers, New Delhi

B. Sc. Microbiology 4th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	IV
Course Title	MICROBIAL ENZYMOLOGY AND METABOLISM (Theory)			
Course Code	DSC-7T		No. of Credits	04
Contact Hours	60 (4 Hrs. per week)		Duration of SEA/Exam (Hrs.)	2 1/2
Formative Assessment Marks	40		Summative Assessment Marks	60
Subject code	FSD500		QP code	11417

Course Outcomes (COs): At the end of the course the student should be able to:

1. Differentiating concepts of chemo heterotrophic metabolism and chemo lithotrophic metabolism.
2. Describing the enzyme kinetics, enzyme activity and regulation.
3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms

Content of Course 4: DSC-7T, Microbial Enzymology and Metabolism	60 Hrs.
Unit 1: Basics of Enzymes	**15 Hrs.**
Enzymes- Definition, nomenclature and IUB system of classification. Definition of terms: enzyme unit, specific activity and turnover number. Enzyme types with example: exo and endoenzymes, constitutive and induced enzymes, Monomeric, Oligomeric and Multimeric enzymes, Multi-enzyme complex, Isozyme, Lysozyme, Ribozymes, abzymes. **Structure of enzyme:** Apoenzyme, cofactors, prosthetic group-TPP, coenzyme-NAD. Active site-properties and role. Mechanism of enzyme action. Lock and key hypothesis and Induced Fit hypothesis. Enzyme catalysis: types and factors affecting the enzyme catalysed reaction. Enzyme kinetics- Michaeli's and Menten equation, Lineweaver-Burk plot.	
Unit 2: Enzyme regulation and Microbial enzymes	**15 Hrs.**
Enzyme inhibition: Reversible- Competitive, non-competitive and uncompetitive inhibition. Irreversible and Feedback inhibition. Enzyme regulation: Allosteric enzyme - general properties, Hill equation. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Microbial enzymes: source-fungal, bacterial and yeast. Production, Purification and isolation of microbial enzymes. Application of microbial enzymes- Pharmaceutical, Food and Feed industry, Paper and Pulp industry, Leather and Textile industry, Enzymes in cosmetics and detergents. Microbial enzymes as therapeutic agents: Anti-inflammatory, Antibacterial (Enzybiotics, Fibrinolytic enzymes) and Anticancer enzymes, Enzymes as digestive aids.	
Unit 3: Metabolism of Carbohydrates	**15 Hrs.**
Chemoheterotrophic Metabolism- Sugar degradation pathways i.e. EMP, ED, Pentosephosphate pathway. TCA cycle. Utilization of Lactose, Maltose, Cellulose and Pectin. Fermentation: Concept of linear and branched fermentation pathways. Alcohol fermentation and Pasteur effect, 2, 3-butanediol fermentation, acetate Fermentation. Chemolithotrophic Metabolism: Hydrogen oxidation, Sulphur oxidation, Iron oxidation.	

Anaerobic respiration with special reference to assimilatory sulphate reduction.	
Unit 4: Metabolism of Nitrogen, Amino acids, Lipids and Carbon compounds	**15 Hrs.**
Nitrogen metabolism: Biological nitrogen fixation- nodulation in leguminous plants, Nitrogenase, leghaemoglobin, Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification. Biosynthesis of non-essential amino acids and Amino acid degradation. Biosynthesis of long chain fatty acids- palamitate and lipid degradation (beta oxidation). Metabolism of carbon compounds: Methylotrophs- Oxidation of methane, methanol, methylamines. Carbon assimilation in methylotrophic bacteria. Methanogens. Acetic acid bacteria- Ethanol oxidation and sugar alcohol oxidation.	

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

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

Course 4: Practical: DSC-8P,
Microbial Enzymology and Metabolism

Course Title	**MICROBIAL ENZYMOLOGY AND METABOLISM (Practical)**		
Course Code	**DSC-8P**	**No. of Credits**	**02**
Contact Hours	**60 (4 Hrs. per session)**	**Duration of SEA/Exam (Hrs.)**	**03**
Formative Assessment Marks	**25**	**Summative Assessment Marks**	**25**
Subject code	**FSD501P**		

Practical Content

1. Sugar fermentation tests for bacteria
2. Separation of amino acids by paper chromatography
3. Identification of fatty acids and other lipids by TLC
4. Screening of fungi for cellulose degradation
5. Starch hydrolysis.
6. Isolation and characterisation of proteolytic bacteria from soil
7. Gelatin hydrolysis
8. Screening of fungi for invertase
9. Enzyme immobilization by Alginate method
10. Microscopic examination of root nodules
11. Demonstration of Ammonifiaction
12. Demonstration of Nitrification – Nitrite and Nitrate
13. Demonstration of Denitrification
14. Demonstration of lipolytic activity
15. Demonstration of citric acid production
16. Study of photographs/models: Sulphur oxidation, Iron oxidation, Legume-*Rhizobium* system, Nitrogenase complex, Ribozymes, Abzymes, Lock and key hypothesis, Induced fit model, Competitive inhibition, Non-competitive inhibition, Allosteric enzymes, Feedback inhibition

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books / References

1. Philipp, G. Mannual of Methods for General Bacteriology.
2. David T. Plummer. An Introduction to Practical Biochemistry
3. Wood, W. B., Wilson, J.H., Benbow, R.M. and Hood, L.E. (1981). Biochemistry- A Problem Approach, 2nd ed., The Benjamin/ Cummings Pub.co
4. Segel, I.R. (2004). Biochemical calculations, 2nd ed., John Wiley and Sons
5. Irwin H. Segel. Biochemical Calculations, , 2nd Edition John Wiley & Sons

Course 4: Theory: OE- 4T, Human Microbiome

Course Outcomes (COs): At the end of the course the student should be able to:

1. Articulate a deeper understanding on biological complexities of human microbiome.
2. Understand broader goals of biological anthropology.
3. Compare and contrast the microbiome of different human body sites and impact human health promotion

Course 4: Theory: OE- 4T, Human Microbiome	**42Hrs**
Unit 1: Introduction to Microbiome	**14Hrs**
Evolution of microbial life on Earth, Symbiosis host-bacteria. Microbial association with plants and animals, Symbiotic and parasitic, Normal human microbiota and their role inhealth. Microbiomes other than digestive system.	
Unit 2: Microbiomes and Human health	**14Hrs**
Microbiome in early life, Nutritonal modulation of the gut microbiome for metabolic health- role of gut mocrobiomes in human obesity, human type 2 diabetes and longevity. Probiotics- Criteria for probiotics, Development of Probiotics for animal and human use; Pre and synbiotics. Functional foods-health claims and benefits, Development of functional foods.	
Unit 3: Culturing of Microbes from Microbiomes	**14Hrs**
Culturing organisms of interest from the microbiome: bacterial, archaeal, fungal, and yeast, viral. Extracting whole genomes from the microbiome to study microbiome diversity Microbiomes and diseases: Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials. Human microbiome research in nutrition	

Text Books / References

1. Angela E Douglas, (2018). Fundamentals of Microbiome Science: How Microbes ShapeAnimal Biology. Princeton University Press. 248pp.
2. Giulia Enders and Jill Enders, (2018). Gut: The Inside Story of Our Body's Most Underrated Organ (Revised Edition). Greystone Books, 304pp.
3. 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.
4. Edward Ishiguro, Natasha Haskey and Kristina Campbell, (2018). Gut Microbiota. 1stedition. 2008pp.
5. Natalia V Beloborodova, (2021). Human Microbiome. IntechOpen, 166pp. Gregory, P. H.(1961). The Microbiology of the atmosphere. Interscience Publishers,New York.

