

B.Sc. Microbiology Syllabus

Examination 2019-20-21

SCHEME OF EXAMINATION

1. PASS CRITERIA

For a pass in the examination, a candidate is required to obtain at least 36 % in each paper (Theory and Practical) and 36 % marks of total aggregate marks of theory and practical papers separately.

2. CLASSIFICATION OF SUCCESSFUL CANDIDATES

| Division | Total Marks |
|-----------------|---------------------------|
| First Division | 60% and above |
| Second Division | Above 48 % and below 60 % |
| Pass | Above 36 % and below 48 % |
| Fail | Below 36 % |

3. INSTRUCTIONS TO PAPER SETTER

The question paper contains 3 sections. **Section-A** consists of 10 questions (2 questions from each unit of syllabus). **Section-B** consists of 10 questions (2 questions from each unit of syllabus). **Section-C** consists of 5 questions (1 question from each unit of syllabus). The word limit of part A, B and C are 50, 200 and 500 respectively.

4. BACKLOG

As per University Norms

5. WORKLOAD

At least 3 hrs theory and 3 hrs practical slot should be assigned per week for each paper.

6. INSTRUCTIONS FOR PRACTICAL EXAMINATION

Each practical exam is to be conducted by two examiners one External and one Internal. External examiner should preferably be a senior lecturer from any Indian recognized University or its affiliated college. External Examiner will prepare question paper of Practical Examination Students have to perform the given exercises. Exercise must be written in answer books I proper documentation.

Marks distribution for Practical of 65 marks is as under-

| | Part I & II | Part III |
|---|-----------------------------|----------|
| Three Exercises of 10 marks each | 30 marks | 30 marks |
| For B.Sc. Part I | | |
| Exercise | Students Regular Ex. | |
| 1. Culture, Staining and identification of non pathogenic and pathogenic bacteria | 10 | 15 |
| 2. Identification of Fungal and algal Microbes | 10 | 10 |

| | | |
|--|-----------------|------------|
| 3. (a) Determination of Glucose/Proteins/fats | 05 | 10 |
| (b) Enumeration of bacteria | 05 | 05 |
| 4. Spotting -(10) | 15 | 15 |
| 5. Viva-Voce | 10 | 10 |
| 6. Practical Record | 10 | - |
| Total | 65 | 65 |
| For B.Sc. Part II | | |
| Exercise | Students | |
| | Regular | Ex. |
| 1. Experimental work (Major) | 10 | 20 |
| 2. