MANGALORE UNIVERSITY
B.Sc. MICROBIOLOGY

SYLLABUS AND SCHEME

With effect from 2024-25

DISCIPLINE SPECIFIC CORE (DSC) COURSE (As per SEP Commission Policy)

MANGALORE UNIVERSITY
SYLLABUS AND SCHEME
B.Sc. MICROBIOLOGY
SCHEME with Course Titles, Details of Instruction and Examination

I SEMESTER								
Course Code	**Title of the Course**	**Type of Course**	**Hrs./week**	**Duration of Exam (hrs)**	**Max. Marks**			**Credits**
					IA	**Sem. Exam**	**Total**	
	Fundamental Microbiology	THEORY	4	3	20	80	100	3
	Fundamental Microbiology	PRACTICAL	4	3	10	40	50	2
Total Marks and Credits							**150**	**5**
II SEMESTER								
	Microbial Taxonomy and Culture Techniques	THEORY	4	3	20	80	100	3
	Microbial Taxonomy and Culture Techniques	PRACTICAL	4	3	10	40	50	2
Total Marks and Credits							**150**	**5**
III SEMESTER								
	Microbial Biochemistry, Physiology and Genetics	THEORY	4	3	20	80	100	3
	Microbial Biochemistry, Physiology and Genetics	PRACTICAL	4	3	10	40	50	2
	Bio risk, Biosafety and quality control in Microbiology	THEORY Discipline Elective/ Optional Course	2	2	10	40	50	2
Total Marks and Credits							**200**	7

IV SEMESTER								
Course Code	**Title of the Course**	**Type of Course**	**Hrs./week**	**Duration of Exam (hrs)**	**Max. Marks**			**Credits**
					IA	**Sem. Exam**	**Total**	
401	Molecular Biology and Recombinant DNA Technology	THEORY	4	3	20	80	100	**3**
402	Molecular Biology and Recombinant DNA Technology	PRACTICAL	4	3	10	40	50	**2**
403	Diagnostic laboratory techniques in Microbiology	THEORY Discipline Elective/ Optional	2	2	10	40	50	**2**
404	Bio-instrumentation	Compulsory Skill-based course	2	2	10	40	50	**2**
Total Marks and Credits							**250**	9
V SEMESTER								
501	Medical Microbiology and Immunology	THEORY	4	3	20	80	100	**3**
502	Agricultural and Plant Pathology	THEORY	4	3	20	80	100	**3**
503	Medical and Agricultural Microbiology	PRACTICAL	4	3	10	40	50	**2**
504	Project Work	Compulsory Skill-based Course	2	-	10	40	50	2
Total Marks and Credits							**300**	**10**
VI SEMESTER								
601	Food and Industrial Microbiology	THEORY	4	3	20	80	100	**3**
602	Environmental Microbiology	THEORY	4	3	20	80	100	**3**
603	Industrial and Environmental Microbiology	PRACTICAL	4	3	10	40	50	2
604	Food safety and standards	Compulsory Skill-based Course	2	2	10	40	50	2
Total Marks and Credits							**300**	**10**
Grand Total							**1350**	**46**

Program Outcomes:

By the end of the program the students will be able to acquire the competencies required by the candidate securing B.Sc.:

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

SCHEME OF THEORY EXAMINATION

All Sections are compulsory. Illustrate/Draw wherever necessary

Time 3 hours	**Max. Marks 80**	
Section A		
Write briefly on any ten of the following	2 x 10 = 20	1-12 questions
Section B		
Write short notes on any four of the following	4 x 5 = 20	13-18 questions
Section C		
Answer any four of the following	4 x 10 = 40	19-24 questions

SCHEME OF PRACTICAL EXAMINATION

Time 3 hours			**Max. Marks 80**
Question Nr.	**Experiment**	**Marks**	
1	Major	12	**12**
2	Minor	08	**08**
3	Spotters (4)	4 x 3 = 12	**12**
4	Record & Viva-voce	4 + 4 = 08	**08**
		Total marks	**40**

SCHEME OF INTERNAL ASSESSMENT

Assessments	**Theory Examination**	**Practical Examination**	**Elective**
Tests	10	05	05
Seminar	05	05	05
Assignment	05	00	00
Total	**20**	**10**	**10**

Question paper pattern for all semesters

1. All sections are compulsory
2. Illustrate/Draw diagrams wherever necessary

Time:3 Hours Max. Marks:80

Section A

Write briefly on any TEN of the following: 10 x 2 = 20

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

Section B

Write Short notes on any FOUR of the following: 4 x 5 = 20

13.
14.
15.
16.
17.
18.

Section C

Answer any FOUR of the following: 4 x 10 = 40

19.
20.
21.
22.
23.
24.

Questions shall be selected from all the units of the syllabus for all sections of the question papers.

Internal Assessment (Theory)

1. Two theory tests to be conducted for 20 marks and converted to 10 marks
2. Assignments – 05 marks
3. Seminars – 05 marks

Total = 20 marks

Internal Assessment (Practical)
One practical test to be conducted

Question paper pattern for Practical:

Q. 1. Perform major experiment (selected by lots)	12 Marks
Q. 2. Perform minor experiment (selected by lots)	8 Marks
Q. 3. Identify the given spotters with reasons (a, b, c)	4 x 3 = 12 Marks
Q. 4. Viva and Record submission	4 + 4 = 08 Marks
Total	**40 Marks**

MANGALORE UNIVERSITY
UG PROGRAMME IN MICROBIOLOGY (BSc MICROBIOLOGY)
I SEMESTER

Program Name	**BSc in MICROBIOLOGY**	**Semester**	**I**
Course Title	**FUNDAMENTAL MICROBIOLOGY (THEORY)**		
Course Code	**BSCMBCS 101**	**No. of credits**	**03**
Contact Hours	**56 Hours Theory**	**Duration of EA Exam**	**3 hours**
Formative Assessment	**20**	**Summative assessment**	**80**

Course Outcomes:

At the end of the course, the student should be able to:

CO1. Thorough knowledge and understanding of concepts of microbiology.
CO2 Learning and practicing professional skills in handling microbes.
CO3 Thorough knowledge and application of good laboratory and good manufacturing practices in microbial quality control.
CO4.To study the history of Microbiology and contributions of eminent Microbiologists
CO5. To understand the types of Microscopes, its working and function
CO6. To study the sterilization and aseptic techniques in Microbiology, types and methods of sterilization and its mode of action
CO7. To know the nutrition of microorganisms, types, classification and Transport of nutrient in bacteria and its mechanisms and to study the growth patterns of microbes

UNIT I: History and Scope of Microbiology 14 hrs

- Origin of life and evolution of microorganisms: History and scope of microbiology as a modern science. Microorganisms – Types and significance in general (beneficial and harmful). Branches of microbiology
- Contribution of Anton von Leuwenhoek, Edward Jenner, Lazaro Spallanzani, Louis Pasteur, Joseph Lister, Robert Koch, Alexander Fleming and Iwanovsky to Microbiology
- Contribution of M.S. Swaminathan, Har Gobind Khorana, Ananda Mohan Chakrabarty

UNIT II: Microscopy and Staining Techniques 14 hrs

- Microscopy: Principles of microscopy – Magnification, resolving power, numerical aperture, tube length and focal length of compound microscope
- Principle, construction, working and applications of a) Compound microscope b) Phase contrast microscope c) Fluorescent microscope d) Electron microscope – TEM and SEM
- Stains, types of stains, general procedures of staining of bacteria and fungi
- a) Simple staining and negative staining b) Differential staining – grams and acid fast staining c) structural staining – cell wall, endospore, and capsular staining

UNIT III: Sterilization Techniques 14 hrs

- Definition and terms – sterilization, disinfectant, antiseptic, sanitizer, germicide, micro biostatic agents and antimicrobial agents.