B.Sc. Microbiology 5th Semester

Program name	B.Sc.in MICROBIOLOGY		Semester	V
Course Title	MICROBIALGENETICS (Theory)			
Course Code	DSC-9T		No.of Credits	04
Contact Hours	60(4Hrs.perweek)		Duration of SEA/Exam(Hrs.)	$2^1/_2$
Formative Assessment Marks	40		Summative Assessment Marks	60
Subject code	FSE500		QP code	

Course Outcomes(COs):

After the successful completion of the course, the student will be able to;
CO1.Understand the experimental evidences to prove DNA as genetic material.
CO2. Differentiate various method of recombination in bacteria.
CO3.Compare gene interaction in viruses and fungi.
CO4.Understandconceptsinvolvedinreplication,transcription, translation in bacteria. CO5. Outline regulatory mechanisms in bacteria to control cellular processes

ContentofCourse5:Theory: Microbial Genetics	**60Hrs.**
Unit1:DNAasgeneticmaterial and Bacterial genetics	**15Hrs.**
DNA as a genetic material: Griffith experiment of Transformation, Avery, MacLeod and McCarty experiment, Hershey and Chase experiment to prove DNA carries the genetic information.Fraenkel-ConratexperimenttoproveRNAasgeneticmaterial. Structure and organization of chromosomes in prokaryotes. Plasmid-types, Transposons in Prokaryotes. **Bacterial genetics**: Mechanism of genetic exchange in bacteria: Bacterial transformation- Principle and Types of transformation mechanisms found in prokaryotes. Bacterial Conjugation: U-tube experiment, properties of the F plasmid, F^+xF^- conjugation,$F'xF^-$conjugation, Hfr x F^-conjugation, Transduction: Generalized and specialized transduction.	
Unit2:GeneticMaterialandReplication and Transcription of DNA	**15Hrs.**
Genetic Material: Chemical basis of heredity, Watson and Crick model of DNA, DNA types, RNA-types, structure, importance. Modern concept of gene-cistron, muton, recon. **DNA Replication:** Replicon, Enzymes and proteins involved in DNA replication; DNA polymerases, DNA ligase, primase, telomerase. General mechanism of replication. Models of DNA replication including rolling circle, Θ (theta) mode of replication. **Transcription**:Structure of bacterial RNA polymerase, Promoter concept, Recognition of promoters and DNA melting, Transcription bubble, Stages of transcription- initiation elongation and termination. Transcriptional attenuation	
Unit3:Gene expression and Regulation	**15Hrs.**
Gene expression: Genetic code- features, Wobble hypothesis. Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in prokaryotes. Post translational modifications of proteins. Protein maturation and secretion-protein splicing, molecular chaperones.	

Gene regulation: Regulatory mechanisms in bacteria. Operon concept, polycistronic mRNA.*lac* operon- negative inducible, allolactose, structure of *lac* repressor, mechanism of binding of repressor to operator. Catabolite repression of *lac* operon. Regulation by lac repessor and CAP. *trp* operon regulation–repressor control and attenuator control.	
Unit4:Genetics of Viruses and Fungi and Mutation	**15Hrs.**
Genetics of Viruses: Genetic recombination in phages, Heterozygosity in phages. Temperate phage and prophage, Non-genetic interaction of viral gene products- Complementation, Phenotypic mixing, Genotypic mixing and interference. **Genetics of Fungi**: Life cycle of *Neurospora*, Terad analysis,unordered tetrad analysis in yeast, ordered tetrad analysis in *Neurospora*, two point and three point test cross. **Mutation:** Nature and types, Mutagenic agents: physical and chemical mutagens, Damage and repair of DNA: Photoreactivation and SOS repair, Ames test.	

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

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

Practical: Microbial Genetics

Course Title	**MICROBIAL GENETICS(Practical)**		
Course Code	**DSC-10P**	**No.of Credits**	**02**
Contact Hours	**60 (4Hrs.persession)**	**Duration of SEA/Exam(Hrs.)**	**03**
Formative Assessment Marks	**25**	**Summative Assessment Marks**	**25**
Subject code	**FSE501P**		

Practical Content

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

Pedagogy : Experiential learning, Problem solving, Project

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

Text Books/ References

1. Maloyetal.,1994.MicrobialGeneticsbyJonesand BartlettPublishers.
2. J.W.Dale,1994.MolecularGeneticsofBacteriabyJohnWileyand Sons.
3. StreipsandYasbin,1991.ModernMicrobialGeneticsbyNiley Ltd.
4. J. D. Watson, N. H. Hoppkins, J. W. Roberts, J. A. Steitz and A. M. Weiner. 1987. Molecular Biology of the Gene 4th Edition by, Benjamin / Cummings Publications Co.Inc. California.
5. Lewin,2000.GeneVIIbyOxfordUniversityPress.
6. BacterialandBacteriophageGenetics.4thEditionsbyBirge.
7. MicrobialGeneticsbyFrefielder.4thEdition.
8. OrganizationofProkayoticGenome.1999byRobertL.Charlebois,ASMPublications.
9. MolecularGeneticsofBacteria,1997byLarry,SnyderandWendy,Champness, ASM
10. James,D.Watson,TaniaA.Baker,StephenP.Bell,AlexanderGann,MichaelLevine, Richard Losick. Molecular Biology of the Gene, 7th edition. 2017
11. Freifelder'sEssentialsofMolecularBiology.GeorgeMMalacinski,4thed.2015
12. Alberts Bruce, Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of the Cell. 5th Edition, Taylor and Francis. New York, USA.
13. Tropp, B. E. (2012) Molecular Biology: Genes to Proteins. 4rd Edition, Jones & Bartlett, Learning, Burlington, MA
14. AllisonA.Elizabeth(2012)FundamentalMolecularBiology,2ndEdition.JWilleyand Sons, Hoboken,New Jersey
15. Frederick, M., Ausubel, Roger Brent, Robert, E., Kingston, David, D., Moore, J. G. Seidman, John A.Smith, Kevin Struhl (2003). Current Protocols in Molecular Biology. John Wiley & Sons, New York, United States.
16. Sambrook, J. F. and Russell, D. W. (2001). Molecular Cloning: a Laboratory Manual. 3rd edition. Cold Spring Harbor, N.Y. Cold Spring Harbor Laboratory Press
17. Yılmaz, M., Ozic, C., Gok, İ. (2012). Principles of Nucleic Acid Separation by Agarose Gel Electrophoresis. Gel Electrophoresis - Principles and Basics, Dr. Magdeldin S (Ed.), ISBN: 978-953-51-0458-2, InTech.

B.Sc.Microbiology 5th Semester

Program name	**B.Sc.in MICROBIOLOGY**	**Semester**	**V**
Course Title	**FOODMICROBIOLOGY(Theory)**		
Course Code	**DSC-11T**	**No.of Credits**	**04**
Contact Hours	**60(4Hrs.perweek)**	**Duration of SEA/Exam(Hrs.)**	**$2^1/_2$**
Formative Assessment Marks	**40**	**Summative Assessment Marks**	**60**
Subject code	**FSE502**	**Qp code**	

Course Outcomes (COs):

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

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

CO2. Understand the preservation and food safety protocols

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

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

CO5.Learnthetypesoffermentedfoodand dairy products and its significance

Content of Course 6: Theory:FoodMicrobiology	**60Hrs.**
Unit1: Production of food crops and their diseases	**15Hrs.**
Role of microbes in food crops production: Biofertilizers: Definition, Mass production, mode of applications, advantages and limitations of *Rhizobium*, *Azotobacter*, *Azospirillum*, cyanobacterial fertilizers. Role of *Frankia* and VAM in soil fertility. Biopesticides: Definition, types- bacterial, viral and fungal-mode of action, factors influencing, target pests. Microbial herbicides. **Diseases of food crops**: Study of symptoms, etiology, epidemioloyg and management of diseases caused by fungi (Tikka disease of groundnut, blast disease of paddy, Red rot of sugarcane),bacteria(Citruscanker, Bacterial blight of rice),viruses(Bean mosaic,Papaya ringspot) and viroid (Potato spindle tuber disease).Post-harvestdiseases.	
Unit2:Microbial qualityof air and water for food processing and disposal of wastewater	**15Hrs.**
Bioaerosols in food: Air borne microbes and their impact on food. Bioaerosol sampling: Vertical clinder spore trap, Hirst spore trap, Rotorod sampler, Andersen sampler, impingers and filtration. Control of bioaerosols- UV light, HEPA filters, desiccation, Incineration. **Water quality in food safety**: Water sample collection, methods to detect potability of water samples: presumptive/MPN tests, confirmed and completed tests for faecal coliforms, SPC, IMViC reactions, membrane filter technique.Waterborne pathogens, Control of water borne pathogens-Precipitation, filtration, chemical disinfection, UV light. **Disposal of wastewater in food industries**: Microbiological characteristics of wastewater. Wastewater treatment-primary (screening, coagulation and sedimentation),secondary (trickling filter, oxidation pond) tertiary(reverse osmosis, ion exchange).Methods of solid Waste disposal (composting and biogas).BOD and COD.	
Unit3: Food spoilage, Infection and Preservation	**15Hrs.**

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

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

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

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

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

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

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

Practical: Food Microbiology

Course Title	FOODMICROBIOLOGY(Practical)		
Course Code	DSC-12P	No.of Credits	02
Contact Hours	60 (4Hrs.persession)	Duration of SEA/Exam(Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25
Subject code	FSE503P		

Practical Content

1. Isolation and characterization of *Rhizobium* spp.associated with root nodules.
2. Microscopic observation of diseased specimen of food crops: Citrus canker, Downy mildew of grapes, Tikka disease of groundnut and Potato spindle tuber disease
3. Determination of microbial contamination of air by passive sampling method.
4. Standard analysis of water samples and Determination of MPN.
5. Biochemical differentiation of Enterobacteriaceae isolates by IMViC reactions.
6. Determination of bacteriological quality of water by H_2S paper strip test.
7. Measurement of Biochemical Oygen Demand (BOD) of food processing wastewater.
8. Estimation of total solids of waste water from food processing unit.
9. Isolation and identification of indigenous wine yeast and its use in alcohol fermentation
10. Determination of mesophilic aerobic count in foods and expression of count in log CFU/g
11. Turbidity index for the detection of efficiency of sterilization of milk.
12. Methylene blue and Resazurin reduction test for assessing the raw milk quality.
13. Laboratory scale production of yogurt and its sensory evaluation.
14. Culturing of *Spirulina* sp.as single cell protein.
15. Demonstation of air samplers, display of photographs of water purification process and wastewater treatment.

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

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books/ References

1. Rangaswamy, G. and Bagyaraj, D. J. (2001), Agricultural Microbiology, 2nd ed. Prentice hall of India pvt.ltd., New Delhi.
2. Rao,M.N.andDatta,A.K.(1987).Waste WaterTreatment.Oxfordand I.B.H.
3. Rheinhermer,G.(1986).Aquatic MicrobiologyJhonWielyandsons,Newyork.
4. SubhaRao,N.S.,1988.BiofertilizersinAgricultural2nded.OxfordandIBHPub.Co.,New Delhi.
5. DanielEnvironmental Microbiology.
6. Grant,W.D.andP.E,Long:1981EnvironmentalMicrobiology,ThomsonLitho ltd.
7. Mehrotra,R.S.,PlantPathalogy,TataMcGrawHillPubilicationsLimited,NewDelhi.
8. Michael, J. Pelczar, Jr.E. C. S. Chan, Moel: Microbiology, Mc Graw Hill Book Company,New 33ork).
9. Mitchell,R.(1992),IntroductiontoEnvironmentalMicrobiology,PrenticeHallInc,Englewoo d Cliffs.
10. Adams, M. R. and Moss, M. O. (1995) Food Microbiology. Royal Society of Chemistry ,Cambridge University Press.
11. Frazier&Westhoff,D.C.(1995)FoodMicrobiologyTataMcGrawHillPub.Company Ltd.,New Dehli.
12. Jay,J.M.(1985).ModernFoodMicrobiology.CBSPublishersanddistributors,New Delhi.
13. DoyleM.P.and Beuchat L.R. (2007). Food Microbiology- Fundamentals. Frontiers, ASM Press.
14. GarbuttJ.(1997).EssentialsofFoodMicrobiology,Armold-InternationalStudents edition,London. 8. Marriott N. G. and Gravani R. B. (2006).
15. ThomasJ., Matthews,Karl;Kniel,Kalmia E (2017),Food Microbiology:An Introduction, AmericanSociety for (ASM).
16. Deak T. and Beuchat L. R. (1996). Hand Book of Food Spoilage Yeasts, CRC Press, NewYork.

