

**Rashtrasant Tukadoji Maharaj Nagpur  
University, Nagpur**

**SYLLABUS**

**REVISED**

**FOR**

**2020-21 ONWARDS**

**B.Sc. Microbiology**

**(Semester Pattern)**

# Syllabus

## B.Sc. Part- I

### Microbiology

SEMESTER I		
Course Code	Title	Lectures
Paper I	FUNDAMENTALS OF MICROBIOLOGY.	
Unit-I	<b>History of Microbiology</b> <ol style="list-style-type: none"><li>1. Discovery of Microbes,</li><li>2. Theory of biogenesis &amp; abiogenesis</li><li>3. Contributions of- Antonie van Leeuwenhoek, Louis Pasteur , Robert Koch, Joseph Lister, Winogradsky, Beijerinck, John Tyndall, Thomas M. Rivers</li><li>4. Branches of Microbiology- Definition and scope of a) Systemic Microbiology- Bacteriology, Mycology, Phycology, Virology, b) Biotechnology, c) Geo microbiology, d)Exobiology, e) Medical microbiology, f) Environmental Microbiology g) Industrial Microbiology h) Food Microbiology</li></ol>	09
Unit-II	<b>Bacterial cell structure</b> <ol style="list-style-type: none"><li>1. Differences between prokaryotes and eukaryotes</li><li>2. Description of sizes, shapes and arrangements of bacteria</li><li>3. <b>Typical Bacterial cell structure-</b> a) Structure of cell wall (Gram positive &amp; Gram negative bacteria) b) Cell membrane:- Fluid mosaic model, mesosomes</li><li>4. Ribosomes, Nucleoid, Plasmids, cytoplasmic inclusions</li><li>5. Capsules, slime layer, pilli, flagella</li><li>6. Endospore structure- formation, germination.</li><li>7. Exospores, Myxospores, Eukaryotic spores</li><li>8. Significance of dormancy</li></ol>	07

<b>Unit- III</b>	<b>Microbial Nutrition</b>  1. Nutritional types of bacteria 2. Basic nutritional requirements. 3. Types of culture media- Selective, Differential, Enriched, Synthetic and non synthetic (Definition, ingredients, principle and applications). 4. Media for isolation of fungi- Definition, ingredients, principle and applications 5. Enrichment Culture	07
<b>Unit-IV</b>	<b>Microbial growth:</b>  1. Bacterial reproduction. 2. Axenic cultures. 3. Growth curve 4. Mathematical expression of growth. 5. Continuous culture – Chemostat and turbidostat 6. Synchronous growth 7. Diauxic culture 8. Factors influencing microbial growth.	07
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<b>SEMESTER I</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>BASIC TECHNIQUES IN MICROBIOLOGY</b>	
<b>Unit-I</b>	<b>Microscopy</b>  <b>Principle, applications and ray diagram:</b> 1. Simple, compound microscope—Bright field Microscopy, 2. Dark field Microscopy, 3. Electron microscopy (TEM, SEM), 4. Phase-contrast microscopy, 5. Fluorescent microscopy.	08

<b>Unit-II</b>	<b>Staining Techniques.</b> <ol style="list-style-type: none"> <li>1. Stains &amp; dyes, chromophore, auxochrome, chromogenes, types of stains</li> <li>2. Theories of staining</li> <li>3. Staining techniques : Simple, negative staining, differential staining- Gram staining, acid-fast staining</li> <li>4. Staining of specific structures: flagella , spores, capsule</li> </ol>	07
<b>Unit- III</b>	<b>Microbial Techniques</b> <ol style="list-style-type: none"> <li>1. Isolation of pure culture by various methods.</li> <li>2. Determination of nutritional requirement by auxonographic technique, replica plating technique &amp; multi-point inoculator technique.</li> <li>3. Measurement of growth</li> <li>4. Preservation of microorganisms, National &amp; international collection centers</li> </ol>	07
<b>Unit-IV</b>	<b>Microbial control</b> <ol style="list-style-type: none"> <li>1. Terms &amp; definitions used in microbial control- Sterilization, inhibition, Microbiostatic, microbicide, disinfectant, sanitizer, viricide, sporicide, antimetabolite antibiotic, germicide, Preservative etc.</li> <li>2. Concept of microbial death</li> <li>3. Properties of ideal antimicrobial agent.</li> <li>4. Physical control methods—types, mode of action &amp; applications only-a) High &amp; low temperature b) filtration c) radiation d) osmotic pressure.</li> <li>5. Chemical agents—Different types, mode of action &amp; applications only- a) Phenols b) Alcohols c)Halogenes d) Heavy metals e) Quaternary ammonium compounds f) surface active agents g) phenol-coefficient</li> <li>6. Mechanism of cell injury</li> <li>7. Chemotherapeutic agent—sulphonamides only- mode of action &amp; application, Antibiotics, examples according to mode of action,source</li> </ol>	08
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<b>SEMESTER I</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
	<b>PRACTICAL</b>	
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	General concept of basic equipments & apparatus.	
3	Preparation of media & stains.	
4	Study of permanent slides of Streptococci, Diplococci, Capsule forming bacteria, Micrococcus sp. <i>Clostridium tetani</i> , <i>Bacillus anthracis</i> , <i>Vibrio cholera</i> , <i>Mycobacterium tuberculosis</i> , <i>Treponema palladium</i> , Cell organelles	
5	Demonstration of microbes from environment & body parts – Study colony characteristics	
6	Staining—Simple staining,	
7	Differential staining - Gram staining,	
8	Endospore staining.	
9	Bacterial motility by hanging drop method (Major).	
10	Isolation of pure culture by streak plate method,	
11	Isolation of pure culture by spread plate and pour plate method (Major).	
12	Anaerobic cultivation of bacteria.	
13	Oligodynamic effect (Major).	
14	Effect of UV radiation on bacteria using replica plate technique (Major).	
<b>Perform at least 8 practical (Excluding 1, 2 and 3). Experiment no. 9, 10, 11 are compulsory.</b>		
<p><b>Scheme of practical examination-</b></p> <ol style="list-style-type: none"> <li>1. One long expt.-----10 Marks</li> <li>2. One short expt.-----05 Marks</li> <li>3. Spotting-----05 Marks</li> <li>4. Viva-voce-----05 Marks</li> <li>5. Record-----05 Marks</li> </ol> <p style="text-align: center;">————— 30 Marks</p>		

## Books

1. Prescott, Hurley. Klein-Microbiology, 7<sup>th</sup> edition, International edition, McGraw Hill.
2. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology International edition 2002,| McGraw Hill.
3. Michael T. Madigan & J. M. Martin, Brock, Biology of Microorganisms 12<sup>th</sup> Ed. International edition 2006, Pearson Prentice Hall.
4. A.J. Salle, Fundamental Principles of Bacteriology.
5. Stanier. Ingraham et al ,General Microbiology 4th & 5th Ed. 1987, Macmillan Education Ltd
6. Microbiology TMH 5th Edition by Michael J. Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
7. BIS:12035.1986: Code of Safety in Microbiological Laboratories
8. Microbiology An Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.
9. Introduction to Microbial Techniques by Gunasekaran
10. Microbiology: Fundamentals and Applications by Ronald M. Atlas, New York: Macmillan Publication

# Syllabus

## B.Sc. Part- I

### Microbiology

	SEMESTER II	
Course Code	Title	Lectures
Paper I	<b>MICROBIAL DIVERSITY</b>	
Unit-I	<b>Prokaryotic microbes</b>  1. General characters of a) Proteobacteria, b) Mycoplasma, c) Rickettsia and d) Chlamydia 2. Cyanobacteria: Characteristics of anabena and applications of cyanobacteria 3. Actinomycetes: Characteristics of Streptomyces and their applications 4. Archae bacteria: Types of archae bacteria (Brief description), Methanogenic bacteria and their importance	09
Unit-II	<b>Eukaryotic microbes</b>  1. Fungi and yeast: General characters, Asexual and sexual mode of reproduction, 2. Algae:-General characters and industrially important algal cells 3. Protozoans: General characters and life cycle of <i>Entamoeba histolytica</i>	06
Unit- III	<b>Acellular microbes: Viruses.</b>  1. Discovery of viruses, General structure, symmetry and classification 2. Cultivation, chick embryo & tissue culture method 3. Detection of viral growth 4. T4-Bacteriophages- lytic cycle, 5. Lambda phage- Lysogenic cycle.	07

<b>Unit-IV</b>	<b>Microbial interaction</b>  1. Positive and negative interaction: Commensalism, synergism, syntropism, mutualism, parasitism, predation, antagonism, competition 2. Protist-Protist Interaction: Bdellovibrio 3. Protist-Plant interaction: Root nodule bacteria 4. Protist-Animal interaction: Rumen bacteria, insect midgut bacteria, luminescent bacteria	08
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<b>SEMESTER II</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>FOOD MICROBIOLOGY &amp; MILK MICROBIOLOGY</b>	
<b>Unit-I</b>	<b>Spoilage of Food</b>  1. Classification of food on the basis of ease of spoilage 2. Sources of microorganisms in food, microbial load 3. Spoilage of vegetables – factors responsible & types of spoilage. 4. Spoilage of meat & meat products- factors responsible & types of spoilage. 5. Spoilage of canned food – factors responsible & types.	07
<b>Unit-II</b>	<b>Preservation of food &amp; Food borne diseases</b>  1. General principles of food preservation. 2. Preservation by physical methods- i) By high temperature- TDP, TDT, Effect of high temperature on food, factors affecting high temperature application. Canning in detail. ii) By low temperature— chilling, freezing, and thawing, factors affecting low temperature, effect of low temperature on food. 3. Preservation by chemical preservatives—Acetates, citric acid, lactic acid, propionates, sorobates, nitrates, salt & sugar. Mode of action, applications.	07



<b>Unit- III</b>	<b>Milk Microbiology</b>  <ol style="list-style-type: none"> <li>1. Composition of milk.</li> <li>2. Sources of microorganisms in milk.</li> <li>3. Types of spoilage of milk &amp; milk products.</li> <li>4. Preservation by high temperature—Pasteurization in detail, UHT, Pasteurization test—Phosphatase test</li> <li>5. Preservation by low temperature</li> <li>6. Determining the quality of milk—plate count &amp; MBRT.</li> <li>7. Production of curd/Dahi &amp; Shrikhand.</li> <li>8. Production of Cheese—Classification of cheese. Production of Cheddar cheese &amp; cottage cheese</li> </ol>	08
<b>Unit-IV</b>	<b>Food Borne Diseases and Food Standards</b>  <ol style="list-style-type: none"> <li>1. Food Poisoning –food intoxication and food infection</li> <li>2. <i>Clostridium</i>, <i>Staphylococcal</i> enterotoxic poisoning, and <i>Bacillus cereus</i> food poisoning: organism, source, foods involved, outbreak conditions, effect on human health &amp; prevention</li> <li>3. Aflatoxin- sources of contamination, foods involved, effect on human health &amp; prevention</li> <li>4. Introduction to FDA, BIS and FSSAI- objectives and responsibilities</li> <li>5. Introduction to HACCP</li> </ol>	08
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<b>SEMESTER II</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
<b>PRACTICAL</b>		
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	Study of permanent slides of special bacteria--- Fungi ( <i>Aspergillus</i> , <i>Penicillium</i> and <i>Mucor</i> ) Protozoa ( <i>Plasmodium vivax</i> , <i>Trypanosoma</i> and <i>amoeba</i> ) & Algae ( <i>Spirullina</i> , <i>Anabena</i> and <i>Euglena</i> ), <i>Mycoplasma</i> , <i>Rickettsia</i> and <i>Chlamydia</i>	
3	Slide culture techniques for the cultivation and study of mould.	
4	Determining the microbiological quality of food- Total aerobic bacterial count and yeast & mold count by SPC method (Major).	

5	Coliform detection in food as per BIS.	
6	Enumeration total aerobic viable count in milk in raw and pasteurized milk by serial dilution method (Major).	
7	Quality of milk by MBRT.	
8	Phosphatase test.	
9	Effect of salt on microbial growth (Major).	
10	Effect of sugar on microbial growth (Major).	
11	Determination of TDP & TDT	
12	Determination of MIC of preservative on test organism (Major).	
13	Production of curd by using standard lactic culture and determine acidity.	
<b>Perform at least 8 practical</b>		
<p><b>Scheme of practical examination-</b></p> <ol style="list-style-type: none"> <li>1. One long expt.----- 10 Marks</li> <li>2. One short expt.----- 05 Marks</li> <li>3. Spotting-----05 Marks</li> <li>4. Viva-voce-----05 Marks</li> <li>5. Record-----05 Marks</li> </ol> <p style="text-align: center;">————— 30 Marks</p>		

## Books

1. Food Microbiology by Frazier 5th ed
2. Modern Food Microbiology by James Jay 6th ed
3. Applied Dairy Microbiology by Martha & Steele
4. Prescott, Hurley. Klein-Microbiology, 7<sup>th</sup> edition, International edition, McGraw Hill.
5. Kathleen Park Talaro & Arthur Talaro- Foundations in Microbiology International edition 2002, McGraw Hill.
6. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology, 5th Edn. McGraw-Hill Education (India).
7. Banwart G. J. (1989). Basic Food microbiology, 2nd Edn. Chapman and Hall. International Thompson Publishing.
8. Michael T. Madigan & J.M. Martin, Brock Biology of Microorganisms 12<sup>th</sup> Ed. International edition 2006, Pearson Prentice Hall.
9. Stanier, Ingraham et al., General Microbiology 4<sup>th</sup> & 5<sup>th</sup> Ed. 1987, Macmillan Education Ltd
10. Microbiology TMH 5th Edition by Michael J. Pelczar Jr., E.C.S. Chan, Noel R. Krieg
11. Microbiology An Introduction. 6th Edition. Tortora, Funke and Case. Addison Wesley Longman Inc. 1998.
12. BIS standards, FSSAI
13. Outlines of Biochemistry. E.E. Conn & P.K. Stumpf, G. Bruening, R.N. Doi. 5 Edition, John Wiley and sons
14. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk and milk products, 4th Ed. McGraw-Hill book Company, Incorporated.
15. Sarkar Chatterjee Swagata Food and Microbes, Himalaya Publishing House

# Syllabus

## B.Sc. Part- II

### Microbiology

SEMESTER III		
Course Code	Title	Lectures
Paper I	<b>CHEMISTRY OF ORGANIC CONSTITUENTS AND ENZYMOLOGY</b>	
Unit-I	<b>Carbohydrates and Lipids</b> 1. Classification of carbohydrates, 2. Structure of glucose, fructose, maltose, lactose, sucrose, raffinose, starch, hyaluronic acid, glycogen, cellulose, osazone formation 3. Classification of lipids, structure of triglyceride, compound lipids, derived lipids	07
Unit-II	<b>Amino acids and proteins</b> 1. Classification of amino acids, 2. Titration curve, acidic, basic and neutral amino acids, 3. Peptide bond theory, 4. Organizational levels of proteins, 5. Concept of oligomeric protein	06
Unit- III	<b>Enzymology</b> 1. Definitions and nature of enzymes, classification, nomenclature, 2. Primary concept of enzyme kinetics, MM equation, modifications of MM equations, 3. Activation energy, transition state, ES complex, enzyme activity, katal, specific activity ,turnover number 4. Enzyme inhibition and their types, 5. Enzyme regulation, their types, 6. Allosteric sites, allosteric modulators, 7. Functional diversity such as holoenzyme, apoenzyme, coenzyme, cofactor, prosthetic group, isoenzymes, 8. Membrane bound enzymes, multienzyme complex, zymogens	09

<b>Unit-IV</b>	<b>Nucleic acid and Vitamins</b> 1. Structure of purines, pyrimidines, nucleosides, nucleotides, 2. Structure of DNA, RNA, and various forms of DNA 3. Types of vitamins, Classification on the basis of solubility, functions of vitamins, 4. Hypervitaminosis – Definition, causes, symptoms, treatment of Vit. A and D 5. Hypovitaminosis – Definition, causes, symptoms, treatment of Vit. B12, A and D	08
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<b>SEMESTER III</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>INDUSTRIAL MICROBIOLOGY</b>	
<b>Unit-I</b>	<b>Fundamentals of industrial microbiology and Fermentor design</b> 1. Definition, History and scope of industrial microbiology, 2. Design of typical fermentor, parts of fermentor, 3. Types of fermentors, 4. Types of fermentation processes 5. Isolation of industrially important micro organisms- Primary screening and secondary screening	07
<b>Unit-II</b>	<b>Upstream processing in fermentation process</b> 1. Strain development, 2. Inoculum development, 3. Scale up of fermentor process 4. Raw materials used for media preparation, 5. Sterilization of fermentors, production media and air 6. Factors affecting fermentation process such as agitation, aeration, pH, dissolved oxygen and rheological properties	07
<b>Unit- III</b>	<b>Downstream processing in fermentation process and Quality Control</b> 1. Outline of downstream process 2. Harvesting of biomass- methods and principles 3. Product recovery and purification- methods and principles 4. Concept of Good Manufacturing Practices 5. Microbiological quality checking as per pharmaceutical compendium such as IP and USP	08

<b>Unit-IV</b>	<b>Entrepreneurial microbiology</b> Production, biochemistry, recovery and uses of 1. Single Cell Protein - Spirulina 2. Bakers yeast, 3. Ethanol 4. Penicillin, semi synthetic penicillin, 5. Citric acid 6. Beer and Wine	08
		30

<b>SEMESTER III</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
	<b>PRACTICAL</b>	
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	Calibration of pH meter, validation of autoclave, Validation of Laminar air Flow unit	
3	Qualitative detection of carbohydrates, protein, nucleic acid and lipids	
4	Detection of enzymes: amylase, catalase, gelatinase, lipase, oxidase	
5	Isolation of amylase producer from soil	
6	Sugar and alcohol tolerance of <i>Saccharomyces cerevisiae</i> (Major)	
7	Production and estimation of alcohol (Major)	
8	Leavening capacity of yeast (Major)	
9	Detection of penicillinase activity (Major)	
10	Chemical estimation of penicillin	
11	Determination of sugar quantity in any natural source of carbohydrate	
12	Determination of protein quantity (Major).	
13	Bioassay of penicillin	
14	Sterility testing of pharmaceutical products	
15	Microbiological quality of non sterile pharma products as per IP (Major)	
16	Growth promotion test (Major)	
<b>Perform at least 8 practical. Experiment no. 1 is compulsory.</b>		

**Scheme of practical examination-**

1. One long expt.-----10 Marks
2. One short expt.-----05 Marks
3. Spotting-----05 Marks
4. Viva-voce-----05 Marks
5. Record-----05 Marks

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30 Marks

**Books**

1. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005
2. Microbiology an Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.
3. Prescott, Hurley. Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
4. Garrett, R. H. and Grisham, C. M. (2004) Biochemistry. 3rd Ed. Brooks/Cole, Publishing Company, California.
5. Conn Eric, Stumpf Paul K., Bruening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.
6. H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd.
7. Butterworths Heinemann. *Bioreactor Design and Product Yield* (1992), BIOTOL series,
8. Casida, L. E., (1984), Industrial Microbiology, Wiley Easterbs, New Delhi
9. Indian Pharmacopia and British Pharmacopia (Latest Edn).
10. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) *Bioprocess Engineering: Syatems, Equipment and Facilities*, John Wiley and Sons Inc.
11. *Operational Modes of Bioreactors*, (1992) BIOTOL series, Butterworths Heinemann.
12. Peter F. Stanbury. Principles Of Fermentation Technology, 2E, Elsevier (A Division of Reed Elsevier India Pvt. Limited), 2009
13. Prescott, S.C. and Dunn, C. G., (1983) Industrial Microbiology, Reed G. AVI tech books.
14. Reed G. Ed. Prescott and Dunn's Industrial Microbiology. 4th Ed., CBS Pub. New Delhi.
15. Stanbury, P. F. and Whittaker, A. (1984) Principles of Fermentation technology, Pergamon press.
16. Van Damme E. J. (1984) Biotechnology of Industrial Antibiotics, Marcel Dekker Inc. New York.
17. Wiseman A.(1985) Topics in Enzyme and Fermentation - Biotechnology, Vol. 1 and 2, John Wiley and Sons, New York

# Syllabus

## B.Sc. Part- II

### Microbiology

SEMESTER IV		
Course Code	Title	Lectures
Paper I	<b>METABOLISM</b>	
<b>Unit-I</b>	<b>Carbohydrate</b> 1. General strategy of metabolism, 2. EMP pathway and its regulation, 3. TCA cycle and its regulation, 4. Outline of ED pathway, 5. Pentose Phosphate pathway, 6. PK pathway	08
<b>Unit-II</b>	<b>Lipid and Nucleic Acid</b> 1. Betaoxidation and Omegaoxidation, 2. Replication of DNA, modes of replication, general features, enzymes involved, rolling circle and knife and fork model, 3. Prokaryotic transcription including general features, enzymes involved and reverse transcription	08
<b>Unit- III</b>	<b>Amino acids and Proteins</b> 1. Amino acid breakdown, deamination, (alanine, tyrosine, methionine), 2. Metabolic breakdown of individual amino acids (alanine, arginine, methionine and tryptophan) 3. Glucogenic and ketogenic amino acids 4. Genetic code and 5. Prokaryotic translation	08
<b>Unit-IV</b>	<b>Energy Generation</b> 1. High energy molecules, 2. Substrate level phosphorylation, 3. Cyclic and noncyclic photophosphorylation, 4. Oxidative phosphorylation and ATP generation	06
		30

<b>SEMESTER IV</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>ENVIRONMENTAL MICROBIOLOGY</b>	
<b>Unit-I</b>	<p><b>Fresh Water microbiology</b></p> <ol style="list-style-type: none"> <li>1. <b>Fresh water</b> – Definition, Examples of fresh water i.e. ice sheets, ice caps, glaciers, icebergs, bogs, ponds, lakes, rivers, streams, and underground water and their outline.</li> <li>2. <b>Potable water</b> - Definition, Water treatment using SSF and RSF, Methods of chlorination, Water Quality Standards (BIS and WHO).</li> <li>3. <b>Microbiological Quality Testing</b> - Significance of bacteriological analysis of water, collection and handling of water samples, indicators of excretal pollution, bacteriological analysis of water for coliforms and faecal streptococci (MTFT, MFT), differences between fecal and non fecal organisms</li> </ol>	06
<b>Unit-II</b>	<p><b>Waste Water Treatment</b></p> <ol style="list-style-type: none"> <li>1. Sewage types, composition, physical, chemical and biological characteristics, BOD, COD, ThOD</li> <li>2. Primary Treatment,</li> <li>3. Secondary Treatment – Trickling filter, Activated sludge, RBC, Sludge digester, Oxidation pond, Septic tank, and Imhoff tank</li> <li>4. Tertiary Treatment,</li> <li>5. Disposal of treated wastewater.</li> </ol>	08
<b>Unit- III</b>	<p><b>Air and Agricultural microbiology</b></p> <ol style="list-style-type: none"> <li>1. <b>Air Microbiology</b> - Significance of Microbial analysis of air, settling plate and Anderson technique.</li> <li>2. <b>Agricultural Microbiology</b> – Symbiotic nitrogen fixing bacteria, mechanism of nitrogenase enzyme, formation of root nodules, non-symbiotic nitrogen fixing bacteria, bacteria and fungi as biopesticides, Phosphate solubilizing microorganisms, mycorrhiza</li> </ol>	08



<b>Unit-IV</b>	<b>Bioremediation and Biomagnifications</b>  1. <b>Bioremediation</b> - Role of plant and microbes 2. <b>Bioaugmentation</b> - Definition, significance with example 3. <b>Xenobiotics and recalcitrant compounds</b> – Definition, environmental significance and examples 4. <b>Microbial leaching</b> – Concept, advantages and bioleaching of copper 5. <b>Bioaccumulation and Biomagnification</b> - Definition, environmental significance and examples	08
		30

<b>SEMESTER IV</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
	<b>PRACTICAL</b>	
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	Isolation of Salmonella from water and sewage	
3	Determination of MPN of drinking water (Major)	
4	IMViC Test	
5	Determination of DO (Major)	
6	Determination of Alkalinity	
7	Determination of total solids, water soluble and water insoluble solids in waste water	
8	Determination of BOD and COD of waste water (Demonstration)	
9	Determination of Available Chlorine in Bleaching Powder/Sodium hypochlorite (Major)	
10	Isolation of Rhizobium from root nodules (Major)	
11	Isolation of Phosphate solubilizing microorganisms from soil	
12	Monitoring of indoor microbial count	
<b>Perform at least 8 practical</b>		

**Scheme of practical examination-**

1. One long expt.-----10 Marks
2. One short expt.-----05 Marks
3. Spotting-----05 Marks
4. Viva-voce-----05 Marks
5. Record-----05 Marks

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30 Marks

**Books**

1. Principles of Biochemistry- G. Zubay, W.W. Parson, D.E.Vance. Wm.C.Brown Publishers
2. Fundamentals of Biochemistry. D. Voetand J. Voet Publisher Wiley plus Edition 5th.
3. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 4 edition W.H. Freeman & Company[Low price edition- for sale in India, Pakistan, Sri Lanka, Bangladesh, Nepal & Bhutan]
4. Principles & techniques of Biochemistry & Mol biology 6th ed, Keith Wilson & John Walker, Cambridge University press, 2006
5. Laboratory manual in Biochemistry- J. Jayaraman
6. Ajay Singh, Owen P. Ward, 2004 edition, Applied Bioremediation and Phytoremediation (Soil Biology). Springer;
7. David S. Ingram, N.F. Robertson (1999). Plant Disease.1st Edn.: Collins
8. George Nicholas Agrios (2005).Plant Pathology.5th Edn. Academic Press Inc.
9. James M. Jay, Martin J. Loessner, David A. Golden (2005). Modern food microbiology, 7th Edn. Springer Science & Business.
10. John Postgate, (1998). Nitrogen Fixation. Cambridge University Press
11. K. S. Bilgrami, H. C. Dube (1984). A textbook of modern plant pathology. 7th Edn.
12. Martin Alexander (1999). Biodegradation and Bioremediation. Academic Press
13. Matthew Dickinson, (2003). Molecular Plant Pathology. Garland Publishing Inc.
14. N. S. SubbaRao. (1995). Soil Microorganisms and Plant growth. 3rd Edn. Science Pub Inc
15. R. Barry King, John K. Sheldon, Gilbert M. Long, 1997 Practical Environmental
16. Bioremediation: The Field Guide, 2nd Edn. CRC Press
17. Air Quality Standards- NAAQS Manual , Volume I 4. Prescott's Microbiology, 8th Edition; Joanne M. Willey, Linda M. Sherwood, Christopher J.Woolverton,2011, McGraw Hill International Edition
18. Fundamentals of Microbiology, 9 th Edition , Frobisher, Hinsdill, Crabtree, Goodheart, 1974, Saunders College Publishing
19. Introduction to Environmental Microbiology – Barbara Kolwzan , Waldemar Adamiak (E Book)
20. Soil Microbiology-4th Edition, N.S Subba Rao,2000, Oxford and IBH Publishing Co. Pvt. Ltd

# Syllabus

## B.Sc. Part- III

### Microbiology

SEMESTER V		
Course Code	Title	Lectures
Paper I	<b>MEDICAL MICROBIOLOGY</b>	
Unit-I	<p><b>Epidemiology and host–parasite relationship.</b></p> <p><b>1. Definitions:</b></p> <p>i. Signs, symptoms and syndrome of disease, stages of infectious diseases-incubation period, prodromal phase, Invasive phase, decline phase and the period of convalescence, primary infection, secondary infection, acute infection, chronic infection local and systemic infection, iatrogenic infection, nosocomial infection, congenital infection, teratogenic infection, fulminating infection, atypical infection, latent infection</p> <p>ii. Bacteremia, septicaemia, pyamia, toxemia, Viremia.</p> <p>ii. Epidemic, Endemic, Pandemic, Zoonotic, Exotic, prosodemic sporadic disease.</p> <p><b>2. Dynamics of disease transmission:</b></p> <p>i. Causative or etiological agents[list]</p> <p>ii. Sources of reservoir of infection. Exogenous Human (case and carrier) Non-living reservoir. Endogenous infections</p> <p>iii. Portal of exit</p> <p>iv. Mode of transmission-Contact, Vehicle, Vector, Air-borne, trans placental and laboratory/hospital infections.</p> <p>v. Portal of entry.</p> <p>vi. Susceptibility of host.</p> <p><b>3. Control of communicable diseases:</b> Control of sources, blocking the channels of transmission, protecting the susceptible host.</p>	08

<b>Unit-II</b>	<b>Infectious Microbiology and Normal Flora</b> 1. Microbial mechanism of Pathogenicity: pathogenicity and virulence, exaltation and attenuation, MID, MLD, ID 50, LD50. i. Invasiveness:-adherence,capsule,enzymes. ii. Toxigenicity:-Exotoxins and Endotoxins. 2. Normal flora of healthy human host: i. Definition, origin, significance, Germ free and Gnotobiotic life. ii. Characteristics of normal flora 3. Infectious microbiology: Microbial diseases of skin, eye, digestive, respiratory, cardiovascular, lymphatic, urinary, reproductive and nervous systems. (Outline of structure of each system and lists of infectious diseases affecting the particular system).	08
<b>Unit- III</b>	<b>Study of pathogenic organisms</b> <b>Morphology, cultural characteristics, biochemical characteristics, pathogenesis, serology, lab diagnosis</b> <b>1. Bacteria</b> i. <i>Escherichia coli</i> ii. <i>Staphylococcus aureus</i> iii. <i>Salmonella typhi</i> and <i>paratyphi</i> A&B iv. <i>Mycobacterium tuberculosis</i> . v. Spirochetes- <i>Treponema pallidum</i> <b>2. Viruses</b> i. HIV ii. Hepatitis A&B <b>3. Protozoa</b> i. <i>Plasmodium vivax</i>	07
<b>Unit-IV</b>	<b>Disease control</b> 1. Basic mechanism of action of drugs. i. Bacterial cell wall synthesis inhibitor; Penicillin ii. Bacterial protein synthesis inhibitor: Chloramphenicol iii. Bacterial DNA synthesis inhibitor: Nalidixic acid, Floxacin iv. Anti metabolites: Trimethoprim, sulfamethoxazole. 2. Non automated and automated <i>in vitro</i> drug susceptibility testing- Kirby-Bauer disc diffusion method and E-strip method. 3. Various mechanisms of development of drug resistance	07
		30

<b>SEMESTER V</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>MOLECULAR BIOLOGY AND BIOINSTRUMENTATION</b>	
<b>Unit-I</b>	<b>Gene mutation and regulation.</b> 1. Concept of gene, muton, recon, cistron, mono cistronic and polycistronic gene, gene within gene, spit gene. 2. Gene regulation: lac operon(detail) 3. Mutation: Definition, random vs directed mutation, type of mutation, base pair substitution, frame shift, point, nonsense, missense, and silent mutation. 4. Genetic suppression: Intergenic and Intragenic. 5. Molecular basis of mutation: Mechanism of spontaneous and induced mutation.	08
<b>Unit-II</b>	<b>Genetic recombination:</b> 1. Definition, Basic concept of recombination 2. General types of recombination. 3. Transformation. 4. Conjugation 5. Transductions 6. Transposable genetic elements (Prokaryotic)	07
<b>Unit- III</b>	<b>Bioinstrumentation-I (Principles and applications)</b> 1. Spectroscopy: Laws of absorption, limitations of Beer law, UV-Visible spectroscopy and its applications. 2. Centrifugation: Type of centrifuge, analytical and differential centrifugation. 3. Electrophoresis: Principle, agarose gel electrophoresis and SDS- PAGE. 4. Factors affecting electrophoresis mobility	08
<b>Unit-IV</b>	<b>Bioinstrumentation-II (Principles and applications)</b> 1. Chromatography: Thin layer chromatography, ion exchange, gel filtration 2. Isotope tracer technique: Method and applications. 3. Detection and measurement of radioactive isotope: GM counter, scintillation counter.	07
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<b>SEMESTER V</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
	<b>PRACTICAL</b>	
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	Agarose gel electrophoresis (Major)	
3	Calibration of spectrophotometer	
4	Estimation of creatinine by spectrophotometric method (Major)	
5	Perform gel filtration (Major)	
6	Perform paper chromatography of amino acids and sugars	
7	Perform TLC of amino acids and sugars (Major)	
8	Identification of bacteria: <i>E.coli</i> , <i>S.aureus</i> , <i>Salmonella</i> , <i>Proteus vulgaris</i> (Major)	
9	Antibiotic sensitivity test by Kirby-Bauer method and E strip method	
10	MIC of antibiotic by well diffusion method/dilution method (Major)	
11	Antigen Preparation: O & H antigen preparation of Salmonella and Confirmation by slide agglutination	
12	Acid fast staining of <i>M. tuberculosis</i> .	
<b>Perform at least 8 practical</b>		
<p style="text-align: center;"><b>Scheme of practical examination-</b></p> <ol style="list-style-type: none"> <li>1. One long expt.-----10 Marks</li> <li>2. One short expt.-----05 Marks</li> <li>3. Spotting-----05 Marks</li> <li>4. Viva-voce-----05 Marks</li> <li>5. Record-----05 Marks</li> </ol> <hr style="width: 20%; margin: 10px auto;"/> <p style="text-align: center;">30 Marks</p>		

## Books

1. Tortora, G.J., Funke, B.R., Case, C.L, 1992. Microbiology: An introduction 5th Edition, Benjamin Pub. Co. NY
2. Roitt, P.I: Mims, C.J. Medical Microbiology
3. Chakraborty, P., 2003 A textbook of Microbiology, 2nd Edition New Central Book Agency, India.
4. Medical Microbiology edited by Samuel Baron. Fourth edition. (University of Texas Medical Branch of Galvesion)
5. Sherris, John C, Ed, Medical Microbiology: an Introduction to infectious diseases. Elsevier Publication IInd edition.

6. Virulence mechanisms of bacterial pathogens (Second edition) by Roth, Bolin, Brogden Minion and Michael.
7. Ganti, A. Sastry.1975. Veterinary Pathology. Seventh Edition. Revised by P. Rama Rao.
8. Davis B.D., Delbacco, 1990 Microbiology 4th edition, J.B. Lippincott Co. NY
9. Wolfgang K. Joklik, 1992, Zinsser Microbiology 20<sup>th</sup> Edition, McGraw-Hill Professional Publishing.
10. Dey, N.C and Dey, TK. 1988, Medical Bacteriology, Allied Agency, Calcutta, 17 Edition
11. Ananthnarayana, R. and C.E, Jayaram Panikar, 1996 Text book of microbiology, 5th edition, Orient Longman.
12. Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur
13. David Greenwood, 1995, Antimicrobial Chemotherapy, 3<sup>rd</sup> Edition, Oxford University Press.
14. Franklin, T.J and Snow, G. A. 2012, Biochemistry of Antimicrobial Action. Springer Science & Business Media
15. Mukherjee, K.L 1988 Medical Laboratory Technology, Vol III, 10th Edition, Tata Mc. Graw-Hill Pub Co
16. Bruce A. (2008), Molecular Biology of the Cell, 5<sup>th</sup> Edn. Publisher: Garland Science, New York.
17. David Freidfelder, (1987).Molecular Biology, 2<sup>nd</sup>Edn. Jones & Bartlett Pub.
18. Gardner, Simmons, Snustad. (2006), Principles of Genetics, 8<sup>th</sup>Edn. John Wiley & Sons. Inc. New York.
19. Gunther S. Stent, (1978), Molecular Genetics: An Introductory Narrative, 2<sup>nd</sup> Edn. W.H.Freeman& Co.
20. Hayes, W. (1964), The Genetics of Bacteria and their Viruses, CBS Pub. New Delhi. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael
21. Levine, Richard Losick, (2013 ), Molecular Biology of the Gene, 7<sup>th</sup> Edn. Pearson Publishers.
22. Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, (2012) Lewin's GENES XI, 11<sup>th</sup> Edn. Jones & Bartlett Learning
23. Lodish H. et al. (2012), Molecular Cell Biology, 7<sup>th</sup> Edn. W. H. Freeman & Company. New York.
24. Primrose, S. B. (2002).Principles of Gene Manipulation 6<sup>th</sup> Edn. Oxford: Blackwell Scientific Publications
25. Russel Peter. (2009), iGenetics: A Molecular Approach, 3<sup>rd</sup> Edn. Publisher Benjamin Cummings
26. Russel, Peter, (1990), Essential Genetics, 7<sup>th</sup> Edn. Blackwell Science Pub.
27. Strickberger, M.W. (1985), Genetics, 3<sup>rd</sup> Edition Macmillan Pub. Co. NY.

# Syllabus

## B.Sc. Part- III

### Microbiology

SEMESTER VI		
Course Code	Title	Lectures
Paper I	IMMUNOLOGY	
Unit-I	<b>Immunity and Non specific defenses</b> 1. Immunity: Definition and general concept 2. Haematopoiesis and Cells of immune system a) Diagram of Haematopoiesis b) General characteristics of i. B and T cells, ii. Monocytes and macrophages, iii. Neutrophils, Eosinophils and basophiles. iv. Mast cells v. Dendritic cells vi. Natural Killer cells 3. Non specific defenses of the host: a) Species, race and individual resistance. b) Age, sex, hormonal and nutritional influences. 4. Mechanism of non-specific defenses: a) First line of defense – Physical, chemical and biological barriers b) Second line of defense: i. Humoral components: Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), complement, kinins, acute phase reactants. ii. Cellular components: Phagocytic cells – PMNL, macrophages (reticulo-endothelial cell system) and dendritic cells 5. Functions: Phagocytosis (oxygen dependent and independent systems), Complement activation (General concept), Coagulation system, Inflammation (cardinal signs, mediators, vascular and cellular changes, role of Toll-like receptors)	08



<p><b>Unit-II</b></p>	<ol style="list-style-type: none"> <li><b>1. Antigen</b> <ol style="list-style-type: none"> <li>a) Concepts and factors affecting immunogenicity</li> <li>b) Antigenic determinants, haptens and cross-reactivity, Carriers, Adjuvants</li> <li>c) Types of antigens: Thymus-dependent and thymus-independent antigens, Synthetic antigens, Soluble and particulate antigens, Autoantigens, Isoantigens, Species specific antigens, Organ specific antigens, Heterophile antigens</li> </ol> </li> <li><b>2. Immunoglobulins</b> <ol style="list-style-type: none"> <li>a) Structure of basic unit, chemical and biological properties</li> <li>b) Characteristic of domain structure, functions of light and heavy chain domains</li> <li>c) Molecular basis of antibody diversity (kappa chain, lambda chain and heavy chain diversity)</li> <li>d) Classes of Immunoglobulins and their functions.</li> </ol> </li> <li><b>3. Organs of immune system</b> <ol style="list-style-type: none"> <li>a) Primary lymphoid organs (Thymus and Bursa): Thymus – structure, thymic education (positive and negative selection), Bone marrow</li> <li>b) Secondary lymphoid organs – Structure and function of spleen and lymph node, mucous associated lymphoid tissue and lymphatic system and lymph circulation</li> </ol> </li> </ol>	<p>08</p>
<p><b>Unit- III</b></p>	<ol style="list-style-type: none"> <li><b>1. Adaptive / Acquired Immunity (Third line of defense):</b> <ol style="list-style-type: none"> <li>a) Acquired immunity: Active and Passive immunity.</li> <li>b) Primary and secondary response and its significance in vaccination programs</li> <li>c) Clonal selection and clonal deletion (immune tolerance)</li> <li>d) B cell biology, role of cytokines in activation and differentiation of B-cells</li> </ol> </li> <li><b>2. Cell Mediated Immune Response</b> <ol style="list-style-type: none"> <li>a) Activation and differentiation of T cells</li> <li>b) Mechanism of CTL mediated cytotoxicity, ADCC</li> <li>c) Applications of CMI</li> </ol> </li> <li><b>3. T-cell biology</b> <ol style="list-style-type: none"> <li>a) T-cell dependent antibody response. outline</li> <li>b) T-cell independent antibody response. outline</li> <li>c) Types of T-cells and Cluster of differentiation(CD)</li> <li>d) T-cell receptor(TCR)</li> </ol> </li> <li><b>4. Cytokines</b> <ol style="list-style-type: none"> <li>a) Definition and general characteristics</li> <li>b) Types- colony stimulating factor, Interleukins, Tumor necrosis factor alpha</li> </ol> </li> </ol>	<p>07</p>