- Physical methods of sterilization – Heat – a) dry heat – hot air oven and incineration b) moist heat, autoclave, pressure cooker, c) Tyndallization (fractional sterilization). Filtration – types of filters, laminar air flow, radiation methods: UV rays and Cathode rays
- Chemical methods of sterilization: Use and mode of action of alcohol, aldehydes, phenols, halogen, heavy metals and metallic salts, quarternary-ammonium compounds and sterilizing gases as antimicrobial agents

UNIT IV: Microbial Nutrition **14 hrs**

- Nutritional requirements of microorganisms – Macronutrients, micronutrients and growth factors. Nutritional types of microorganisms: Autotrophs and heterotrophs, phototrophs and chemotrophs. Physical factors affecting growth of microorganisms: Temperature, pH and oxygen. Growth rate and generation time, bacterial growth curve – phases of growth and their significance. Diauxic and synchronous growth, continuous and batch cultivation
- Measurement of growth – Direct microscopic count, hemocytometer, viable count, membrane filtration, electronic coulter counting method. Measurement of cell mass. Chemostat and Turbidostat – Batch and continuous culture
- Nutrient transport – passive, facilitated active and group translocation

PRACTICAL

Semester-I Course Title	**FUNDAMENTAL MICROBIOLOGY PRACTICAL**	**Practical Credits**	**02**
Course Code	**BSCMBCP 102**	**Contact Hours**	**04 hours/week**
Formative Assessment	**10 marks**	**Summative Assessment**	**40 marks**

1. Safety measures in Microbiology Laboratory
2. Study of compound microscope – Construction, working, principle, care to be taken while using the microscope. Use of oil immersion objective
3. Study of instruments – autoclave, hot air oven, laminar air flow chamber, colony counter, inoculation loop and needle, incubator, centrifuge, pH meter, colorimeter, spectrophotometer
4. Study of aseptic techniques, preparation of cotton plugs for test tubes and pipettes, wrapping of petri plates and pipettes, transfer of media and inoculum.
5. Cleaning and sterilization of glassware
6. Simple staining technique for bacteria
7. Negative staining technique
8. Gram's staining technique
9. Endospore staining technique
10. Staining and mounting of algae
11. Staining and mounting of fungi
12. Study of bacterial motility by hanging drop technique

References

1. Black J.G. and Black L.J. 2017 Microbiology – Principles and explorations, 10th Ed, John Wiley & Sons, New York, USA
2. Dubey R.C. and Maheshwari D.K. 2022. A Text Book of Microbiology, 5th Ed., S. Chand & Sons, Co. Ltd.
3. Madigan M.T., Martinko J.M, Bender K.S., Buckley D.H., Sattley W,M., Stahl D.A. 2021. Brock Biology of microorganisms, 16th Ed., Pearson, Boston New Jersey.
4. Pelczar (Jr.) M. J., Chan, E. C. S. and Kreig, N. R. 2023. Microbiology, 5th Ed., Affiliated East West Press Pvt. Ltd.
5. Stainer I. 2008. General Microbiology, International Ed., McGraw Hill.
6. Tortora G.J., Funke B.R., Case C.L., Warner B.B., Weber D. 2023. Microbiology, an Introduction, 14th Ed., Pearson Education Pvt. Ltd.
7. Willey J.M., Sherwood L., Sandman K., and Wood D. 2022. Prescott's Microbiology, 12th Ed., McGraw Hill Higher Education.

II SEMESTER

Program Name	BSc in MICROBIOLOGY	Semester	II
Course Title	MICROBIOLOGY TAXONOMY AND CULTURE TECHNIQUES (THEORY)		
Course Code	BSCMBCS 201	No. of credits	03
Contact Hours	56 Hours Theory	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO 1 Demonstrate skills as per National Occupational Standards (NOS) of "Lab Technician/Assistant" Qualification Pack issued by Life Sciences Sector Skill Development Council-LFS/Q0509, Level3.

CO2 Perform microbiology and analytical techniques. Knowledge about environment, health, and safety (EHS), good laboratory practices (GLP), good manufacturing practices (GMP) and standard operating procedures (SOP)

CO3 Demonstrate professional skills at work, such as decision making, planning, and organizing, Problem solving, analytical thinking, critical thinking, and documentation.

CO4 Principles which underlies sterilization of culture media, glassware and plastic ware to be used for microbiological work.

CO5 Principles of a number of analytical instruments which the students have use during the study and also later as microbiologists for performing various laboratory manipulations.

CO6 Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced to a variety of modifications in the microscopes for specialized viewing.

CO7 Several separation techniques which may be required to be handled later as microbiologists.

UNIT I: Bacterial Taxonomy and Diversity 14 hrs

- Criteria for classification of prokaryotes – morphological, physiological, biochemical. Chemotaxonomy and numerical taxonomy. A brief account on Bergey's manual of systematic bacteriology. Cladograms and genograms.
- Bacteriology – General characteristics of bacteria, cell structure, size, shape and arrangement of bacterial cells. Fine structure, composition and function of bacterial cell wall, cell membrane, cytoplasm, nucleoside, flagella, pili/fimbriae, slime layer, capsule, spores, cysts and reproduction
- Classification of bacteria, reproduction of bacteria, general characteristics and significance of Rickettsia, Chlamydia, Mycoplasma, Actinomyces. Brief account of Archaea.

UNIT II: Fungal and Viral Taxonomy and Diversity 14 hrs

- Classification of viruses (Baltimore and ICTV) Ultrastructure of viruses – capsid

symmetry, envelope, enzymes and genome. Structure, replication and significance of – Bacteriophage (T 4 and Lambda), Herpes (Enveloped), Polyoma virus (Icosahedral), Adeno virus (DNA genome) and HIV (RNA genome and reverse transcriptase enzyme).

- Brief account on - Cyanophages and mycophages, acellular entities – Viroids and Prions.
- Brief history of Mycology, General characteristics, structure and organization of fungi. Classification of fungi (Alexopoulos and Mims) Fungi: General aspects of fungal nutrition. Reproduction and significance of major groups of fungi (Phycomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes).Type study (Aspergillus, Rhizopus, Penicillium, Trichoderma and Yeast)

UNIT - III General account of Algae and Protozoa 14hrs

- Algae: Introduction, Classification of Algae (G. M. Smith), general structure and reproduction (Vegetative, Asexual and Sexual). Type study-Chlamydomonas, Volvox and Spirogyra
- General characteristics, cell structure and reproduction of Cyanobacteria. Type study of Anabaena and Spirulina. Parallelism between bacteria and cyanobacteria.
- Protozoa: General features and significance. Type study -Amoeba and Plasmodium.

UNIT IV: Types of culture media and microbial culture technique 14hrs

- Synthetic and non-synthetic – solid, liquid and semisolid media. Special media – Enriched, Selective, transport, differential, maintenance (NA, PDA, YEMA, SDA, MacConkey's agar, Blood agar, Chocolate agar, EMB, Cary Blair's media, RCM, VR medium).
- Methods of isolation of bacteria and fungi. Streak plate, spread plate method, Serial dilution technique, Slide culture technique, Cultivation of Anaerobic bacteria. Strain selection and improvement technique. Preservation and maintenance of cultures. Microbial culture collection centers. Media and methods used for cultivation of algae, large scale cultivation. Cultivation and assay of Viruses.

PRACTICAL

Semester – II Course Title	**MICROBIAL TAXONOMY AND CULTURE TECHNIQUES PRACTICAL**	**Practical Credits**	**02**
Course Code	**BSCMBCP 202**	**Contact Hours**	**04 hours/week**
Formative Assessment	**10 marks**	**Summative Assessment**	**40 Marks**

1. Preparation of media- Nutrient broth, Nutrient Agar, SDA/ PDA/Mc Con keys Agar
2. Isolation of microorganisms: Spread plate, Streaking technique,Swab technique and point inoculation
3. Isolation of bacteria by Serial dilution and Pour plating technique
4. Study of colony characteristics of Gram positive and Gram-negative bacteria.
5. Measurement of size of cells by Micrometry
6. Enumeration of microorganisms by Hemocytometer

7. Study of Bacterial growth curve.
8. Study of effect of pH and temperature on bacterial growth
9. Study of Slide culture technique.
10. Type study of *Aspergillus, Penicillium, Yeast, Rhizopus and Fusarium* (Specimens)
11. Study of protozoa- Amoeba, Paramaecium and Euglena. (Permanent slides)
12. Study of Blue green algae- *Nostoc, Oscillatoria* and *Spirulina.* (Specimens)

References

1. Alexopoulos C.J., Mims C. W. and Blackwell M. (2002) Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
2. Becker E.W., (2008). Microalgae: Biotechnology and Microbiology. Cambridge University Press.
3. Dimmock N. J., Easton A. J. and Leppard K. N. (2016). Introduction to Mordern Virology. 7th ed. Blackwell publishing, USA.
4. Dinabandhu Sahoo, Joseph Seckbach (2015). The Algae World. Springer.
5. Dube H. C., (2023) A Textbook of Fungi, Bacteria and Viruses, 3rd ed. Science and Technology Publishing.
6. Flint S. J., Racaniello V. R., Rall G. F., Hatziioannou T., Skalka A. M. (2020) Principles of Virology, 5th ed. ASM Press.
7. Madigan M. T., Martinko J. M., Bender K. S., Buckley D. H., Stahl D. A. (2015). Brock biology of micoorganisms, 14th ed. Pearson, Boston.
8. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd ed. The McGraw Hill. New York.
9. Mehrotra R. S., and Aneja K. R. (2015). An Introduction to Mycology. New Age Publications.
10. Pommerville J. C.(2013). Alcamo's Fundamentals of Microbiology. Cambridge University Press, Cambridge.
11. Stanier, Ingraham. (2008). General Microbiology, International ed. McGraw Hill.
12. Sharma O.P. (2023). Fundamentals of Algae, 3rd ed. MedTech. Science Press.
13. Sullia S. B. and Shantharam S. (2000). General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd., India.
14. Tortora G. J., Funke B. R., Case C. L., Warner B.B., Weber D. (2023). Microbiology an Introduction, 14 th ed. Pearson Education Pvt. Ltd.
15. Vashishta B. R., Sinha A.K., Singh V.P. (2010) Botany for Degree Students – Algae. Rev. Ed. S. Chand & Company Ltd.
16. Vashishta B. R., Sinha A.K., (2016) Botany for Degree Students – Fungi. Rev. Ed. S. Chand & Company Ltd.
17. Willey J. M., Sherwood L., Sandman K., & Wood D. (2022) Prescott's Microbiology. 12th ed. McGraw – Hill Higher Education.

III SEMESTER

Program Name	BSc in MICROBIOLOGY	Semester	III
Course Title	BIOCHEMISTRY, MICROBIAL PHYSIOLOGY AND GENETICS (THEORY)		
Course Code	BSCMBCS 301	No. of credits	03
Contact Hours	56 Hours Theory	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO1. to understand the basic biochemical concepts of a bacterial cell and acid ,base electrolytes.

CO2. To study of basic biomolecules ,introduction and various factors affecting their structure and function.

CO 3 To understand the energy transfer, oxidation reduction reactions happening in the bacteria including photosynthetic bacteria.

to know the metabolic pathways of bacteria.

CO 4. To study the chromosomal features and bacterial genetics including various recombination types of microorganisms

CO 5. To know the concept and types of mutations in bacteria affecting genotype and phenotype, plasmid genetics and transposomal elements.

UNIT I: Biochemistry 14 Hrs

- Major elements of life and their primary characteristics-C, H, O, N, S and P.
- Biological solvent - structure and properties of water.
- Acids, bases, buffers, pH and Electrolytes.
- Definition, classification, properties and functions of carbohydrates, proteins, nucleic acids, and lipids. Structural organization of proteins. Definition and Classification of vitamins and amino acids.
- Enzymes – Introduction, Properties, Nomenclature and Classification, Mechanism of enzyme action, Effect of various factors influencing enzyme activity, Enzyme Inhibition and its types.

UNIT II: Bioenergetics and Microbial Physiology 14 hrs

- Bioenergetics – Definition, Free energy, ATP and its production, High Energy Compounds, Oxidation – Reduction Reactions, Energy Coupling Reactions, Exothermic and Endothermic Reactions
- Metabolism - Anabolism, Catabolism, Respiration – Glycolysis, Krebs cycle, ETC, Oxidative and Substrate level Phosphorylation, Pentose Phosphate pathway.
- Fermentation: Definition and types, Homolactic and Heterolactic fermentation
- Microbial Photosynthesis: Photosynthetic Pigments, Types of bacterial Photosynthesis,

Cyclic and Non-Cyclic Photophosphorylation, Oxygenic and Anoxygenic Bacteria. Comparison Of Photosynthesis in Green Plants and Bacteria,

UNIT III: Microbial Genetics **14 hrs**

- Fundamentals of Genetics, Genomic organization in prokaryotes and eukaryotes.
- DNA and RNA: Chemical compositions, Watson & Crick model of DNA, Types of DNA: A, B, C, D, Z and H, Supercoiling of DNA, Single stranded and Circular DNA Structure of RNA, Types of RNA-rRNA, tRNA (Clover Leaf Model), mRNA
- DNA replication in Prokaryotes: Semi-conservative and dispersive methods, Rolling circle model and Cairn's model (Theta model), Primers and templates, replication fork, unidirectional and bidirectional replication.
- Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains; Transduction - Generalized transduction, specialized transduction,

UNIT IV: Mutations, Plasmids and Transposons **14 hrs**

- Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; detection and isolation of mutants (Replica plate method); Uses of mutations
- Genotypic and phenotypic variations in microorganisms
- Plasmid genetics: Types of plasmids- F plasmid, R Plasmids, Ti plasmids and linear plasmids. Plasmid replication, plasmid amplification, Regulation of copy number, curing of plasmids
- Transposable elements: A general account. Uses of transposons and transposition

PRACTICAL

Semester – III Course Title	**Biochemistry, Microbial Physiology and Genetics**	**Practical Credits**	**02**
Course Code	**BSCMBCP 302**	**Contact Hours**	**04 hours/week**
Formative Assessment	**10 marks**	**Summative Assessment**	**40 Marks**

1. Fermentation of carbohydrates by microorganisms
2. Starch hydrolysis test
3. Gelatin liquefaction test
4. Catalase test
5. Oxidase test
6. TSI agar test
7. IMViC test
8. Urease test
9. Estimation of reducing sugar glucose by DNS method
10. Estimation of protein by Biuret method
11. Isolation of mutants by Replica plating method

12. Study of Transformation, transduction and conjugation charts

References-

1. Pelczar M.J. Chan E.C.S and Krieg N.R. Microbiology McGraw Hill Book Company, New York.
2. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Strickberger, M.W., *Genetics*, Prentice Hall of India Private Limited, New Delhi.
4. Freifelder David, *Microbial Genetics*, Narosa Publishing House, New Delhi.
5. R P Sing. Microbiology 5th Edition
6. Stanier R.Y., Ingraham J.L.,*General Microbiology*, Prentice Hall of India Private Limited, New Delhi.
7. Aneja K.R. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
8. Powar and Daginwala, General Microbiology Vol I and II
9. Atlas R.M., Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
10. Nelson David L. and Cox Michael M. Lehninger Principles of Biochemistry, Macmillan Press/Worth Publishers, New Delhi.

DISCIPLINE-BASED ELECTIVE / OPTIONAL COURSE

Program Name	**BSc in MICROBIOLOGY**	**Semester**	**III**
Course Title	**BIORISK, BIOSAFETY AND QUALITY CONTROL IN MICROBIOLOGY**		
Course Code	**BSCMBCSE 303**	**No. of credits**	**02**
Contact Hours	**24 Theory (2Hrs per week)**	**Duration of EA Exam**	**2 hours**
Formative Assessment	**10**	**Summative assessment**	**40**

BSCMBCSE -303 BIORISK, BIOSAFETY AND QUALITY CONTROL IN MICROBIOLOGY

UNIT I **12 hrs.**

1. Bio risk, Biosafety and Biohazards: - Primary Containment for Biohazards.

2. Introduction to Biological Safety Cabinets; Biosafety guidelines, - Government of India. Biosafety Levels for various microorganisms.

3. Management of biohazardous waste - disinfection and disposal. Good microbiological and laboratory practices.

UNIT II **12 hrs.**

1. Introduction and significance of 'Quality control' and 'Quality assurance" in Microbiology. SOPs, Accreditation of laboratories and its significance.

2. Emerging infection, diseases surveillance, Public health and its significance. Awareness

about health-related organizations- ICMR, IPHA,NIMHANS, WHO, CDC

3. Intellectual property rights, Patents and Copyrights and its significance. Artificial Intelligence and its applications in Microbiology.

References:

1. Baird R M, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt' Ltd.
3. Harrigan WF (1998) Academic Press. Laboratory Methods in Food Microbiology, 3rd ed.
4. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer.
5. Laboratory Exercises in Microbiology, George. A. Wistreich & Max. D. Lechtman, 3rd Ed, Glencoe Press, London.
6. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
7. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007
8. Gurumani, N. Research Methodology, For Biological Sciences. MJP Publishers, Chennai 2006

IV SEMESTER

Program Name	BSc in MICROBIOLOGY	Semester	IV
Course Title	Molecular Biology and Recombinant DNA technology (Theory)		
Course Code	BSCMBCS 401	No. of credits	03
Contact Hours	56 Hours Theory	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO1. Understand concepts involved in replication, transcription, translation, regulation of gene expression in pro- and eukaryotes.

CO2. Differentiate the process of replication, transcription, translation, regulation of gene expression in pro- and eukaryotes.

CO3. Understand the genetic switch in bacteriophages.

CO4. Compare and contrast housekeeping, constitutive, inducible and repressible genes

CO5. Outline regulatory mechanisms in bacteria to control cellular processes

UNIT I: Molecular Biology **14 hrs**

- Central Dogma of Molecular Biology, gene concept, Genetic code
- Transcription in Prokaryotes- Ribosomes, Types of RNA Involved in Transcription, Mechanism of Transcription. Post Transcriptional Modifications-A General Account
- Transcription in Eukaryotes- Ribosomes, Types of RNA Involved in Transcription, Mechanism of Transcription. Post Transcriptional Modifications-A General Account
- Regulation of gene expression in prokaryotes- The operon concept, Induction and repression, The lac operon and tryptophan operon.

UNIT II: Recombinant DNA technology **14 hrs**

- History and fundamentals of r-DNA technology
- Tools for r-DNA technology-Restriction enzymes, Ligases and other DNA modifying enzymes
- Gene cloning vectors-Salient features of Plasmids (properties, types - pBR322 and pUC18 series vectors), Cosmids, Phagemids, shuttle vectors and bacteriophages (λ and M 13), Vectors for plants: *Agrobacterium tumifaciens,* Vectors for Animals: SV 40.
- Applications of Genetic engineering- Production of insulin, hepatitis B vaccine, Gene therapy and transgenic plants. Potential hazards and safeguards
- A general account of GM organisms.

UNIT III: Biostatistics **14hrs**

- Introduction and significance of statistics. Graphical representation of data
- Measures of central tendencies: definitions with examples – mean, median and mode.

Geometric mean, harmonic mean

- Measures of dispersion: definitions with examples – range, quartile deviation, mean deviation, standard deviation. Probability and sampling
- Correlation: definition, types of correlation. Regression: definition and properties

UNIT IV: Bioinformatics **14 hrs**

- Introduction to Bioinformatics. Relevance of bioinformatics to study biomolecules
- Biological databases and data tools: types of databases, database software, genomics, proteomics, protein chip, DNA chip, Search engine
- Genome data visualization tools, annotation, genome comparison and analysis and data submission
- Application of bioinformatics in agriculture, pharmacogenomics and aquaculture and Clinical research. molecular docking and its significance.

PRACTICAL

Semester-IV **Course Title**	**Molecular Biology and recombinant DNA Technology- Practical**	**Practical Credits**	**02**
Course Code	**BSCMBCP 402**	**Contact Hours**	**04 hours/week**
Formative Assessment	**10 marks**	**Summative Assessment**	**40 Marks**

1. Preparation of buffers-citrate and phosphate buffers.
2. Estimation of DNA by Diphenylamine method.
3. Estimation of RNA by Orcinol method.
4. Test for antibiotic sensitivity and determination MIC of antimicrobial agents.
5. Separation of amino acids by paper Chromatography
6. Separation of amino acids/carbohydrate by Thin layer Chromatography
7. Demonstration of protein/DNA separation by gel electrophoresis
8. Extraction of DNA from yeast.
9. Study of effect of UV light on microorganisms
10. Charts on genetic engineering. a) pBR 322 b) pUC 18 and 19 c) SV40 d) Bacteriophages-Lambda e) Gene cloning f) Selection of recombinants by replica plate technique
11. Calculation of mean, median and mode

References

1. Dale JW.1990. *Molecular genetics of Bacteria*. John Wiley and Sons.
2. De Robertis EDP and De Robertis EMF.1995.*Cell and Molecular Biology*. 8th edition, BI Waverly Pvt. Ltd., New Delhi.
3. Gardner *et al*.2003.*Principle of Genetics* -8thedition. John Wiley and Sons, New
4. Gupta ML. and ML. Jangir. 2002. *Cell Biology-Fundamentals and Applications*. Argosies, Jodhpur, India.
5. Lewin B.1994. *Genes VII* 5th edition. Oxford University Press, London. Powar CB. *Cell*

Biology 3rd edition. Himalaya Publishing House, Mumbai.
6. Rajeshwari S Setty and V.Sreekrishna.2002.*Biotechnology*-2 (Cell biology, Genetics, Microbiology). New Age International Publishers, New Delhi.
7. Taylor DJ. Green NPO and Stout GW.1998. *Biological Science* 3rd Edn., Cambridge edition, Cambridge University Press, UK.
8. Trevor. Enzyme biochemistry, Biotechnology and Clinical Chemistry. Harwood Publishers. Upadhyay and Upadhyay A.2000. *Biophysical Chemistry-Principles and Techniques*. Himalaya Publishers, New Delhi,
9. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (3rd Edn.).2022

DISICPLINE-BASED ELECTIVE / OPTIONAL COURSE

Program Name	**BSc in MICROBIOLOGY**	**Semester**	**IV**
Course Title	**CLINICAL LABORATORY TECHNIQUES IN MICROBIOLOGY**		
Course Code	**BSCMBCSE 303**	**No. of credits**	**02**
Contact Hours	**24 Theory (2Hrs per week)**	**Duration of EA Exam**	**Theory 2 hours**
Formative Assessment	**10**	**Summative assessment**	**40**

Unit I **12 hrs**

1. Management of Clinical Microbiology Laboratory, methods of sample collection, transport and processing of clinical specimens - Blood, Urine, Sputum, Pus & Faces for microbiological examination.
2. Examination of urine: sample collection, microscopic examination - crystals, casts, sediments, pregnancy test.
3. Phlebotomy, Blood smear preparation: Staining & differential WBC count - E.S.R. Hemoglobin, Blood indices – Total count, Platelet count. BT, CT.

Unit- II **12hrs**

1. Significance of Biomarkers - enzymes and physiological parameters in human diseases diagnosis.
2. Laboratory methods in Basic Mycology - Collection and transport of clinical specimens - Microscopy, Culture- SDA, KOH mount, Fungal diseases.
3. Laboratory methods in basic Virology, Cultivation of viruses, Methods and serological test to diagnose viral diseases. Accreditation of laboratories - NABL and NABH, Standard operating procedures (SOP), and Quality assurance in laboratory.

References:

1. Bailey &Scott's (2014). Diagnostic Microbiology. 13th edition, The C.V. Mosby Company.
2. Abdul Khader. (2003). Medical Laboratory Techniques. First edition, Frontline Publications, Hyderabad.
3. Mukherjee, L. (1997). Medical Laboratory Technology. Volume I & II. Tata McGrew-Hill Publishing Company Limited, New Delhi

4. Sundararaj, T (2005). Microbiology Laboratory Perungudi, Chennai-96. Manual,
5. Godkar, P.B. (2003). Textbook of Medical Laboratory Technology, 2nd Edition, Bhalani Publication.
6. Seiverd, Charles, E. Hematology for Medical Technologies, 4th Edition, Lea & Febiger,
7. Ramink Sood, (2006). A Textbook of Medical laboratory Technology, Jaypee Brothers Medical Publishers (p).LTD, New Delhi.

COMPULSORY SKILL-BASED COURSE

Program Name	**BSc in MICROBIOLOGY**	**Semester**	**IV**
Course Title	**SKILL-BASED COURSE - BIOINSTRUMENTATION**		
Course Code	**BSCMBCS 404**	**No. of credits**	**02**
Contact Hours	**24 hrs (2 hrs per week)**	**Duration of EA Exam Practical**	**2 hours**
Formative Assessment	**10**	**Summative assessment**	**40**

UNIT -I

- Centrifuge-Basic principles of sedimentation, types of centrifuges - (clinical, high speed, refrigerated and ultra centrifuge),
- Colorimeter-Beer-Lambert's law, Principle, working and applications.
- Spectrophotometer-UV and Visible types of spectrophotometer- IR, NMR and atomic adsorption spectrophotometry and applications.

UNIT -II

- Chromatography-Principle and working of paper, paper, Thin layer chromatography, Ion exchange, GC and HPLC and its applications.
- Southern and Northern blotting - principle, working and applications
- Electrophoretic Techniques- principle and working of paper, gel and immunoelectrophoresis. Electrophoresis of proteins and nucleic acid.
- Polymerase chain reaction - Principle, mechanism, types and applications.

V SEMESTER

Program Name	BSc in MICROBIOLOGY	Semester	V
Course Title	MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)		
Course Code	BSCMBCS 501	No. of credits	03
Contact Hours	56 Hours Theory 4hrs / week	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO1: To gain a preliminary understanding about various immune mechanisms.

CO2: To familiarize with Immunological techniques and serodiagnosis of infectious diseases

CO3: To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process

CO4: To understand pathogenic bacterial infections, symptoms, diagnosis and To understand pathogenic bacterial infections, symptoms, diagnosis and treatment process treatment process.

UNIT I: Medical Microbiology **14 hrs**

- Introduction to Medical Microbiology: History, Development and scope of Medical Microbiology.
- Microbial infections: Normal flora of human body, Types of infections, modes of transmission, portal of entry: Oral cavity and respiratory infection, Gastrointestinal infection. Urinary tract infection, sexually transmissible infection, Infection of the central nervous system, Infections of circulatory system, Collection and transport of clinical specimens, Microbial examination of urine, stool, sputum for diagnosis of diseases. Anaerobic microbes and its cultivation

UNIT II: Immunology **14 hrs**

- Introduction to Immunology: Immunity: Types: Innate immunity, Acquired immunity and nonspecific immunity. Vaccination schedule for infant in India. Immune response. Humoral or antibody mediated immunity, cell mediated immunity. Immune cells and organs. Significance of phagocytes, Natural Killer cells, mast cells, basophils and dendritic cells.
- Antigens and Antibodies: properties of antigen. Antibodies – structure, types and function, monoclonal antibodies and its clinical applications,
- Antigen-antibody reaction – precipitations, agglutination test, complement fixation (or complement cascade) reaction and ELISA. MHC: Significance and mechanisms.
- Hypersensitivity significance and types. Autoimmune diseases: Rheumatoid arthritis.

UNIT III: Infectious diseases **14 hrs**

- Terminology – Endemic, Epidemic diseases, Pathogenesis, virulence, strain, titer. Pathogenesis, Laboratory diagnosis and Prevention of diseases caused by Viruses: Chicken pox, Rabies, hepatitis, AIDS, Dengue, Chikungunya.
- Emergent Diseases: SARS Swine flu, Corona.
- Bacterial diseases: Tuberculosis, Leptospirosis, Typhoid, Botulism, Tetanus, Anthrax, Syphilis, Staphylococcal and streptococcal infection.
- Fungal diseases: Candidiasis, Aspergillosis, Dermatomycosis- Tinea, Malassezia
- Protozoan diseases: Malaria, Giardiasis, Trichomoniasis

UNIT IV: Antibiotics **12 hrs**

- Antibiotics: Definition; Characteristics of antibiotics, antimicrobial spectrum of antibiotics
- Mode of action; Penicillin (Cell wall affecting), streptomycin, tetracycline, (Protein synthesis inhibiting), polymyxin (cell membrane damaging), Nalidixic acid and quinolones (Nucleic acid synthesis inhibiting), Trimethoprim (Enzyme inhibitor), Nystatin and Amphotericin B (Antifungal); Metronidazole (antiprotozoal), AZT (antiviral antibiotics)
- Standardization of Antibiotics: MIC by Tube dilution method, Diffusion method-well and disc diffusion. Antibiotic resistance – causes and mechanisms, antibiotic resistant bacteria, MRSA, MDR, XDR.

References

1. Abbas A, . Lichtman AH and Pillai S. 2015. *Cellular and Molecular Immunology.* Elsevier Saunders Co.
2. Brock TB and Madigon. 1988. *Biology of Microorganisms*. Prentice Hall, New Jersey.Cassida, L.E. 1968. *Industrial Microbiology*. John Wiley & Sons.
3. Ivan Riott, Jonathan Brostoff and David Male. *Immunology* 3rd edition. Mosby Publishers. Janeway and Travers. *Immunobiology* 3rd edition. Churchill Livingstone Publications.
4. Kuby J. 2000. *Immunology*. Freeman and Company Publishers.
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6. Pelczar MJ, Reid RD and Chan ECS. 1997. *Microbiology, dynamics and diversity*. HaricotBrace College Publishers.
7. Prescott LM, Harley JK and Oxford DA. 1993. *Microbiology*. WMC Brown Publishers,USA.
8. Schlegel Haris G. 1988. *General Microbiology* 6th edition. Cambridge University Press, UK.
9. Sharma PD. 1991. *Microbiology*, Rastogi Publications, Meerut.
10. Subba Rao N.S. 1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi
11. Torture GJ, Frank BR, and Case CL. 1992. *Microbiology- An Introduction.* CommuningPublishing Company Inc, California.

Program Name	BSc in MICROBIOLOGY	Semester	V
Course Title	AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY		
Course Code	BSCMBCS 502	No. of credits	03
Contact Hours	56 Hours Theory 4 hrs./week	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO1.To understand the types and properties of soil ,biogeochemical cycles and different types of plant microbe interaction

CO 2.Appliations of using microbes in agriculture to increase crop yield and for organic farming including study of organic farming

CO 3.To study the host parasite relationship in plants, plant diseases caused by bacteria, viruses.

CO 4. To know the defense mechanisms of plants against diseases.

CO 5.To study plant diseases and to understand the management of various plant diseases, applications and significance of studying plant pathology

UNIT-1 Soil Microbiology 14 hrs

- Soil Microbiology definition, Soil as habitat for microbes, Soil Profile, Soil composition, physio-chemical properties of soil, Soil microflora and their significance – bacteria, fungi, algae, protozoa and virus.
- Bio geochemical cycles-Definition, Carbon, Nitrogen, Phosphorus and sulphur cycle. and their significance. .
- Plant microbe interaction: Rhizosphere, Phyllo sphere, Mycorrhiza association. Interaction among microorganisms in soil with examples- Neutralism, Positive interaction- Symbiosis, Commensalism, Negative interactions -Competition, Antibiosis parasitism, predation.

UNIT-II Agricultural Microbiology 14hrs

- Microorganisms in Agriculture: Bio fertilizers – General account and production of Rhizobium, Azotobacter, Azospririllum and Cyanobacteria.
- Biopesticides-General account and production and Advantages of *Trichoderma harzianum*, *Bacillus thuringenesis*, *Beaveria bassiana* pesticide.
- Organic matter decomposition -Factors affecting organic matter decomposition in soil, Enzymes involved and the process of Decomposition of Cellulose, Hemicelluloses, Lignin and Chitin in soil.

UNIT III: Plant Pathology **14 hrs**

- Terms and Concepts in Plant pathology -Definition, Plant Disease, Parasite, Pathogen, Pathogenesis, Pathogenicity, Symptom, Syndrome, Biotroph, Hemibiotroph, Necrotroph, Epidemic disease, Endemic disease, Sporadic disease, Pandemic.
- Classification of Plant Disease on basis of effect and basis of their cause , Biotic and Abiotic causes of Plant Diseases , Disease triangle, Diseases cycle / Infection cycle, Host parasite interaction, Role of secondary metabolites (toxins, hormones, enzymes)in disease development.
- Defence mechanism (Pre-existing structural and chemical defenses, Induced structural and biochemical defenses)

UNIT IV: Plant Diseases and Management

- Terms of Plant disease: Chlorosis, Canker, damping off, Wilt, Powdery Mildew, Blight, Rust, Die back disease, Anthracnose.
- A study of symptoms, etiology, epidemiology and control of the plant diseases- Bacterial Disease-Citrus canker, Wilt of tomato, Bacterial blight of rice, Fungal disease- Koleroga of arecanut, Rust of coffee, Blast disease of Paddy, Bud rot of Coconut.
- Remote sensing techniques of importance in Plant pathology, Principles of Plant Disease management- Avoidance, Exclusion of Inoculum, Eradication, Protection, Immunization**,** Integrated Plant disease management of -Main components of IPDM, Main strategies of IPDM.