B.Sc.Microbiology 5th Semester

Program name	B.Sc.in MICROBIOLOGY		Semester	V
Course Title	MICROBIAL AND BIOCHEMICAL TECHNIQUES(Theory)			
Course Code	SEC-4T		No.of Credits	02
Contact Hours	30 (2Hrs.perweek)		Duration of SEA/Exam(Hrs.)	02
Formative Assessment Marks		20	Summative Assessment Marks	30
Subject code				

Course Outcomes (COs):

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

CO1:Demonstrate skills in microbiological and analytical techniques.

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

CO3: Understand principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.

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

Content of Course: Theory: Microbial and Biochemical Techniques	30Hrs.
Unit1: Microbial Techniques	**15Hrs.**
Methods and practices of cleaning and management of lab: Learning and Practice of Integrated clean-in-place (CIP) and sterilize-in-place (SIP) as per industry standards, Standard Operating Procedure (SOP) for various equipment in the QC Lab. Sterility check, Bio-burden and Logbook maintenance. **Handling and calibration of lab equipment**- weighing balance, Micropipette Autoclave, Hot air Oven, Incubator, Centrifuge, Water bath, Colony Counter, and stability chamber, Preparation of Normality, Molarity, and buffer solutions. **Types of culture media and their maintenance:** Preparation of various culture media. Cultivation of Bacteria, Fungi, Actinomycetes and Algae. Isolation and preservation of pure culture. Morphological and biochemical characterization of bacteria.	
Unit2:BiochemicalTechniques	**15Hrs.**
Centrifugation: Principles of Centrifugation and Ultracentrifugation techniques and its applications. **Chromatography**: Principle and techniques with applications (Partition, adsorption, ion exchange, exclusion and affinity chromatography). Electrophoretic technique (agarose and polyacrylamide gel) its components, working and applications. **Spectrophotoscopy and Radiobiology**: Principle, mechanism and application of instruments used in Spectrophotometric techniques (UV and visible).Radiobiological techniques – characters of radioisotopes, autoradiography, Radioisotope dilution technique and pulse chase experiments. Basic principles & Law of absorption and radiation and its application.	

Practical: Microbial and Biochemical Techniques

Course Title	Microbial and Biochemical Techniques (Practical)		
Course Code	SEC-5P	No. of Credits	01
Contact Hours	30 (2Hrs.persession)	Duration of SEA/Exam(Hrs.)	03
Formative Assessment Marks	25	Summative Assessment Marks	25

Practical Content

1. Usage and maintenance of basic equipment of microbiology lab: Principles, calibrations, and SOPs of balances, pH meter, Autoclaves, Laminar flows, Biosafety cabinets, Microscopes, Homogenizers and Magnetic stirrers.
2. Cultivation of microorganisms: (i) Bacterial cultivation: (a) Streak-plate method (*E.coli, Staphylococcus aureus*) Streaking with inoculation loop. Streaking with toothpick. (b) Pour-plate method (*E.coli*).
3. Maintenance of microorganisms (slant culture, stab culture, glycerol stocks) (ii) Fungal cultivation (a) Yeast (*Saccharomyces cervisiae*) Moulds (*Penicillium notatum, Aspergillus niger*)
4. EstimationofCFUcountbyserialdilution-spreadplatemethod/pourplatemethod.
5. Study of colony characteristics on nutrientagar
6. Biochemical characterization of bacteria:
   a. Sugar utilization test(minimal medium+sugar)
   b. Sugar fermentation test(peptone water method,Ammonium salt sugar method
   c. IMViC reactions
   d. Enzymedetection–Amylase,Gelatinase,lipase,caseinase,Catalase,andOxidase
   e. Oxidative-fermentativetest,argininehydrolysis,ornithine,lysinedecarboxylase, nitrate, nitrite reduction
7. Separation of mixtures by paper/thin layer chromatography.
8. Demonstration of column packing in any form of column chromatography.
9. Separation of protein mixtures by any form of chromatography.
10. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
11. Determination of absorption max for an unknown sample and calculation of extinction coefficient.
12. Separationofcomponentsofagivenmixtureusingalaboratoryscalecentrifuge.

Text Books/ References

1. MichaelLufaso(2016)."LaboratorySkillsforScienceandMedicine:AnIntroduction". CRCPress.
2. ColinA.Ramsden(2014)."AnalyticalMolecularBiology".OxfordUniversityPress.
3. JohnM.WalkerandRalphRapley(2014)."MolecularBiomethodsHandbook". HumanaPress.
4. WilsonandWalke,r(2000).PrinciplesandTechniquesinPracticalBiochemistry.5th Edition
5. CambridgeUniversityPress.
6. Murphy, D. B. (2001). Fundamental of Light Microscopy &Electron Imaging.1st Edition. Wiley-Liss.
7. Murphy, D. B. (2001). Fundamental of Light Microscopy &Electron Imaging.1st Edition. Wiley-Liss.
8. PranavKumar,(2016).FundamentalsandTechniquesofBiophysicsandMolecularBiology
9. AuroraBlair.LaboratoryTechniques&ExperimentsinBiology.IntellizPress
10. Plummer,D.T.(1987).AnIntroductiontoPracticalBiochemistry.McGrawHill Publication
11. Beckner,W.M.,Kleinsmith,L.J.andHardin,J.(2000).Theworldofcell.IVedition Benjamin/Cummings
12. Prescott, M. J., Harley, J. P. and Klein, D. A. (2002). Microbiology. 5th Edition WCB McGrawHill, New York,
13. BlackJ.G.(2002). Microbiology-PrinciplesandExplorations.JohnWiley&SonsInc. NewYork,
14. Maheswari,D.K.(2010).Practical Microbiology.S Chand publications
15. Cowanand Steel's Manual for the Identification of Medical Bacteria.G.I.Barrow(Editor), R. K. A. Feltham (Editor) 3rd Edition. 2004

B.Sc. Microbiology 6thSemester

Program name	**B.Sc.in MICROBIOLOGY**	**Semester**	**VI**
Course Title	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)**		
Course Code	**DSC-13T**	**No. of Credits**	**04**
Contact Hours	**60(4Hrs.perweek)**	**Duration of SEA/Exam(Hrs.)**	**$2^1/_2$**
Formative Assessment Marks	**40**	**Summative Assessment Marks**	**60**
Subject code	**FSF500**	**Qp code**	

CourseOutcomes(COs):

After the successful completion of the course, the student will be able to: CO1:
Gain a preliminary understanding about various immune mechanisms.
CO2: Familiarize with immunological techniques and sero-diagnosis of infectious diseases
CO3: Understand pathogenic bacterial infections, symptoms, diagnosis and treatment

Content of Course 7:Immunology and Medical Microbiology	**60Hrs.**
Unit1:IntroductiontoImmunesystem	**15Hrs.**
Immune system: Historical perspective of immunology. Immunity-Definition and types.Cells and organs of immune system: B and T Lymphocytes, Natural killer (NK) cells, Granulocytes (Neutrophils, Eosinophils and Basophils), Monocytes and macrophages, Dendritic cells and Mast cells. Primary lymphoid organs-Bone marrow and Thymus. Secondary lymphoid organs-Spleen and Lymphnodes. Lymphoid tissues- MALT and GALT. **Antigen and Antibody**: Antigen-Definition, properties and types. Immunogenicity and antigenicity, epitopes, haptens. Degree of foreignness, molecular weight, degradability. Adjuvants andtheir importance. Antibody: Definition, Basic structure of antibody, Structure and functions of different types of antibodies (IgG, IgA, IgM, IgD and IgE).Antigenic Determinants on immunoglobulins: Isotype, allotype and idiotype.	
Unit2:Antigen-antibodyinteractionsandHypersensitivereactions	**15Hrs.**
Antigen-antibody reactions: Definition, salient features, antibody affinity and avidity, cross reaction. Agglutination reactions: Hemagglutination-blood grouping, Immunoprecipitation: Radial (Mancini) and double (Ouchterlony) immunodiffusion and Immunoelectrophoresis. Complement mediated opsonization, complement fixation test. Immunotechniques: ELISA, Radioimmunoassay and Immunofluorescence. **Hypersensitive reactions**: Classification, antibody mediated hypersensitivity; Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity TypeIV (DTH). Autoimmne diseases and Transplantation Immunology in brief.Immunoprophylaxis-Vaccines-Types-Killed,Live attenuated and Toxoid with an Example each. National Immunization Schedule and Mission Indradhanush.	
Unit3: Host-pathogen interaction and Medical Bacteriology	**15Hrs.**
Host pathogen interaction: Normal microflora of human skin,oral cavity, gastrointestinal tract, urogenital tract and their importance. Host pathogen interaction: Definitions-Infection, Invasion, Pathogenicity, Virulence, Attenuation, Exaltation,	

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

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

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

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

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

Pedagogy: Lectures, Seminars,Industry/InstituteVisits,Debates,Quiz,Projectand Assignments

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

Practical: Immunology and Medical Microbiology

Course Title	**IMMUNOLOGYANDMEDICALMICROBIOLOGY(Practical)**		
Course Code	**DSC-14P**	**No.of Credits**	**02**
Contact Hours	**60 (4Hrs.persession)**	**Duration of SEA/Exam(Hrs.)**	**03**
Formative Assessment Marks	**25**	**Summative Assessment Marks**	**25**
Subject code	**FSF501P**		

Practical Content

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

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

Pedagogy: Experiential learning, Problem solving,Project

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

Text Books/ References

1. Ananthanarayan,R.andPanikerC.K.J.(2009).TextbookofMicrobiology,8th Edition, University Press,Publication.
2. Brooks, G. F.,Carroll, K. C., Butel, J. S., Morse, S. A. and Mietzner,T. A. (2013). Jawetz, MelnickandAdelberg'sMedicalMicrobiology.26thedition.McGrawHillPublication
3. Goering,R.,Dockrell,H.,Zuckerman,M.andWakelin,D.(2007).Mims'Medical Microbiology. 4thedition.Elsevier
4. Willey,J.M.,Sherwood,L.M.,andWoolverton,C.J.(2013)Prescott,Harleyand Klein'sMicrobiology.9th edition. McGraw Hill Higher Education
5. Madigan, M. T., Martinko, J. M., Dunlap, P. V. and Clark, D. P. (2014). Brock Biology ofMicroorganisms.14thedition. Pearson International Edition
6. Delves, P., Martin, S., Burton, D., Roitt, I.M. (2006). Roitt's Essential Immunology.11th edition Wiley-BlackwellScientific Publication, Oxford.
7. Goldsby, R. A., Kindt, T. J., Osborne, B. A. (2007). Kuby's Immunology. 6th edition W. H. Freeman andCompany, New York.
8. Murphy,K.,Travers,P.,Walport,M.(2008).Janeway'sImmunobiology.7th edition GarlandScience, Publishers, NewYork.
9. Peakman,M.andVergani,D.(2009).BasicandClinicalImmunology,2ndedition Churchill, Livingstone Publishers, Edinberg.
10. Richard,C.andGeiffrey,S.(2009).Immunology.6thedition.WileyBlackwell Publication.

B.Sc. Microbiology 6thSemester

Program name	**B.Sc.in MICROBIOLOGY**	**Semester**	**VI**
Course Title	**INDUSTRIALMICROBIOLOGY (Theory)**		
Course Code	**DSC-15T**	**No.of Credits**	**04**
Contact Hours	**60(4Hrs.perweek)**	**Duration of SEA/Exam(Hrs.)**	**$2^1/_2$**
Formative Assessment Marks	**40**	**Summative Assessment Marks**	**60**
Subject code	**FSF502**	**Qp Code**	

Course Outcomes(Cos):

After the successful completion of the course, the student will be able to:
CO1. Learn the overview of scope and importance of industrially important microbes.
CO2. Acquaint with different types of fermentation processes and equipment.
CO3.Acquire the knowledge of purification of value-added products.
CO4. Acquire knowledge on the concepts and terminology in genetic engineering.
CO5. Learn about principles involved in manipulating genes and DNA.
CO6.Familiar with various techniques used ingenetic engineering.

Content of Course 8 : Industrial Microbiology and Genetic Engineering	**60Hrs.**
Unit1:Introduction to Industrial Microbiology	**15Hrs.**
Introduction to Industrial Microbiology: Scope and concepts. Microorganisms of industrial importance: Selection criteria, Strain improvement and Preservation. Fermentor: Design and components of a bioreactor. Specialized bioreactors: Airlift bioreactors, fluidized bed reactor, packed bed reactors, Photo-bioreactors and membrane bioreactors .Sterilization of fermentor. Control of air, temperature and pH. Aseptic inoculation and sampling methods. **Fermentation media and process**: Strategies for media formulation, Natural and synthetic media. Production medium and Inoculum medium. Raw materials (Molasses and its types, corn steep liquor, sulphite waste liquor and whey). Buffers, Precursors, Inhibitors and Antifoam agents. Types of fermentation process: Submerged fermentation, Solid state fermentation (Koji), Batch fermentation and continuous fermentation.	
Unit2:Downstream processing, General production strategies of microbial Products and Enzyme immobilization	**15Hrs.**
Downstream processing- Definition, Stages in downstream processing. Methods of downstream processing: Precipitation, filtration, centrifugation, distillation, cell disruption, solvent recovery, drying and crystallization. **Microbial production of industrial products**: Industrial production and uses of Ethyl alcool, wine, Penicillin, Lactic acid, Citric acid, Amylase. Oyster mushroom cultivation. **Enzyme immobilization**: Immobilized enzymes, Revesible immobilization- Adsorption, Irrevesible immobilization-covalent coupling, entrapment, copolymerization. Applications of Enzyme immobilization, Advantages and disadvantages of immobilized enzymes.	
Unit3:Genetic Engineering tools used in Strain improvement of microbes of Industrial importance	**15Hrs.**

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

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

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

Techniques in genetic engineering: Isolation of DNA, restriction digestion and ligation of DNA, Agarose gel electrophoresis, Blotting techniques, DNA sequencing- Sanger's method. PCR techniques and applications. DNA transfer methods: Microinjection, Biolistic, Electroporation, Calcium phosphate mediated NA transfer. Identification and selection of recombinants: DNA 42ybridization, blue white selection, colony and plaque hybridization.

Industrial production of recombinant products: Products of human therapeutic interest – insulin, hGH, antisense molecules. Bt Cotton, Bt Brinjal. Gene therapy, recombinant vaccines. Biological, ethical and social issues of gene cloning and IPR. Gene Library: Construction and application of cDNA and genomic libraries. Application of recombinant microorganisms in basic research, industry, medicine, agriculture, environment.

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

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

Practical: Industrial Microbiology

Course Title	**INDUSTRIALMICROBIOLOGY (Practical)**		
Course Code	**DSC-16P**	**No.of Credits**	**02**
Contact Hours	**60 (4Hrs.persession)**	**Duration of SEA/Exam(Hrs.)**	**03**
Formative Assessment Marks	**25**	**Summative Assessment Marks**	**25**
Subject code	**FSF503P**		

Practical Content

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

Note:Visit to distilleries and molecular biology laboratory.

Pedagogy: Experiential learning, Problem solving, Project

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

Text Books/ References

1. ArindamKuilaandVinaySharma(2018).PrinciplesandApplicationsofFermentation Technology,Wiley.
2. Casida,L.(2016).IndustrialMicrobiology,2nd edition,NewAgeInternational Publisher.
3. Crueger, W. and A Crueger. (2017). Cruegers Biotechnology: A Text Book of IndustrialMicrobiology.Edited by K.R. Aneja. Panima Publishing Corporation.
4. Michael,J.W.,Neil,L.Morgan.(2013).IndustrialMicrobiology:anIntroduction. Blackwell science
5. NdukaOkaforandBenedictOkeke(2017).ModernIndustrialMicrobiologyand Biotechnology. 2nd Edition :CRC Press Publishers
6. StanburyP. F.,W.Whitaker and S.J.Hall(2016).Principlesof Fermentation Technology. 3rd edition. Elsevierpublication
7. Alexander, N. Glazer, Hiroshi Nikaido (2014). Microbial Biotechnology: Fundamental of appliedMicrobiology, 2nd Edition, Cambridge University Press
8. Brown,T.A.(2010).GeneCloningandDNAAnalysis.6thedition.BlackwellPublishing, Oxford, U.K.
9. Clark, D. P. and Pazdernik, N. J. (2009). Biotechnology: Applying the Genetic Revolution. ElsevierAcademic Press, USA
10. Krebs, J., Goldstein, E., Kilpatrick, S. (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
11. Primrose,S.B.andTwyman,R.M.(2006).PrinciplesofGeneManipulationand Genomics, 7thedition. Blackwell Publishing, Oxford, U.K.
12. Primrose,S.B.andTwyman,R.M.(2008).Genomics:Applicationsinhumanbiology. BlackwellPublishing, Oxford, U.K.
13. Russell,P.J.(2009).Genetics-AMolecularApproach.3rdEd,BenjaminCummings
14. Sambrook,J.andRussell,D.(2001).MolecularCloning-ALaboratoryManual.3rdedition. Cold SpringHarbor Laboratory Press
15. Sambrook,J.andRussell,D.W.(2001).MolecularCloning:ALaboratory Manual.4th Edition, Cold Spring HarbourLaboratory press.
16. Watson, J.D., Baker, T.A., Bell, S.P. et al. (2008). Molecular Biology of the Gene, 6th Ed., Benjamin Cummings Wiley
17. Sherwood,L.M.andWoolverton,C.J.(2008).Prescott,HarleyandKlein's Microbiology. McGraw Hill HigherEducation.

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

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

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

- Internship shall be Discipline Specific of 90 hours(2credits)with duration4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6th semester for a maximum of 20 hours.
- The student should submit the final internship report (90hours of Internship)to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

GENERAL PATTERN OF THEORY EXAMINATION
B.Sc MICROBIOLOGY(I –VI Semester)

Duration: 02 & 1/2Hours **Maximum:** 60 Marks

***Note**: All questions are compulsory*
Draw neat labeled diagrams wherever necessary

QNo. I Answer any EIGHT of the following: 2X8=16

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

QNo. II Answer any SIX of the following: 4X6=24

11.

12.

13.

14.

15.

16.

17.

18.

QNo. III Answer any TWO of the following: 10X2=20

19.

20.

21.

22.

PATTERN OF PRACTICAL EXAMINATION

Practical examination – B. Sc MICROBIOLOGY

Duration: 3 hours **Max. Marks: 25**

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

PATTERN OF FORMATIVE ASSESMENT - PRACTICALS

Max. Marks: 25

1	IA 1(Assesment)	10 Marks
2	IA 2(Test +Record)	15 Marks

SCHEME OF THEORY EXAMINATION
I B.Sc., I SEMESTER
DSC-I: GENERAL MICROBIOLOGY

Times: 2 &1/2hrs **Max Marks:60**

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1: Historical development, major contributions, origin of microorganisms and microscopy	2	2	1	22
Unit – 2: Staining, sterilization and preservation of microorganisms	2	2	1	22
Unit – 3: Types, structure, organisation and reproduction of prokaryotic microorganism	3	2	1	24
Unit – 4: Types, structure, organisation and reproduction of eukaryotic microorganisms	3	2	1	24

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

I Main :2x10=20Marks
II Main: 4x8= 32Marks
III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONI SEMESTER (NEP)
PRACTICAL-I: GENERAL MICROBIOLOGY

Duration: 3 hours **Max. Marks: 25**

I Stain the given material **A** by_____method. Write the principle,procedure and record the result. Leave the preparation for evaluation. 08 marks
(Positive staining / Negative staining / Gram's Staining / Structural staining / Hanging drop method)
(Preparation – 2M, Principle – 2M, Procedure – 2M, Result – 2M)

II Demonstrate the given experiment **B**. Write the principle and procedure. 05 marks
(Serial dilution / Pour plate / Spread plate / Streak plate / Stab culture / Slant culture)
Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M

III Write critical notes on C, D, E and F. 4X2=08 marks
(Compound Microscope, Autoclave, Hot air oven, Incubator, pH meter, pectrophotometer, Magnetic stirrer, Inoculation loop, Inoculation needle, Spreader, LAF, Algal specimen, Yeast, Protozoa slide, Culture media, Agar slant, Agar deep, Agar plate)

IV Viva Voce 04 marks

SCHEME OF THEORY EXAMINATION
I B.Sc., II SEMESTER
DSC-I: MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

Times:2&1/2hours **Max Marks:60**

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1 : Biochemical concepts	2	2	1	22
Unit – 2: Macromolecules-Types,Structurand properties	2	2	1	22
Unit – 3: Microbial physiology	3	2	1	24
Unit – 4: Microbial physiology-Bioenergitics,Microbialrespiration Microbial photosynthesis	3	2	1	24

Question Paper to be set for total of 92 marks including choices
I Main: 2x10=20Marks
II Main: 4x8= 32Marks
III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONII SEMESTER (NEP)
PRACTICAL–II: MICROBIAL BIOCHEMISTRY AND PHYSIOLOGY

Duration: 3 hours **Max. Marks: 25**

I. Demonstrate the given experiment **A**. Write the principle and procedure. Interpret the result. 08 marks
(Effect of temperature / Effect of pH / Effect of salt concentration / Effect of carbon /Haemocytometer / Determination of bacterial growth by spectrophotometric method and calculation of generation time)
(Demonstration – 2M, Principle – 2M, Procedure – 2M, Result – 2M)

II. Perform the given experiment **B**. Write the principle, procedure and record the result.Leave the preparation for evaluation. 05 marks
(Qualitative determination of carbohydrates, proteins, amino acids, fatty acids / Quantitative estimation of reducing sugar / protein / Demonstration of anaerobic respiration)
(Performance – 2M, Principle and Procedure – 2M, Result – 1M)

III. Write critical notes on C, D, E and F. 4x2=08 marks
(Bacterial chlorophyll, Cytochrome, ATPase, Chemostat, Haemocytometer, Membrane filter, Spectrophotometer, Nephelometer, Quorum sensing, anaerobic respiration, Buffer solutions, ETC in bacteria)

IV. Viva Voce 04 marks

SCHEME OF THEORY EXAMINATION
I B.Sc., II SEMESTER

OE-I: MICROBIAL TECHNOLOGY FOR HUMAN WELFARE

Times:3hrs **Max Marks:60**

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1 : Food and Fermentation Microbial technology	3	2	2	34
Unit – 2: Agricultural Microbial technology	3	3	1	28
Unit – 3: Pharmaceutical Microbial Technology	4	3	1	30

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

I Main: 2x10=20Marks

II Main: 4x8= 32Marks

III Main: 4x10=40Marks

SCHEME OF THEORY EXAMINATION
I B.Sc., II SEMESTER

OE-II: ENVIRONMENTAL AND SANITARY MICROBIOLOGY

Times: 3hrs **Max Marks:60**

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

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1 : Soil and Air Microbiology	3	2	2	34
Unit – 2: Water Microbiology	3	3	1	28
Unit – 3: Sanitary Microbiology	4	3	1	30

I Main: 2x10=20Marks II

Main: 4x8= 32Marks III

Main: 4x10=40Marks

SCHEME OF THEORY EXAMINATION
II B.Sc., III SEMESTER
DSC-III: Microbial diversity

Times:2hrs **Max Marks:60**

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1: Biodiversity and microbial diversity	2	2	1	22
Unit – 2: Diversity of prokaryotic microorganism	2	2	1	22
Unit – 3: Diversity of Eukaryotic microorganism	3	2	1	24
Unit – 4: Diversity of virus	3	2	1	24

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

I Main :2x10=20Marks

II Main: 4x8= 32Marks

III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONIII SEMESTER (NEP)
PRACTICAL III: MICROBIAL DIVERSITY

Time: 03 Hours Max. Marks: 25

I Demonstrate the experiment **A** by giving principle and procedure. Record the result**.08 marks**
(Measurement of microbial cell size by Micrometry / Isolation and characterization of bacteria from air by exposure plate method / Isolation of enumeration of bacteria from soil or water by serial dilution method / Isolation and identification fungi from air by exposure plate method / Isolation and identification of fungi from soil by serial dilution method)
(Demonstration – 2M, Principle – 2M, Procedure – 2M, Result – 2M)

II Prepare a temporary mount of the given material **B** and identify the organism with labelled diagram and significance. Leave the preparation for evaluation **05 marks**
(Staining of Fungi / Algae / Cyanobacteria)
(Preparation – 1 M, Identification – 1M, Diagram and significance – 3M)

III Write critical notes on **C, D, E and F** **4x2 = 08 marks**
(Permanent slides or photographs of Paramecium, Euglena, TMV, Corona, T4 phage, Oncogenic virus, Actinomycetes, *Aspergillus, Rhizopus, Sachharomyces*, Agaricus, *Chlorella*, Diatoms, *Gracilaria, Nostoc*, *Microcystis, Spirulina*)

IV Viva-voce 04 marks

SCHEME OF THEORY EXAMINATION

II B.Sc., IV SEMESTER

DSC-IV: Microbial Enzymology and Metabolism

Times:2hrs **Max Marks:60**

UNITS	2 mark questions	4mark questions	10 mark questions	Total Marks
Unit – 1: Basics of enzymes	2	2	1	22
Unit – 2: Enzyme kinetics and regulation	2	2	1	22
Unit – 3: Metabolism of carbohydrates	3	2	1	24
Unit – 4: Metabolism of amino acids,nucleotides and lipids	3	2	1	24

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

I Main:

2x10=20

Marks II Main: 4x8=

32MarksIII Main:

4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONIV SEMESTER (NEP)

PRACTICAL IV: MICROBIAL ENZYMOLOGY AND METABOLISM

Time: 3 hrs. **Max. Marks: 25**

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

(Separation of amino acids by paper chromatography / Screening of fungi for invertase / Enzyme immobilization by Alginate method / Screening of fungi for cellulose degradation / Microscopic examination of root nodules / Identification of fatty acids and other lipids by TLC)

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

II Conduct the given biochemical test **B** giving principle and procedure. Write thesignificance. **05 marks**

(Gelatin hydrolysis / Starch hydrolysis / Demonstration of Ammonification / Nitrification / Denitrification / Lipolytic activity / Sugar fermentation / Demonstration of citric acid production)

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

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

(Study of photographs/models: Sulphur oxidation, Iron oxidation, Legume-*Rhizobium* system, Nitrogenase complex, Ribozymes, Abzymes, Lock and key hypothesis, Induced fit model, Competitive inhibition, Non-competitive inhibition, Allosteric enzymes, Feedback inhibition)

IV Viva-voce **04 marks**

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

Times: 2hrs **Max Marks:60**

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

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

I Main :2x10=20Marks

II Main: 4x8= 32Marks

III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONIV SEMESTER (NEP)
PRACTICAL V: MICROBIAL GENETICS

Time: 3 hrs. **Max. Marks: 25**

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

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

III Write critical notes on **C, D, E** and **F** **4x2 = 08 marks**
(Preparation of competent cells for bacterial transformation, Demonstration of bacterial conjugation by plate mating method, Determination of purity of DNA, Visualization of genomic DNA by agarose gel electrophoresis, β-galactosidase activity assay inYeast. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS- PAGE).Study of Griffith`s experiment, conjugation, transduction, plasmid DNA, T4 phage, ordered tetrad analysis in *Neurospora*, Watson and Crick model of DNA, tRNA, semi- conservative replication of DNA, bacterial RNA polymerase, transcription, translation and *lac* operon)

IV Viva-voce **04 marks**

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

Times: 2hrs **Max Marks:60**

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

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

I Main :2x10=20Marks
II Main: 4x8= 32Marks
III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONIV SEMESTER (NEP)
PRACTICAL VI: FOOD MICROBIOLOGY

Time: 3 hrs. **Max. Marks: 25**

I Demonstrate the experiment A giving principle and procedure. Record the result. 0**8 marks**
(Determination of microbial contamination of air by passive sampling method, Standard analysis of water samples and Determination of MPN. IMViC reactions, Determination of mesophilic aerobic count in foods and expression of counting logCFU/g)

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

II Conduct the given biochemical test B giving principle and procedure. Write the significance. **05 marks**
(Turbidity test, resazurin test, MBRT test, Estimation of % of alcohol in a given sample by specific gravity bottle method, IMViCreactions,H2S test)
(Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on C, D, E and F **4x2 = 08 marks**
(Demonstation of air samplers, display of photographs of water purification process and wastewater treatment, Plant diseases)

IV Viva-voce 04 marks

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

Times: 2hrs **Max Marks:60**

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

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

I Main :2x10=20Marks
II Main: 4x8= 32Marks
III Main: 4x10=40Marks

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

Time: 3 hrs. **Max. Marks: 25**

I Demonstrate the experiment A giving principle and procedure. Record the result. 0**8 marks**
(Determination of blood group and Rh factor/Demonstration of precipitation reaction-ODD, DemonsatrationofSingleRadialImmunoDiffusion)

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

II Conduct the given biochemical test B giving principle and procedure. Write the significance. **05 marks**
(IMViC, TSI, nitrate reduction, urease production and catalase tests, Study of bacterial flora of skin by swab method, Kirby-Bauer method)(Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on C, D, E and F **4x2 = 08 marks**
(Polio, Rabies, Chikungunya, AIDS, Histoplasmosis, Candidiasis and Athlete'sfoot, Widaltest/ HCGtest, RPRtest/VDRLtest)

IV Viva-voce 04 marks

SCHEME OF THEORY EXAMINATION
III B.Sc., VI SEMESTER
Times: 2and 1/2hrs **DSC-VIII: INDUSTRIAL MICROBIOLOGY** **Max Marks:60**

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

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

I Main :2x10=20Marks
II Main: 4x8= 32Marks
III Main: 4x10=40Marks

SCHEME OF PRACTICAL EXAMINATIONIV SEMESTER (NEP)
PRACTICAL VII: INDUSTRIAL MICROBIOLOGY
Time: 3 hrs. **Max. Marks: 25**

I Demonstrate the experiment A giving principle and procedure. Record the result. 0**8 marks**
(Estimation of citric acid produced from *Aspergillus niger* by titrimetric method,
Estimation of% alcohol in a given sample bys pecific gravity bottle method)
(Demonstration – 2M, Principle – 2M, Procedure – 2M, Result – 2M)

II Conduct the given biochemical test **B** giving principle and procedure. Write the significance. 0**5 marks**
(Preparation of buffers-TE,TAEand Lysis buffer)
(Demonstration – 2M, Principle and Procedure – 2M, Significance – 1M)

III Write critical notes on **C, D, E** and **F** **4x2 = 08 marks**
(Studyofspecializedbioreactors,Microbialproductionofindustrialproducts,Cloning vectors, cloning of DNA inserts and Bluewhite screening of recombinants, Mushroom cultivation, amplification of DNA by PCR, Southern blotting,Wine ,Isolation of plasmid DNA from *Escherichia coli*,Media used in industries,Production of amylase)
IV Viva-voce **04 marks**

Annexure-1

Approved list of Paper setters and Valuers

Sl No.	Name	College address
1	Dr.M .Seema	Assistant professor & Chairperson Dept. of Microbiology JSS College, Ooty road, Mysore
2	H.P.Spoorthy	Assistant professor Dept. of Microbiology JSS College, Ooty road, Mysore
3	Dr.S.Mahadevamurthy	Associate Prof & HOD Dept. of Microbiology Yuvaraja's college Mysore.
4	Dr.Syeda Kauser Fathima	Associate Prof. of Microbiology Government College for women, Mandya.
5	Dr. H.S. Jayanth.	Asso.Prof.of Microbiology Dept. of Microbiology Yuvaraja's college Mysore.
6	Dr.Uma Maheshwari	Assistant professor JSS University, JSSAHER, 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. of Microbiology Government Science College, Chintamani
10	Sri. R.A. Manjunath	Assistant professor. Dept. of Microbiology Saradavilas College,Mysore
11	Dr.M.P. Ragavendra	Assistant professor Dept. of Microbiology Maharani's Science College,Mysore
12	Dr.K.Girish	Assistant professor. Dept. of Microbiology Maharani's Science College, Mysore

13	Sri. G.S. Siddegowda	Assistant professor Dept. of Microbiology Sir MV Government Science College Bhadravathi
14	Dr.N.S.Devaki	Professor Dept. of Molecular Biology Yuvaraja's College , Mysore
15	Syeda Farahna Parveen	Assistant professor Dept. of Microbiology St.Philomina's College, Mysore
16	Smt. Vanitha	Assistant professor Dept. of Microbiology Maharani's Science College,Mysore
17	Mahadevaprasad	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 JLB Road,Mysuru
20	Uzma Bathool	Assistant professor Dept. of Microbiology St.Philomina's College, Mysore
21	Athiya sultan	Assistant professor Dept. of Microbiology SDM College JLB Road,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, JSSAHER ,Mysuru