<b>Unit-IV</b>	<b>1. Antigen-antibody interaction</b> a) Principles of interactions: Antibody affinity and avidity, b) Ratio of antigen antibody, lattice hypothesis, c) Antibody titre, rising antibody titre, paired sera <b>2. Antigen-antibody Reactions (Diagnostic immunology)</b> a) Precipitation: Precipitation in liquids and gels, Immuno diffusion, Immuno electrophoresis. b) Agglutination: Slide agglutination, tube agglutination, haemagglutination, Haemagglutination inhibition test c) Tagged antibody test: ELISA direct and indirect <b>3. Hypersensitivity reactions</b> a) Definition, Gel & Coomb's classification (Outline). b) Anaphylaxis c) Blood transfusion reaction (Rh compatibility), d) Arthus reaction, e) Mantoux test,	07
		30

<b>SEMESTER VI</b>		
<b>Course Code</b>	<b>Title</b>	<b>Lectures</b>
<b>Paper II</b>	<b>MICROBIAL BIOTECHNOLOGY &amp; RECOMBINANT DNA TECHNOLOGY</b>	
<b>Unit-I</b>	<b>Tools &amp; Techniques of Genetic engineering</b> 1. Introduction- Definition & scope of Biotechnology & Recombinant DNA technology. 2. Preparation of pure sample of DNA, enzymes used in DNA manipulation, analysis of DNA fragment size, joining of DNA fragments, vectors & their types 3. Introduction of rDNA into host cell, transformation of cells, identification of transformed cells, selection of clones – direct & indirect methods. 4. Expression of cloned genes, construction of gene library, cells for cloning, expression of prokaryotic genes. 5. PCR & its application, DNA finger printing.	08

<b>Unit-II</b>	<b>Health care Biotechnology</b> <ol style="list-style-type: none"> <li>1. Production of hormones : Insulin</li> <li>2. Production of Interferon</li> <li>3. Production of vaccines : Conventional vaccines – BCG, Salk, Diphtheria Toxoid , ATS, DNA Vaccine, Edible vaccines</li> <li>4. Hybridoma technology, monoclonal antibody production</li> <li>5. Gene Therapy.</li> </ol>	07
<b>Unit- III</b>	<b>Agricultural Biotechnology.</b> <ol style="list-style-type: none"> <li>1. Protoplast fusion- Protist - Plant interaction, application of <i>Agrobacterium tumifaeciens</i> in gene transfer.</li> <li>2. Production of Biopesticides – Buculo virus</li> <li>3. Production of Biofertilizers – Rhizobium</li> <li>4. Oriental Fermented food: Definition and production of soyasauce</li> <li>5. Genetically modified foods- Definition and concept of golden rice</li> <li>6. Transgenic plants— Definition and concept of BT Cotton</li> </ol>	08
<b>Unit-IV</b>	<b>Industrial Biotechnology</b> <ol style="list-style-type: none"> <li>1. Biosensors—General concept of construction, Applications, Glucose sensor as an example. Concept of Nanobiotechnology</li> <li>2. Biochips- definition, example and applications</li> <li>3. Enzyme technology- Applications of enzymes in industry, Production of industrial enzyme—amylase by deep tank &amp; SSF, purification &amp; recovery. Immobilized enzymes – applications &amp; general methods of production- example invertase immobilization.</li> <li>4. Ethics &amp; hazards of biotechnology</li> </ol>	07
		30

<b>SEMESTER VI</b>		
<b>Sr. No.</b>	<b>Title</b>	<b>Lectures</b>
	<b>PRACTICAL</b>	
1	General guidelines for safety in microbiology laboratory, possible laboratory hazards, safety precautions and disposal of laboratory waste and ethics in microbiology.	30
2	Study of permanent slides- T.S. of spleen, thymus, bursa of fabricius and lymphnode	
3	Isolation of plasmid DNA (Major)	
4	Demonstration of restriction digestion	
5	Perform Quantitative WIDAL test	
6	Rapid plasma reagin (RPR) Test titre	
7	Blood Group Detection (Direct and Reverse typing)	
8	ASO/RA test	
9	Pregnancy test	
10	Perform Immuno diffusion (Major)	
11	ELISA Test	
12	Coomb's Direct test	
13	Estimation of amylase (Major)	
14	Determination of Total viable Rhizobium and Azatobacter count in commercially available biofertilizers (Major)	
15	Immobilization of yeast and demonstration of invertase activity (Major)	
<b>Perform at least 8 practical</b>		
<p><b>Scheme of practical examination-</b></p> <ol style="list-style-type: none"> <li>1. One long expt.----- 10 Marks</li> <li>2. One short expt.----- 05 Marks</li> <li>3. Spotting-----05 Marks</li> <li>4. Viva-voce-----05 Marks</li> <li>5. Record-----05 Marks</li> </ol> <p style="text-align: center;">————— 30 Marks</p>		

## Books

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26<sup>th</sup> Edition, Lange publication
2. Bacterial Pathogenesis –A molecular approach Abigail Salyer And Dixie Whitt 2nd Ed ASM press
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9 edition
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5. Pathak & Palan, Immunology: Essential & Fundamental, 1<sup>st</sup>& 3<sup>rd</sup> Edition, Capital Publishing Company
  
6. Fahim Khan, Elements of Immunology, Pearson Education
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8. Baron Samuel , Medical Microbiology, 4 edition
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10. R. C. Dubey, 2005 A Textbook of "Biotechnology" S. Chand and Company, New Delhi