References:

1. Dubey R. C. And Maheshwari D. K. (2022) A Text Book of Microbiology, 5 th ed. S. Chand & Company Ltd.
2. Martin Alexander 1983. Introduction to Soil Microbiology, Wiley eastern Ltd., New Delhi.
3. Newton, W.E and Orme, Johnson, W.H.1980. Nitrogen fixation vol II: Symbiotic Associations and Cyanobacteria. University Park Press Baltimore, USA.
4. Plant Pathology, George. N. Agrios, Harcourt Asia PTE. Ltd. Academic press, 4th Edition.
5. Plant Pathology, R.S. Mehrotra, Ashok Agarwal, Tata Mc Graw Hill, publishing company. Ltd New Delhi.
6. Prescott LM, Harley JK and Oxford DA. 1993. *Microbiology*. WMC Brown Publishers,USA.
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8. Subba Rao N.S. 1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi.
9. Sullia S. B. and Shantharam S. (2000). General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd., India.
10. Tortura GJ, Frank BR, and Case CL. 1992. *Microbiology- An Introduction.* CommuningPublishing Company Inc, California
11. Subba Rao N.S.1974. *Soil Microbiology*, 4th edition, Oxford & IBH Publishers, New Delhi

PRACTICAL

Course Title	Medical and Agricultural Microbiology (Practical)	Practical Credits	02
Course Code	BSCMBCP 503	Contact Hours	04 hours/week
Formative Assessment	10 marks	Summative Assessment	40 marks

Practical

1. Enumeration of bacteria and fungi from soil
2. Estimation of Organic Carbon by Chromic acid method.
3. Isolation and identification of *Rhizobium* from root nodules.
4. Test for ammonification in soil.
5. Determination of blood group – antigen antibody reaction.
6. Study of Haemolysis on blood agar and maintenance of cultures
7. Isolation of microorganisms from skin -wounds, mouth -dental caries.
8. Study of Fungal specimen by KOH mount and Staining
9. Study of Tuberculosis, Foot and mouth diseases, Staphylococcus, *E. Coli,* Clostridium, Candida, Aspergillus, Ring worm diseases, EMB and Mc Conkeys agar.
10. Study of TMV, Citrus canker, Bacterial blight of rice, Koleroga of areca nut, Rust of coffee, Powdery mildew of Cucurbits.
11. Field trip related to agricultural research institute/ hospital/diagnostic laboratories and submission of report.

COMPULSORY SKILL-BASED COURSE

Program Name	BSc in MICROBIOLOGY	Semester	V
Course Title	COMPULSORY SKILL-BASED COURSE - PROJECT WORK		
Course Code	BSCMBCSk 504	No. of credits	02
Contact Hours	48 Hours project 3 Hrs / week	Duration of EA Exam	-
Formative Assessment	10	Summative assessment	40

To enhance the skills of a student, a Minor project in the interested subject need to be completed and report need to be submitted for evaluation. Students Project need to be assessed and marks need to be given based by viva voce of the project work.

VI SEMESTER

Program Name	BSc in MICROBIOLOGY	Semester	VI
Course Title	FOOD AND INDUSTRIAL MICROBIOLOGY (THEORY)		
Course Code	BSCMBCS 601	No. of credits	03
Contact Hours	56 Hours Theory	Duration of EA Exam	3 hours
Formative Assessment	20	Summative assessment	80

Course Outcomes:

At the end of the course, the student should be able to:

CO1. To understand the association of microbes in food and the quality testing of food
CO2. To understand the preservation and food safety protocols
CO3. To understand the methods of spoilage of food and the diseases associated with it
CO4. To learn the properties of milk and the types of preservation of milk.
CO5. To learn the types of fermented food and dairy products and its significance
CO6. Learn the overview of scope and importance of industrially important microbes
CO7. Acquaint with different types of fermentation processes and equipments
CO8. Evaluate the factors influencing the enhancement of cell and product formation during fermentation
CO9. Acquire the knowledge of the production of value-added products
CO10. Acquire the knowledge of purification of value-added products

FOOD AND INDUSTRIAL MICROBIOLOGY (THEORY)

UNIT I: Food Microbiology **14 hrs**

- Introduction to food microbiology: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors.
- Principles of food preservation- Physical (anaerobic conditions, high temperatures, low temperatures, drying, Canning, processing, Heat treatment) and Chemical preservation, food additives
- Contamination and food spoilage: A general account of Hazard analysis critical control points (HACCP) and Good manufacturing process (GMP) IPR and Patents.

UNIT II: Dairy Microbiology **14 hrs**

- Microbiology of raw milk, Milk as a vehicle of pathogens, Sources of Contamination of milk, Prevention of contamination of raw milk,
- Microbial examination of milk-SPC, DMC, and reductase test,
- Biochemical activities of microbes in milk, Methods of milk preservation-sterilization and pasteurization, Microbiological standards for milk and milk products.
- Fermented dairy products-Cheese, Yoghurt and buttermilk.

UNIT III: Fermentation Technology **14 hrs**

- Introduction, Concepts and Scope. Construction of a typical fermenter and types of

fermenters, Industrial Microorganisms: Screening, Isolation. Identification and characterization of industrially important microbes Strain improvement- mutation, recombination and genetic manipulation.

- Media for Industrial Fermentations: Continuous and batch culture, Media formulation, growth factors, carbon, nitrogen, Energy and Mineral sources, buffers, inhibitors, precursors, inducers, Oxygen requirements, Antifoam agents and others, Sterilization: Media and Fermenter sterilization

UNIT IV: Industrial production of metabolites 14 hrs

- Secondary metabolites, Industrial production of ethyl alcohol, wine, vinegar, Vitamin B-12, gibberellins and Penicillin.
- Production of biogas. Production of Fungal and Bacterial Amylase and proteases
- Downstream processing: A general account of steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Solvent recovery.

References

1. Alexopoulas C.J. and Mims C.W., Introductory Mycology, New age International, New Delhi.
2. Alexopoulos C.J., Mims C. W. and Blackwell M. (2002) Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore.
3. Benson Harold J. Microbiological Application, WCB McGraw-Hill of India Private Limited.
4. Flint S. J., Racaniello V. R., Rall G. F., Hatziioannou T., Skalka A. M. (2020) Principles of Virology, 5th ed. ASM Press.
5. Freifelder David, Microbial Genetics, Narosa Publishing House, New Delhi.
6. Madigan M. T., Martinko J. M., Bender K. S., Buckley D. H., Stahl D. A. (2015). Brock biology of microorganisms, 14th ed. Pearson, Boston.
7. Marjorie Cowan, Kathleen Park Talaro (2009). Microbiology: A Systems Approach. 2nd ed. The McGraw Hill. New York.
8. Mehrotra R. S., and Aneja K. R. (2015). An Introduction to Mycology. New Age Publications.
9. Moat, A.G. and Froster, S.W., *Microbial Physiology*, John Wiley and Sons, New York.
10. Pelczar M J., Chan E.C.S. and Klein Donald A., Microbiology, McGraw Hill Book Company, New York.
11. Pommerville J. C. (2013). Alcamo's Fundamentals of Microbiology. Cambridge University Press, Cambridge.
12. Prescott Lansing M. Harley John P. and Klein Donald A. Microbiology, WCB McGraw- Hill New York.
13. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
14. Sharma O.P. (2023). Fundamentals of Algae, 3 rd ed. MedTech. Science Press.

