JSS MAHAVIDYAPEETA



JSS COLLEGE FOR WOMEN (Autonomous)
Saraswathipuram, Mysuru-570009

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

MICROBIOLOGY SYLLABUS

For B.Sc(Basic/Hons.)

2021 onwards

Syllabus, Course Structure, Scheme of Examination, Question Paper Pattern for the I B.Sc Microbiology course with effect from the academic year 2021 onwards…

JSS College for Women (Autonomous), Saraswathipuram, Mysuru-570009
Curriculum Structure for the Undergraduate Degree Program
BSc (Basic/Hons.)

Structure and Scheme of DSC in B.Sc Microbiology:

Sem	Core Course	Title of the Paper	No. of Credits			Total Credits	Maximum Marks in Theory and Practical Examinations(C3)/ IA (C1+C2)			
			L	T	P		Theory C3	IAC1+ C2	Pract. C3	IAC1+ C2
I	DSC-1	General Microbiology	4	-	2	6	60	40	25	25
II	DSC-2	Microbial Biochemistry and Physiology	4	-	2	6	60	40	25	25
III	DSC-3	Microbial diversity	4	-	2	6	60	40	25	25
IV	DSC-4	Microbial Enzymology and Metabolism	4	-	2	6	60	40	25	25
V	DSC-5	Microbial genetics and Molecular biology	4	-	2	6	60	40	25	25
	DSC-6	Immunology and Medical microbiology	4	-	2	6	60	40	25	25
VI	DSC-7	Food and Dairy Microbiology	4	-	2	6	60	40	25	25
	DSC-8	Industrial Microbiology and Bioprocess Technology	4	-	2	6	60	40	25	25
VII	DSC-9	Microbial Genetic Engineering	4	-	2	6	60	40	25	25
	DSC-10	Environmental and Agricultural Microbiology	4	-	2	6	60	40	25	25
VIII	DSC-11	Pharmaceutical and Forensic Microbiology	4	-	2	6	60	40	25	25
	DSC-12	Biosafety, Bioethics and IPR	4	-	2	6	60	40	25	25

Note:

Internal Assessments Components for C1 and C2include Theory Tests, Assignments, Viva-voce,Practical Tests, Practical Record, Educational Visit Report …

BSc Microbiology (Basic/Hons.)
Semester 1

Title of the Courses:

Course 1: **DSC-1T**, *General Microbiology*		*Course 2:* **OE 1 a-** *Microbial Technology for Human Welfare* **OE 1 b-***Introduction to Microbiology and Microbial Diversity*	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**

BSc Microbiology (Basic/Hons.)
Semester 2

Title of the Courses:

Course 1: **DSC-2T,** *Microbial Biochemistry and Physiology*		*Course 2:* **OE- 2a,** *Environmental and Sanitary Microbiology* **OE- 2b,***Microbes in Human Health and Welfare*	
Number of Theory Credits	Number of lecture hours/semester	Number of Theory Credits	Number of lecture hours/semester
4	**56**	**3**	**42**

BSc Microbiology (Basic/Hons.)
Semester 1

Content of Course 1: Theory: DSC-1T, General Microbiology	**56Hrs**
Unit-1: Historical development of Microbiology,Origin of microorganisms, Scope of Microbiology:	**14Hrs**
Historical development of microbiology-Theory of Biogenesis and Abiogenesis. Fossil evidences of microorganisms. Origin of life, primitive cells and evolution of microorganisms.Scope and Branches of Microbiology. Contributions of AntonyVonLeeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister Edward Jenner, Alexander Fleming, Elie Metchnikoff, Dmitri Iwanovsky, MartinusBeijerinck, and Sergei Winogradsky.	
Unit-2: Staining TechniquesandMicroscopy:	**14Hrs**
A. Nature and Types of stains, principles, mechanism and methods of staining- Simple and Differential-Gram staining. Structural staining- capsule, flagella, nuclear, endospore. **B. Microscopy-** Principles of Microscopy- Resolving Power, Numerical Aperture and Limit of Resolution. Working principle, construction mode of operation and applications/uses of Simple,Compound microscopes and Electron microscopes- Bright field, Dark field, Phase contrast, Fluorescence microscope,TEM and SEM. Preparation of specimen for electron microscopic studies -Fixation, Embedding, Ultra-thin Sectioning, Negative staining, Shadow Casting, and Freeze Etching. Advantages and limitations of TEM and SEM.	05Hrs 09Hrs
Unit – 3: Types, structure, organisation and reproduction of Prokaryotic and Eukaryotic microorganism:	**14Hrs**
A. 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- Cytoskeleton, ribosome, inclusion granules: Nuclear Materials – Bacterial chromosomes. Extra Chromosomal materials. Components external to cell wall- capsule, slime, s-layer, pili, fimbriae, flagella;. Bacterial Endospore - Examples of spore forming organisms, habitats, function, formation and germination. Reproduction in bacteria. **B.**Overview of eukaryotic cell structure: General structure and types of cells; External cell coverings and cell membrane. Structure and function of Cytoplasmic matrix- cytoskeleton: Structure and function; single Membrane organelles- Endoplasmic reticulum, Golgi complex, Lysosomes, Vesicles and Ribosomes; Double Membrane organelles- Nucleus, Mitochondrion and Chloroplast, Peroxisomes; Organelles of motility- Structure of flagella and cilia.	09Hrs 05Hrs
Unit-4: Sterilization Techniques,Microbial Culture Media and Culture Techniques:	**14Hrs**
A. Physical methods: Principle, Construction, Mode of Action & Application of the following: Heat: Dry heat- Hot air oven, Incinerator, Moist heat- Autoclave, Arnold sterilizer Filtration: Bacterial filters: Filter Membrane filter: Membrane Filter Apparatus, HEPA filter - Laminar Air Flow System Radiation treatment: UV rays, γ-rays and Cathode rays. Chemical methods: Disinfectants, Antiseptics, Sanitizers, Microbistatics, Microbicides (Bactericide, Fungicide, Virucide&Sporicide)Practical Applications and Mode of action of – Alcohols, Aldehydes, Halogens, Phenols, Peroxides, Heavy metals, Soaps and Detergents(QUATS), Gaseous Sterilants.	07Hrs

B.General culture media ingredient- Peptone, Beef extract, Yeast extract, Agar. Types of Culture Media –Natural media, Simple media, Semi-synthetic media, Synthetic media, Differential media, Selective media, Indicator media, Enriched media, Enrichment media, Transport media, Sugar media, Anaerobic media, Assay media. Serial dilution. Pure culture techniques: Pour plate, Spread plate, Streak plate, Stab culture,Agar slant culture and Point inoculation. Pure cultures and Colony characteristics. Preservation and Maintenance of pure culture: Subculture, Overlaying with Mineral Oil, Lyophilization, Cryopreservation methods (Freezing technique) Culture Collection Centres – ATCC and MTCC (a brief account)	07Hrs

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

1. a. Microbiological laboratory standards and safety protocols.

Laboratory safety: General rules and regulations- Good Laboratory Practices (GLP).

1. b. Study of Simple & Compound microscopes and their handling including 100x

2. a. Preparation of Stains, Mordant - Methylene Blue, Crystal Violet, Safranine, Nigrosine,

CarbolFuchsin, Malachite Green, Gram's Iodine, Lactophenol Cotton Blue

2. b. Simple staining - Positive staining

2. c. Simple staining - Negative staining

3. Differential staining - Gram's staining

4. a. Structural staining – Endospore staining

4. b. Study of bacterial motility by Hanging Drop Method.

5. a. Cleaning and sterilization of glass wares

5. b. Preparation of culture media –Nutrient Agar Medium, Nutrient Broth, Potato Dextrose Agar Medium, Mac Conkey's Agar Medium, MSA Medium, EMB agar medium

6. Preparation of Physiological Saline and Serial Dilution Technique

7. Culture techniques: Pour Plate, Spread Plate, Streak Plate and Stab culture technique

8. Culture techniques (Contd.): Point inoculation, Agar Slant preparation.

9. Study of colony characteristics and Maintenance of pure cultures by paraffin method

10. Micrometry: Measurements of microorganisms using Stage and Ocular Micrometer

11. Evaluation of disinfectants- Phenol coefficient test

12. Study Antimicrobial agents: Soaps, Detergents, Phenol, Ethyl alcohol, Iodine.

13. a. Study of Microscopes- Dark Field, Phase Contrast, Stereo Binocular Microscope

13. b. Contributions of Microbiologists as mentioned in theory syllabus

14. Demonstration of laboratory equipment- Autoclave, Pressure cooker, Hot air oven, Incubator, Laminar Air Flow System, Inoculating loop &Inoculating needle, Digital Colony Counter.

Text Books / References:

1. General Microbiology 1st Edition, 2020, Linda Bruslind, Oregon State University

2. Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill.

3. Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill.

4. A Textbook of Microbiology, R. C. Dubey and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd.

5. Brock Biology of Microorganisms, M.T.Madigan, J.M.Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings.

6. Microbiology – An Introduction, G. J.Tortora, B. R.Funke, C. L. Case, 10th ed. 2008,Pearson Education.

7. General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited.

8. Microbiology- Concepts and Applications, PelczarJr,Chan, Krieg, International ed, McGraw Hill.

9. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp.

10. Atlas, R.M. 1984. Basic and practical microbiology. Mac Millan Publishers, USA. 987pp.

11. Black, J.G. 2008. Microbiology principles and explorations. 7edn. John Wiley and Sons Inc., New Jersey 846 pp.

12. Pommerville, J.C. Alcamo's Fundamentals of Microbiology. Jones and Bartlett Pub..Sudburry, 835 pp.

13. Schlegel, H.G. 1995.General Microbiology. Cambridge University Press, Cambridge, 655 pp.

14. Toratora, G.J., Funke, B.R. and Case, C.L. 2007. Microbiology 9th ed. Pearson Education Pvt. Ltd., San Francisco. 958pp.

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

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

Course 2: Theory: OE 2T, Introduction to Microbiology and Microbial Diversity

Course 2: OE 2T,Introduction to Microbiology and Microbial Diversity	**42Hrs**
Unit- 1 History of Development of Microbiology and Scope of Microbiology	**14Hrs**
Definition, Development of microbiology as a discipline, golden era of microbiology, relevance of microbiology, Microbiology in different areas- Agriculture, Industry, Dairy, Water, Food, Medical, Air, Soil	
Unit -2 Microbial diversity	**14Hrs**
Study of different groups of microorganisms: Bacteria: occurrence, size, shapes, structure & study of some useful & harmful bacteria(in brief) Fungi: occurrence, structure and study of some useful and harmful fungi(in brief) Algae: occurrence, structure and study of some useful and harmful algae(in brief) Protozoa: occurrence, structure and study of protozoa(in brief) Viruses: occurrence, size, shapes, structure of viruses(in brief)	
Unit -3 Microorganisms and their Habitats	**14Hrs**
Terrestrial Environment: Soil profile and soil microflora Aquatic Environment: Microflora of fresh water and marine habitats Atmosphere: Aeromicroflora and dispersal of microbes Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body	

BSc Microbiology (Basic/Hons.)
Semester 2

Content of Course: DSC-2T, Microbial Biochemistry and Physiology	**56Hrs**
Unit-1: Biochemical Concepts.	**14Hrs**
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, Handerson – Hasselbatch equation.	05Hrs 09Hrs
Unit – 2: Macromolecules – Types, Structure and Properties	**14Hrs**
Carbohydrates: Definition, classification, structure and properties. Amino acids and proteins: Definition, structure, classification and properties of amino acids, Structure and classification of proteins. Lipids and Fats: Definition, classification, structure, properties and importance of lipids. Porphyrins and Vitamins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin.	
Unit – 3: Microbial Physiology	**14Hrs**
A. Microbial Nutrition: Microbial nutrients, Classification of organisms based on carbon source, energy source and electron source, Macro and micronutrients. Membrane Transport: Structure and organization of biological membranes, Types of Cellular transport, Passive, Facilitated, Active, Group Translocation, Membrane bound and binding protein transport system. B. 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. Influence of environmental factors on growth. Microbial growth in natural environments. viable non-culturable organisms. Quorum sensing.	07Hrs 07Hrs
Unit – 4: Microbial Physiology- Bioenergetics, Microbial Respiration, Microbial Photosynthesis	**14Hrs**
A.Bioenergetics: Free energy, Enthalpy, Entropy, Classification of high energy compounds, Oxidation reduction reactions, equilibrium constant, Redox potential, Law of thermodynamics. Microbial Respiration: Respiratory electron transport chain in bacteria, oxidation – reduction reactions, protein translocation, oxidative and substrate level phosphorylation. Fermentation reactions (homo and hetero) **B.**Microbial Photosynthesis: Light reaction:Light harvesting pigments, Photophosphorylation, CO_2 fixation pathways: Calvin cycle, CODH pathway, Reductive TCA pathway.	07Hrs 07Hrs

Course 1: Practicals: 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
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 lipid saponification values of fats and iodine number of fatty acids
11. Determination of bacterial growth by spectrophotometric method & calculation of generation time
12. Effect of Temperature and pH on the growth of microorganisms
13. Effect of Salt and Carbon source on the growth of microorganisms
14. Effect of UV- rays and Oxygen on the growth of microorganisms
15. Demonstration of aerobic and anaerobic respiration in microbes

Text Books / References

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

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

Course 2:OE- 2a, Environmental and Sanitary Microbiology	**42Hrs**
Unit – 1: Soil and Air Microbiology	**14Hrs**
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	**14Hrs**
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	**14Hrs**
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.	

Course 2: Theory: OE 2b,Microbes in Human Health and Welfare

Course 2: OE 2b,Microbes in Human Health and Welfare	**42Hrs**
Unit- 1 Study of some common communicable diseases	**14Hrs**
Bacterial diseases: Cholera Tuberculosis and Typhoid Viral diseases: Ebola, HIV and Corona virus- COVID-19 Fungal diseases: Mucoromycosis, Dermatomycosis and Candidiosis Protozoal disease: Malaria, Amoebic dysentery and Toxoplasmosis	
Unit -2: Personal and Environmental hygiene	**14Hrs**
Introduction to the Principles and Concepts of Hygiene and Environmental Health Environmental Health Hazards, Personal Hygiene Hygienic Requirements of Foods and Drink Service Establishments Hygienic and Safety Requirements for Food of Animal Origin	
Unit -3 Useful microbes- Microbes in Human welfare	**14Hrs**
Antibiotics and vaccines Microbes and fermentation Microbes as food Microbes in sewage treatment Microbes in production of Biogas Microbes as biofertilizers and biopesticides	

Scheme of Practical Examination

Practical: DSC-1P, General Microbiology

Time: 03 Hours **Max. Marks: 25**

I. Stain the given specimen 'A' by ……..method. Write the principle, procedure and leave the preparation for evaluation. 07 Marks

(Preparation– 2 marks, Principle-1 mark, Procedure– 2 marks, Labelled Diagram- 1mark, Result- 1 mark)

(Simple positive/Direct staining, Negative/Indirect staining, Gram's staining, Endospore staining, Hanging drop method)

