Semester No.	Paper No.	Course Code	Title of Paper	Theory	Internal assesment	Total Marks	Min Marks
		B.Sc. First Year					
I	**I**	MCB-111	Fundamentals of Microbiology	**(40)**	**10**	**(50)**	**20**
	II	MCB-112	Microbial Techniques	**(40)**	**10**	**(50)**	**20**
	III	MCB-121	Lab course I (based on MCB-111 & MCB-112)			**(50)**	**20**
			Total			**150**	**60**
II	**IV**	MCB-211	Microbial Chemistry	**(40)**	**10**	**(50)**	**20**
	V	MCB-212	Bacterial Cytology and Virology	**(40)**	**10**	**(50)**	**20**
	VI	MCB-221	Lab course II (based on MCB-211 & MCB-212)			**50**	**20**
			Total			**150**	**60**
		B.Sc. Second Year					
III	**VII**	MCB-311	Environmental Microbiology	**(40)**	**10**	**(50)**	**20**
	VIII	MCB-312	Immunology and Clinical Microbiology	**(40)**	**10**	**(50)**	**20**
	IX	MCB-321	Lab course 3 (based on MCB-311)			**50**	**20**
	X	MCB-322	Lab course 4 (based on MCB-312)			**50**	**20**
			Total			**200**	**80**
IV	**XI**	MCB-411	Food and Dairy Microbiology	**(40)**	**10**	**(50)**	**20**
	XII	MCB-412	Microbial Physiology	**(40)**	**10**	**(50)**	**20**
	XIII	MCB-421	Lab course 5 (based on MCB-411)			**50**	**20**
	XIV	MCB-422	Lab course 6 (based on MCB-412)			**50**	**20**
			Total			**200**	**80**
		B.Sc. Third Year					
V	**XV**	MCB-511	Enzymology and Metabolism	**(40)**	**10**	**(50)**	**20**
	XVI	MCB-512	Microbial Genetics	**(40)**	**10**	**(50)**	**20**
	XVII	MCB-521	Lab course 7 (based on MCB-511)			**50**	**20**
	XVIII	MCB-522	Lab course 8 (based on MCB-512)			**50**	**20**
			Total			**200**	**80**

VI	**XIX**	MCB-611	Molecular Biology& Genetic Engineering	**(40)**	**10**	**(50)**	**20**
	XX	MCB-612	Industrial Microbiology	**(40)**	**10**	**(50)**	**20**
	XXXI	MCB-621	Lab course I (based on MCB-611)			**50**	**20**
	XXXII	MCB-622	Lab course I (based on MCB-612)			**50**	**20**
			Total			**200**	**80**
Internal Assessment: Based on Assignment, Seminar, Unit Test & overall attendance and performance of the student							

Course structure of B.Sc. I (Microbiology optional subject)

(Choice Based Credit System)

Semester I (Core Courses and Skill Enhancement Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	**Credits**
MCB-111	Fundamentals of Microbiology	2 hours	50(40+10)	2
MCB-112	Microbial Techniques	2hours	50(40+10)	2
MCB-121	Lab course I (based on MCB-111 & MCB-112)	3 hours	50	1.5

Total credits for Semester I : 6 (Theory : 4; Laboratory : 2)

Semester II (Core Courses and Skill Enhancement courses)				
MCB-211	Microbial Chemistry	2 hours	50 (40+10)	2
MCB-212	Bacterial Cytology and Virology	2 hours	50 (40+10)	2
MCB-221	Lab course-2 (based on MCB-211 & MCB-212)	3 hours	50	1.5

Total credits for Semester II : 6 (Theory : 4; Laboratory : 2)

B.Sc. First Year Semester – I

Paper -MCB-111. Fundamentals of Microbiology

Unit: I History of Microbiology (10)

1. Definition and concepts
1. Discovery of microorganisms: Contribution of Antony Van Leeuwenhoek.
2. Spontaneous generation theory : Aristotles view, Charles Darwin view. Controversy over spontaneous generation
3. Recognition of the microbial role in diseases: Koch' s postulates, Koch' s direct stimulation theory, Aseptic surgery
4. Discovery of microbial effects on organic and inorganic matter.
5. Recognition of the microbial role in fermentation: Contribution of Louis Pasteur Stahls theory of fermentation,
6. Pure culture concept
7. Patenting of microorganisms : contribution of Louis Pasteur and Anand Chakraborty

Unit: II Microscopy(10)

1. Introduction of Magnification, resolving power, depth of focus, focal length, numerical aperture.
1. Electron Microscope: (SEM and TEM).
2. Phase contrast microscope.
3. Dark field microscope.
4. Fluorescence Microscope.
5. Atomic Force Microscope

Unit: III Taxonomy of microorganisms. (10)

1. Taxonomic rank.
2. Major characteristics used in taxonomy (Morphological, Physiological, Immunological, Metabolic). Compositions of proteins, Composition of nucleic acids, Nucleic acids hybridization, Nucleic acid sequencing, 16S rDNA.
3. Classification system
4. Numerical taxonomy.
5. Phenetic classification.
6. Bergey' s manual of systematic Bacteriology, General characteristics enlisting all parts with major characters and examples in brief.

Unit IV General characteristics of Microorganisms (10)

1. Fungi
2. Actinomycetes
3. Algae
4. Mycoplasma
5. Rickettssia.

6. Archaebacteria
7. Protozoa

Unit: V Tutorials, Seminars and Assignments (05 Periods)

B.Sc. First Year (CBCS)
Paper – MCB-112-Microbial Techniques

Unit– I: Sterilization – contribution of (10)

Richard J.Petri : Petriplates and their types
Schroeder and Dusch : Cotton plug
C. Salomonsen : Hot air oven

Wire loop: Introduction, diameter, Connors transfer loop, Roux and Yersin, Platinum needle.

Agar: Discovery, introduction, structure ,classification of agar and agar gels. Uses of agar.

Agar slant apparatus: Introduction, diagram and angles used in slant preparation.

Incubators: Types of incubator (Anaerobic incubator, Perfusion incubator, Pocket incubator, Thermal gradient incubator)

Pasteurizer: Beer pasteurizing apparatus.

Autoclave :

Hot air oven

Radiations : (Gamma rays, X rays, Ultra violet rays)

Unit II: **Disinfection**

a. Definition and concept: Disinfection, Germicide, Antiseptics, Bacteriostatic, Bactericidal
b. Chemical sterilizing agents (Spectrum, Mode of action, Application, Limitations)
Phenolic, Alcohols , Halogens , Heavy metals , Quaternary ammonium Compounds , Aldehydes.
c. Sterilization using gases (Spectrum, Mode of action, Application, Limitations) : Sulfur dioxide, Ethylene oxide and Beta propiolactone
d. Evaluation of disinfectants : Phenol coefficient

Unit – III Pure Culture Techniques (10)

A. Development of pure culture
B. Single Cell Isolation
C. Methods for isolation of pure culture -
Streak plate method, Pour plate method, Spread plate methods
D. Handling of pathogenic microorganisms
E. Methods for disposal of microbial wastes
F. Techniques for enumeration of microorganisms

Cell count by Direct Microscopic Count, Colony count
Measurement of turbidity, Measurement of cell mass

Cultivation of microorganisms

A. Properties of a good culture medium.
B. Definition and concept
   a. Living media : Embryonated chicken eggs, Tissue culture & Animals
   b. Non living media : Natural, Semi-synthetic & Synthetic
C. Types of culture media on the based of their specific use w.r.t. role of media ingredients (with examples)
   Selective, Differential, Enriched, Enrichment, Assay, Minimal, Maintenance and Transport media
D. Role of Buffers in culture media.
E. Media used for cultivation of bacteria, fungi, actinomycetes, yeasts, algae and photosynthetic bacteria (at least two)
F. Techniques for cultivation of anaerobes : John H. Brewer Instrument and Anaerobic Jar closure assembly
G. Method for detecting microscopic organisms using bacteriophage : Kent J. Voorhees Apparatus.
H. Measurement of gas production by Wilkins et al method.

Unit IV – Stains and Staining (10)

A. Fundamentals of microorganisms
   a. Definition : stain, dye, chromogen, chromophore, auxochrome,
   b. Types of stains: Acidic, basic
   c. Staining reagent: Primary stain, Secondary stain, Mordant and Decolorizer
   d. Fixation of Smear: Physical and Chemical methods
   . Physicochemical basis of staining.
B. Staining methods
   a. Staining (Principle, application and methodology)
      Monochrome staining and Negative staining
   b. Differential staining (Principle, application and methodology)
      Gram' s staining and Acid fast staining
   c. Structural/ Special staining procedures
      Cell wall, Capsule, Spore, Flagella, Metachromatic granule, Blood staining
   d. Staining of Fungi.
   c. Micrometry
   d. Hanging drop technique
   e. Microscopic photograph

Unit: V Tutorials, Seminars and Assignments (05 Periods)

B. Sc. First Year (CBCS)
Paper - MCB-211 .Microbial Chemistry

Unit- I : Basic Principles (10)

I. Concepts of Atom, Molecule, pH, Acids, Bases, Buffer, Solvent, Solute, Types of solutions (hypotonic, hypertonic, isotonic) and redox potential
II. Types of Isomers and their importance in biology.
III. Types of bonds and their importance: Electrovalent, covalent, non-covalent, Ester, Phospho-diester, Thio-ester, Peptide, Glycosides

UnitII : Amino acids and Proteins (10)

Amino Acids: Definition, General structure and features of amino acids, amphoteric nature, List of 20 amino acids. Classification of amino acids: based on R-group, Uncommon amino acids and their functions.
Proteins: Definition. Classification of Proteins, Primary, secondary, tertiary, quaternary structures of proteins (outline). Biological significance of proteins. Classification of Proteins, Primary, secondary, tertiary, quaternary structures of proteins . Biological significance of proteins

Unit- III : Carbohydrates (10)

a) Definition and Classification. b] Monosaccharides, Triose, Tetrose, Pentose, Hexose (Examples and structures). c] Disaccharides: Glycoside Linkage (Lactose, Maltose and Sucrose). d] Oligosaccharides: Trisaccharides (Structure of raffinose).
e] Polysaccharides: Homo and heteropolysaccharides, structure of (Starch, Cellulose, Hyluronoc acid)., Biological Significance of carbohydrates.

Unit IV : Lipids and Nucleic acids (12)
Definition and Classification. Types of Lipids: Simple lipids-Triglycerides.
Conjugated Lipids- Phospholipids, Phosphatidic acid, and Cholesterol.
Biological importance of Lipids.
Purine , pyrimidine bases , Ribose and Deoxyribose sugars, phosphodiester bonds, m-RNA, t-RNA and r-RNA.

Unit V Tutorials, Seminars and Assignments (05 Periods)

Paper MCB-212- Bacterial Cytology and Virology

Unit– 1: Bacterial morphology and outer ultra structures of cell. (10)

1. Cytology of a typical bacterial cell.
2. Morphology – size and arrangement of bacterial cells.
3. Structure, chemical composition and functions of:
   i. Capsule and slime layer
   ii. Flagella : Arrangement, Structure, mechanism of flagellar movement, Chemotaxis, phototaxis, Magnetotaxis.
   iii. Pili
   iv. Cell wall : Gram positive and Gram negative bacteria
   v. Cell membrane / Unit membrane

Unit – 2: Bacterial morphology and inner ultra structures of cell. (10)

   i. Bacterial Endospores: Structure, Formation and Germination process
   ii. Ribosomes.
   iii. Nuclear material
   iv. Mesosomes
   v. Reserved food material: Nitrogenous, Non-nitrogenous (Starch and Glycogen, Poly beta hydroxy butyric acid), polyphosphate, Sulfur granules.
4. Bacterial cell division: Binary fission

Unit -3: Viral Morphology and Genomic structure (10)

1. Introduction and General characteristics
2. Discovery and Early development of Virology
3. Virions, Viroids, Virusoids, Prions.

4. Structure of viruses: Size, Shape, Proteins, Capsids and capsomers.

    i) The structure of filamentous viruses and nucleoproteins
    ii) The structure of isometric viruses (tetrahedron, cube, octahedron, dodecahedron, icosahedrons)
    iii) Enveloped (membrane bound) viruses
    iv) Viruses with head-tail morphology

5. Viral genomes

    i) Positive-Sense Single stranded RNA Viruses
    ii) Negative-Sense Single stranded RNA Viruses
    iii) Double-Stranded RNA Viruses
    iv) Retroviruses
    v) Double-Stranded DNA Viruses
    vi) Single-Stranded DNA Viruses

Unit-4: Classification, Multiplication, Cultivation and Impact of viruses (10)

1. Classification: ICTV (International Committee on Taxonomy of Viruses), Baltimore and LHT System)

2. Multiplication: Lytic cycle in Animal and Bacteria
3. Lysogeny
4. Cultivation of Viruses: Egg inoculation and Tissue culture
5. List of common viral diseases with causative agents and important symptoms in plants, animals and human beings.
6. Emerging human viral diseases

    i. H1N1 Influenza Virus (Swine Flu)
    ii. Avian Influenza (Bird Flu)
    iii. Ebola Hemorrhagic Fever (Ebola virus disease)
    iv. Chikungunya Virus
    v. Severe acute respiratory syndrome (SARS)
    vi. Nipah virus disease
    vii. Zika virus infection

7. Viruses and cancer
8. Viral vaccines
9. Antiviral therapy (Drugs and interferons)
10. Viruses used in Recombinant DNA technology

Unit V : Tutorials, Seminars and Assignments (05 Periods)

B. Sc. First Year
MICROBIOLOGY

Lab Course 1 MCB -121

1. Microscopy- Different parts of compound microscope. Use and care of compound microscope
2. Preparation of Standard Operating Procedures (SOPs) for common microbiology laboratory instruments: Introduction to Laboratory equipments, Construction, Operation and utility of laboratory equipments.
   a)Autoclave
   b) Hot air oven
   c) Incubator
   d) pH meter
   e) Centrifuge
   f) Colorimeter/Spectrophotometer
   g) Anaerobic jar
   h) Seitz filter

i) Laminar air flow

3. Disinfection & discarding techniques in laboratory

4. Staining

a. Simple staining: Monochrome, Negative

b. Differential : Gram' s staining

c. Structural staining:

i. Cell wall staining (Chance' s method)

ii. Capsule staining (Maneval' s method)

iii. Spore staining (Schaeffer and Fultons' s method)

5. Hanging drop technique.

6. Measurement of size of cells by micrometry

7. Preparation of buffers- Citrate and phosphate buffer

8. Study tour to related laboratories /industries

B. Sc. First Year
MICROBIOLOGY

Lab Course 2 MCB-221

1. Cleaning and sterilization of glassware: Preparative procedures for glasswares before sterilization.

2. Study of aseptic techniques: Preparation of cotton plugs for test tubes and pipettes, wrapping of petriplates and pipettes, Methods of inoculum transfer .

3. Preparation of Media: Nutrient broth, Nutrient Agar, MacConkey" s broth and agar, Sabouraud's Agar.

4. Study of bacterial growth curve

5. Study of methods of isolation of bacteria from mixed cultures:

i) Streak plate technique

ii) Spread plate technique

iii) Pour plate technique

6. Morphological , Cultural characterization of isolates.
7. Effect of pH, Temperature & UV on bacterial growth
8. Isolation of Bacteria and Fungi from soil

a) Preparation of serial dilutions.

b) Spread plate and pour plate techniques

11. Qualitative tests for:

I. Carbohydrates- Benedict' s test

II. Proteins- Biuret Test

III. Nucleic acids- DNA-Diphenyl amine test and RNA- Orcinol test

Books Recommended for Theory & Practical of B.Sc. I, SEMI & II

1. General Microbiology by Hans G. Schlegel.
2. General Microbiology by R.Y. Stayner.
3. Fundamentals of Microbiology by Crabtree, & Martin Frobisher.
4. Fundamentals of Bacteriology by A.J. Salle
5. A text of Microbiology by Dubey RC and Maheswari DK (2012).
6. Geeta Sumbali and Mehrotra RS (2009). Principles of Microbiology.
7. General Microbiology volume 1 and 2 by Powar CB and Daginawala H F.
8. Microbiology by Pelczar TR M J Chan ECS and Kreig N R.
9. Robert F Boyd (1984). General microbiology.
10. Microbiology by Prescott L M, J P Harley and D A Klein.
11. Introduction to Microbiology by Ingraham J.L. and Ingrahm C.A
12. History of Microbiology & Microbiological Methods by A.B. Solunke, V.S. Hamde, R.S. Awasthi& P.R. Thorat.
13. General Microbiology by Hans G. Schlegel.
14. Air Microbiology an environment & Health Prospective by S.C. Aithal, P.S. Wakte& A.V. Manwar.
15. Water Microbiology by S.C. Aithal, & N. Kulkarni.
16. General Microbiology by R.Y. Stayner.
17. A text of Microbiology by Dubey RC and Maheswari DK.
18. Manual of Methods for Pure Culture Study by A.B. Solunke, V.S. Hamde, R.S. Awasthi& P.S. Wakte.
19. Text Book of Microbial Chemistry and Physiology by P.H.Kumbhare&U.V.Thool Rajani Prakashan, Nagpur.
20. Text Book of Applied Microbiology by P.H.Kumbhare&U.V.Thool, Rajani Prakashan, Nagpur.
21. General Virology by Luria S.E.
22. A textbook of Fungi and Viruses by Dubey H.C.
23. Alcamo Fundamentals of Microbiology

24. Experiments in Microbiology by Aneja K.R.
25. Introduction to Microbial Techniques by Gunasekaran,
26. Elementary Microbiology by Modi H.A.
27. Handbook of Media, Stain and Reagents in Microbiology by Deshmukh A.M.,
28. Biology of Microorganisms by Brock T.D. and Madigan M.T.
29. Biochemistry by J.L. Jain
30. Biochemistry by Zubay
31. Principles of Biochemistry by Nelson David L and Cox Michael M. Lehninger.
32. Disinfectants and Disinfection by A.G. Young
33. Filtration by F.E. Vey
34. Biological Stains by H.J. Conn.

B. Sc. Second Year
[Microbiology]Semester III
Paper MCB-311
Environmental Microbiology

Unit 1: Microbiology of air: (10)

Composition of air.

Number and kinds of microorganisms in air (indoor outdoor Distribution and sources of

our borne microorganisms.
Air as a carrier of microorganisms
Droplet, droplet nuclei, Dispersal of Microorganisms in air. Techniques for microbiological analysis of air.
Significance of air flora in human health, hospitals, industries.
Air sanitation- dust control, UV radiation, bactericidal vapors, filtration, Laminar air flow system (HEPAfilters)

Unit 2. Microbiology of Water and Waste water: (10)

sources of microbes in water.
Determining sanitary quality of water indicators of fecal pollution:
Fecal and non fecal coliforms (IMVIC& elevated temperature tests).
Bacteriological examination of water: Presumptive, confirmed, completed test, SPC, MPN and Membrane filter technique.
Water purification methods: Disinfection of potable water supplies.
Definition of sewage and chemical composition.
Microbiology of sewage treatment: septic tank, evapotranspiration, Imhoff's tank
Muncipal sewage treatment process: Primary, Secondary, (aerobic and anaerobic process), chemical treatment chlorination.
Disposal of treated sewage. (Sludge as fertilizer, imigation and dilution)

Unit 3.Microbiology of Soil: (10)

Soil as an environment, as a culture medium.
Brief account and definition of microbial interactions with examples.
Symbiosis, mutualism, commensalism, competition, synergism, satellitism, predation, parasitism with example:

I Microbe-microbe interactions (any one example)

II. Plant-microbe interactions (Phyllosphere)

III. Animal-microbe interactions[Rumen; Bioluminescence)
Major biogeochemical cycles: Carbon nitrogen, phosphorus, sulphur (cyclic turnover with microbiology). General account of microbes used as biofertilizers, phosphate solubilizers.

(Defination, Types, advantages, disadvantages) Rhizosphere: definition, rhizosphere and non rhizospheremicroflora and R: S ratio, significance for fertility.

Unit 4. Environmental Pollution (10)

Air pollution sources, causes, health hazards, airborne diseases any 5 (list of causative agents) Water pollution : sources, causes, health hazards, waterborne diseases any 5 (list of causative agents). Waste water pollution: sources, causes, health hazards, Eutrofication and Acid mine drainage :basic concept,
Soil: sources, causes, health hazards,

UnitV : Tutorials, Seminars and Assignments (05 Periods)

B.Sc. Second Year
MICROBIOLOGY

Lab Course 3 MCB-221

1. Enumeration of microbes from: Indoor and outdoor environment.
2. Bacteriological examination of drinking water: MPN, SPC
3. Qualitative analysis of water: Presumptive, Confirmed, Completed test
4. Demonstration of Automated water testing methods (The growth direct by Rapidmicro biosystem, Bioburden testing)
5. Dust Fall Jar: Construction and analysis of pollution trend in the selected area.
6. Collection of Data from Internet : Respiratory suspended particulate matter (RSPM) in various metro cities in India
7. Fabrication: Fabricate Sedimentation Tank in the laboratory.
8. Testing of (water & domestic sewage) for physicochemical parameters like chlorine, phosphate, nitrate and BOD and COD, TS, TDS, TSS.
9. Isolation of E. coli and identification by IMVIC
10. Isolation of coliphages from sewage
11. Isolation enteric pathogens from domestic sewage (salmonella and shigella spp)