15. Stanier R.Y. Ingranam J.L. 2008. General Microbiology, Prentice Hill of India Private Limited New Delhi.
16. Stickberger, M.W., *Genetics*, Prentice Hall of India Private Limited, New Delhi.
17. Sullia S. B. and Shantharam S. (2000). General Microbiology (Revised) Oxford & IBH Publishing Co. Pvt. Ltd., India.
18. Tortora G. J., Funke B. R., Case C. L., Warner B.B., Weber D. (2023). Microbiology an Introduction, 14 th ed. Pearson Education Pvt. Ltd.
19. Willey J. M., Sherwood L., Sandman K., & Wood D. (2022) Prescott's Microbiology, 12th ed. McGraw – Hill Higher Education.
20. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited

Program Name	**BSc in MICROBIOLOGY**	**Semester**	**VI**
Course Title	**ENVIRONMENTAL MICROBIOLOGY - Theory**		
Course Code	**BSCMBCS 602**	**No. of credits**	**03**
Contact Hours	**56 Hours Theory 4 hrs/week**	**Duration of EA Exam**	**3 hours**
Formative Assessment	**20**	**Summative assessment**	**80**

Course Outcomes:

At the end of the course, the student should be able to:

CO 1. To study the microbes in the air, techniques to study of indoor and outdoor air flora and to know various airborne diseases.

CO 2. To know the significance of microbes in the water, waterborne diseases and water treatment systems

CO 3. To study the Sewage microbes, water pollution, significance of MPN Test for water potability, level of oxygen for aquatic life.

CO 4. To know the microbes surviving in extreme environments and their significance

CO 5. To study the types of microorganisms used for bioremediation based on environmental issues.

UNIT I: Air microbiology **14 hrs.**

1. Environmental Microbiology: Concepts and scope of environmental microbiology. Microbiology of Air: Air microflora of indoor and outdoor environment, factors affecting airflora,
2. Techniques of trapping airborne microorganisms: Impactors- Anderson sampler, Impingers- Pre & porton impingers, settle plate methods.
3. Air as a medium for transmission of diseases-Mode, general symptoms and control of bacterial diseases- Tuberculosis, Sore throat; Fungal- Blastomycosis, Histoplasmosis; Viral- Corona, Mumps.
4. Significance of air microflora- Allergy & Air pollution

UNIT II: Aquatic Microbiology **14 hrs**

1. Distribution of microorganisms in the aquatic environment- Fresh water, Marine water and estuary including stratification.
2. Municipal water treatment system –sedimentation, filtration, chlorination.
3. Water as a medium for transmission of diseases-Mode, general symptoms and control of diseases - Typhoid, Cholera, travelers' diarrohea; Viral- Hepatitis, Poliomyelitis; Protozoan- Amoebiasis, Giardiasis.

UNIT III: Sewage Microbiology **14 hrs**

1. Water pollution- sources, Waste water (sewage)treatment: small scale- cess pool, septic tank; Large scale treatment - Primary (screening, coagulation and sedimentation), secondary (trickling filter, activated sludge process, oxidation pond), Tertiary (chlorination),
2. Biological indicators of water pollution- characteristics. Determination of sanitary quality of water- MPN, IMViC, SPC, BOD and COD.

UNIT IV: Microbes in extreme environment and Geomicrobiology **14 hrs**

1. Microbes in extreme environment: Diversity of microorganisms in extreme environments- An account of Thermophiles, acidophiles, alkalophiles, halophiles, barophiles and their survival mechanisms (adaptations).
2. Bioremediation -definition, Microbes in bioremediation, Factors affecting bioremediation and types-In situ & Ex-situ, advantages and disadvantages.
3. A general account of microbial degradation of xenobiotics-pesticides
4. Bioleaching and bio-mining, Microbes in metal extraction-bioleaching of copper.

Course Title	**Industrial and Environmental Microbiology (Practical)**	**Practical Credits**	**02**
Course Code	**BSCMBCP 603**	**Contact Hours**	**04 hours/week**
Formative Assessment	**10 marks**	**Summative Assessment**	**40 Marks**

1. Enumeration of bacteria and fungi from spoiled fruits and vegetables, curds, canned food and spoiled food.
2. Determination of quality of milk by MBRT and Phosphatase method
3. Estimation of lactic acid content in milk.
4. Preparation of wine and estimation of total acidity of wine.
5. Enumeration of bacteria in raw and pasteurized milk by SPC method.
6. Estimation of CO2 in water.
7. Estimation of dissolved oxygen in water.
8. Standard analysis of water
9. Isolation of microbes from air by plate exposure method to study allergens
10. Production and estimation of microbial amylase enzyme by submerged fermentation method

References

1. Atlas RM and Bartha R. (2000). *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Dubey R. C. And Maheshwari D. K. (2022) *A Text Book of Microbiology*, 5 th ed. S. Chand & Company Ltd.
3. *Environmental Microbiology*, Ralph Mitchell, Wiley-Liss Publication.
4. *Environmental pollution and its control*, S. A Abbari, Cogent International.
5. *Environmental pollution*, KC Agarwal, Nidhi Publishers. Bikaner.
6. *Fresh water microbiology*, David C Sigee, John Wiley and sons Ltd.
7. Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology*. 2nd edition, Academic Press
8. Pelczar MJ, Reid RD and Chan ECS. 1997. *Microbiology, dynamics and diversity*. HaricotBrace College Publishers.
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12. Jogdand SN.2010. *Environmental Biotechnology.* Himalaya Publishing House, Bangalore

COMPULSORY SKILL-BASED COURSE

Course Title	**FOOD SAFETY AND STANDARDS -**		
Course Code	**BSCMBCSk 604**	**No. of credits**	**02**
Contact Hours	**24 Hrs** **2 Hrs per week**	**Duration of EA Exam** **Practical**	**02**
Formative Assessment	**10**	**Summative assessment**	**40**

To enhance the skills in handling food, water and its safety, a hands-on training will be given with demonstration in the Lab or during the industry visits. The skills pertaining to this paper can be learned by visiting the food industry or conducting the training or demonstration practices

UNIT-I

- Overview of food chemistry and food Microbiology.
- General principles of food hygiene and sanitation in food preparation, handling and storage.
- Food safety management systems-HACCP- (Hazard Analysis and critical control points)
- Food packaging and safety of the food, food fortification, food contaminants and Food adulteration.

UNIT-II

- Food laws and regulations- FSSAI (Food safety and standards authority of India), Food safety and standards Act, provisions, definitions and different sections of Act.
- ISO 2000 and other food safety Management systems.
- International Food Laws-CODEX Alimentarius commission and relevant international food control systems with its significance.