II. Demonstrate/perform the experiment 'B'. Write the principle, procedure and interpret the result. 07 Marks

(Demonstration – 3 marks, Principle – 1 mark, Procedure-2 marks and Result – 1 mark)

(Serial Dilution Technique, Pour Plate, Spread Plate, Streak Plate, Stab culture, Point inoculation, Agar Slant preparation, Phenol coefficient test)

III. Micrometry: Measure the size of the given specimen 'C' using stage and ocular micrometer. Write the principle, procedure and result. 05 Marks

(Principle– 1 mark, Procedure – 2 marks, Calibration – 1 mark, Result – 1)

IV. Writecritical notes on D,E and F 2x3=6 Marks

(Autoclave, Hot air oven, Incubator, Laminar Air Flow System, Membrane Filter Apparatus, Inoculation loop, Inoculation needle, Digital Colony counter, Dark Field Microscope, Phase Contrast Microscope, Stereo Binocular Microscope, Oil immersion objective, Soaps, Detergents, Phenol, Ethyl alcohol, Iodine, Antony Von Leewenhoek, Edward Jenner, Dmitri Iwanovsky, Louis Pasteur, Robert Koch, Joseph Lister, Elie Metchnikoff, Alexander Fleming)

Scheme of Practical Examination

Practical: DSC-2P,Microbial Biochemistry and Physiology

Time: 03 Hours **Max. Marks: 25**

I. Demonstrate/perform the experiment **A** giving the principle and procedure. Record and interpret the result. **09 Marks**

(Demonstration – 3 marks, Principle – 2 marks, Procedure – 3 marks, Result – 1 mark)

(Qualitative determination and identification of Carbohydrates, Proteins,Amino Acids,Fatty Acids, Quantitative estimation of Reducing Sugar by DNS method, Quantitative estimation of Proteins by Biuret and Lowry's method, Determination of lipid saponification values of fats and iodine number of fatty acids)

II. Demonstrate the experiment **B** giving the principle and procedure. Record and interpret the result.

10 Marks

(Demonstration – 3 marks, Principle – 2 marks, Procedure – 3 marks, Result – 2 marks)

(Effect of Temperature on the growth of microorganisms, Effect of pH on the growth of microorganisms Effect of carbon sources on the growth of microorganisms, Effect of oxygenon the growth of microorganisms, Effect of Salt concentrationon the growth of microorganisms, Effect of UV rayson the growth of microorganisms, Demonstration of aerobic and anaerobic respiration in microbes, Determination of bacterial growth by spectrophotometric method & calculation of generation time)

III. Write critical notes on **C, D** and **E.** **2x3=06 Marks**

(Colorimeter/Turbidometer/pH meter,GasPak method, Results of Microbial Physiology experiments performed)

Question Paper Pattern for Theory Examination

Time: 2 Hours **Max.Marks: 60**

A. Answer the following: **1x5=05 Marks**

1.

2.

3.

4.

5.

B. Answer briefly any FIVE of the following: **3x5=15 Marks**

6.

7.

8.

9.

10.

11.

12.

C. Write short notes on any FOUR of the following: **5x4=20 Marks**

13.

14.

15.

16.

17.

18.

D. Answer in detail any TWO following: **10x2=20 Marks**

19.

20.

21.

22.

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JSS COLLEGE FOR WOMEN(Autonomous)
Saraswathipuram, Mysuru-09

Curriculum Framework for Undergraduate Programme in Colleges at University of Mysore, Mysuru

NATIONAL EDUCATION POLICY 2020

3rd and 4th Semester Model Syllabus for B. Sc. in Microbiology

Board of Studies in Microbiology
Department of Microbiology
JSS COLLEGE FOR WOMEN (Autonomous)
Saraswathipuram, Mysuru-09

2023-24 onwards

B. Sc.: Curriculum and Credit Framework for Undergraduate Programme

Sem.	Discipline Specific Courses - Core (DSC), Elective (DSE)(Credits) (L+T+P)	Minor/ Multidisciplinary/Open Elective (OE) Courses(Credits) (L+T+P)	Ability Enhancement Courses (AEC) (Credits)(L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-A1(4), A2(2) DSC-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-A3(4), A4(2), DSC-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC-A5(4), A6(2), DSC-B5(4), B6(2)	OE-3 (3)/ India and Indian Constitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/CyberSecurity/Financial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) /Cultural (2) (0+0+4)/ SEC(2)	25
IV	DSC-A7(4), A8(2), DSC-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term.						
V	DSC-A9(4), A10(2), A11(4), A12(2);	DSC-B9(4), B10(2), B11(4),B12(2)		**SEC-4**: Employability Skills/Cyber Security (3) (2+0+2)		27
VI	DSC-A13(4), A14(2), A15(4), A16(2);	DSC-B13(4), B14(2), B15(4), B16(2)		Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

III and IV Semester Courses for Undergraduate Program in MICROBIOLOGY

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional hours per week		Duration of Exam (Hrs.)	Exam/ Evaluation Pattern (Marks)		
					Theory	Practical		IA	Exam	Total
III	DSC	DSC-5T	Microbial diversity	4	4		$2^1/_2$	40	60	100
		DSC-6P	Microbial diversity	2		4	3	25	25	50
	OEC	OE-3T	Microbial Entrepreneurship	3	3		$2^1/_2$	40	60	100
IV	DSC	DSC-7T	Microbial Enzymology and Metabolism	4	4		$2^1/_2$	40	60	100
		DSC-8P	Microbial Enzymology and Metabolism	2		4	3	25	25	50
	OEC	OE-4T	Human Microbiome	2	2		$2^1/_2$	20	30	50

MODEL CURRICULUM

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 + Seminars / 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% marks

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

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- Archea, Actinomycetes, *Rickettsia, Chlamydiae*, *Mycoplasma* and *Spirochaetes* **Microbial diversity in ecosystem –Soil ecosystem** **1.**Types of soil**,** soil horizons, soil microflora- Bacteria, Fungi, Algae, Protozoa and Viruses **2.**Rhizosphere and Rhizoplane- Rhizpsphere effect **3.Interaction of microorganisms in soil** **Positive interaction-**Amensalism, Commensalism and Mutualism (Syntrophism, Synergisms) **Negative interaction-** Antagonism, Parasitism, Mycophagy and Nematophagy) Cyanobacteria- *Nostoc, Microcystis, Spirulina*:	
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, H1N1 and Oncogenic virus in general. Plants viruses: TMV, Ring spot virus in Papaya 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**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	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**

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. Demonstration of Antagonism
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
Test	10
Attendance	05
Performance	05
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. Prentice Hall. New Jersey
2. Vashishta, B. R, Sinha A.K and Singh V. P. (2005). Botany – Fungi, S. Chand and Company 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, 10th edn., PearsonEducation
9. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R. (1993). Microbiology. 5th edn. McGraw Hill Book Company.
10. Vashishta, B. R Sinha A. K and Singh V. P. (2005). Botany - Algae S. Chand and Company 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 of IndianFoods. 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

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, Pentose phosphate 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, Propionic acid fermentation and 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 amino acids and Amino acid degradation. **Lipid metabolism**: Formation of Malonyl CoA from Aectyl CoA, Acyl carrier protein, Fatty acid synthetase complex Biosynthesis of long chain fatty acids (Palmitate) 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**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	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**

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. Effect of temperature and pH on enzyme (α-amylase) activity
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. 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
Test	10
Attendance	05
Performance	05
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 in health. 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 Shape Animal 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. 1st edition. 2008pp.
5. Natalia V Beloborodova, (2021). Human Microbiome. IntechOpen, 166pp. Gregory, P. H. (1961). The Microbiology of the atmosphere. Interscience Publishers,New York.

SCHEME OF PRACTICAL EXAMINATION

III SEMESTER (NEP)

PRACTICAL III: Microbial Diversity

Time: 03 Hours **Max. Marks: 25**

1. **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)

2. **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)

3. **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*)

4. **Viva-voce** **04 marks**

SCHEME OF PRACTICAL EXAMINATION
IV SEMESTER (NEP)

PRACTICAL IV: Microbial Enzymology and Metabolism

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

1. **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 / Effect of Teparature and pH on enzyme (α-amylase) activity / 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)

2. **Conduct the given biochemical test B giving principle and procedure. Write the significance.** **05 marks**

(Gelatin hydrolysis / Starch hydrolysis / Demonstration of Ammonification / Nitrification / Denitrification / Lipolytic activity / Sugar fermentation

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

3. 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)

4. **Viva-voce** **04 marks**

B. Sc. Microbiology 5th Semester

Program name	**B. Sc. in MICROBIOLOGY**		**Semester**	**V**
Course Title	**FOOD MICROBIOLOGY (Theory)**			
Course Code	**DSC-11T**		**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**

Course Outcomes (COs):

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

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

CO2. Understand the preservation and food safety protocols

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

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

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

Content of Course 6: Theory: Food Microbiology	**60 Hrs.**
Unit 1: Production of food crops and their diseases	**15 Hrs.**
Role of microbes in food crops production: Biofertilizers: Definition, Mass production, mode of applications, advantages and limitations of *Rhizobium, Azotobacter, Azospirillum,* cyanobacterial fertilizers. Role of *Frankia* and VAM in soil fertility. Biopesticides: Definition, types- bacterial, viral and fungal-mode of action, factors influencing, target pests. Microbial herbicides. **Diseases of food crops**: Study of symptoms, etiology, epidemiology and management of diseases caused by fungi (Tikka disease of groundnut, blast disease of paddy, Red rot of sugarcane), bacteria (Citrus canker, Potato scab), viruses (Bean mosaic, Bunchy top of banana) and viroid (Potato spindle tuber disease). Post-harvest diseases.	
Unit 2: Microbial quality of air and water for food processing and disposal of wastewater	**15 Hrs.**
Bioaerosols in food: Air borne microbes and their impact on food. Bioaerosol sampling: Vertical cylinder spore trap, Hirst spore trap, Rotorod sampler, Andersen sampler, impingers and filtration. Control of bioaerosols- UV light, HEPA filters, desiccation, Incineration. **Water quality in food safety**: Water sample collection, methods to detect potability of water samples: presumptive/MPN tests, confirmed and completed tests for faecal coliforms, SPC, IMViC reactions, membrane filter technique. Water borne pathogens, Control of water borne pathogens- Precipitation, filtration, chemical disinfection, UV light. **Disposal of wastewater in food industries**: Microbiological characteristics of wastewater. Wastewater treatment- primary (screening, coagulation and sedimentation), secondary (trickling filter, Activated sludge) tertiary (Chlorination). Methods of solid waste disposal (composting and biogas). BOD and COD.	
Unit 3: Food spoilage, Infection and Preservation	**15 Hrs.**

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 & Class II). Bio preservation. Canning. Food Packaging- Types of packaging materials, properties and benefits. Food sanitation & control- Good Hygiene practices, GLP, GMP, HACCP, FSSAI, FDA & BIS in brief.

Unit 4: Microbiology of milk and fermented food products	**15 Hrs.**

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

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

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

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	

B. Sc. Microbiology 6th Semester

Program name	B. Sc. in MICROBIOLOGY		Semester	VI
Course Title	IMMUNOLOGY AND MEDICAL MICROBIOLOGY (Theory)			
Course Code	DSC-7		No. of Credits	04
Contact Hours	60 (4 Hrs./ week)		Duration of SEA/Exam (Hrs.)	2 1/2
Formative Assessment Marks		40	Summative Assessment Marks	60

Course Outcomes (COs):

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

CO1: Gain a preliminary understanding about various immune mechanisms.

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

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

Content of Course 7: Immunology and Medical Microbiology	60 Hrs.
Unit I- Immune System : Immune Organs and Tissue, Antigens and Antibodies	**15 Hrs.**
A. History and development of Immunology **B.** Types of Immunity**–** Innate & Adaptive immunity. Antibody Mediated Immunity (AMI), Cell Mediated Immunity (CMI) **C.** Cells, Tissues and Organs of Immune System**–** Structure and Role of Primary Lymphoid Organs (Bone Marrow and Thymus), Secondary Lymphoid Organs (Spleen, Lymph nodes, Tonsils and MALT), B & T lymphocytes, Phagocytes, NK cells. Lymphatic system (In brief). **D. Antigens–** Nature and Types **E. Antibodies–** Classes of Antibodies: Salient features & their functional diversities. Structure of IgG. Antigenic determinants on immunoglobulins: Isotype, allotype and idiotype. **F.** Complement System (in brief)	
Unit 2: Antigen-antibody interactions, Immunoprophylaxis and Immunopathology	**15 Hrs.**
A. Antigen-antibody reactions: Definition, Salient Features, Antibody Affinity and Avidity. Agglutination reactions: Haem-agglutination- Blood Grouping. Precipitation reactions: Oudin, Oklay-Fulthorpe, Radial and Ouchterlony immunodiffusion. Complement Fixation Test (CFT). Immuno techniques: ELISA, Radioimmuno Assay (RIA) and Immunofluorescence. **B. Immunoprophylaxis**- Vaccines: Types - Killed, Live attenuated and Toxoid with an example each. National Immunization Schedule and Mission Indradhanush. **C. Immunotherapy–** Anti Tetanus Serum (ATS), Hybridoma Technology **D.Immunopathology- Hypersensitive reactions**: Classification, Antibody Mediated Hypersensitivity: Type I (IgE), Type II (IgG and IgM-ADCC), Type III (Antigen-antibody complex), and Cell mediated hypersensitivity: Type IV (DTH). Auto-immune diseases in brief.	

Unit 3: Host-pathogen interaction and Medical Bacteriology	**15 Hrs.**
A. Normal microflora of human skin, Oral Cavity, Gastrointestinal Tract, Urogenital Tract and their importance. **B. Host pathogen interaction**: Definitions- Infection, Invasion, Pathogenicity, Virulence, Attenuation, Exaltation, Toxigenicity, Carriers and their types. Infection-types of infection, Source of infection, Methods of Transmission of Infection. **C. Laboratory Specimen**- Collection, Handling and Transport. **D. Bacterial Diseases:** Etiology, Disease Symptoms, Pathogenesis, Epidemiology, Lab diagnosis, Prophylaxis and Treatment of the following- Tuberculosis, Diptheria, Cholera, Typhoid, Tetanus, and Syphilis.	

Unit 4: Medical Virology, Mycology, Parasitology and Chemotherapy	**15 Hrs.**
Etiology, Disease Symptoms, Pathogenesis, Epidemiology, Lab diagnosis, prophylaxis and treatment of the following: **A. Viral diseases:** Polio, Rabies, Hepatitis-B, Dengue, AIDS, Corona. **B. Fungal Diseases:** Dermato mycoses- Tinea infections. Systemic mycoses- Histoplasmosis Opportunistic mycoses – Candidiasis. **C. Protozoan Diseases:** Malaria and Trichomoniasis. **D. Chemotherapy:** 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- Mechanism of drug resistance, MDR, XDR, MRSA, NDM-1	

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

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Attendance	10
Seminar	10
Debate/Quiz/Assignment	10
Class test	10
Total	**40**
Formative Assessment as per guidelines are compulsory	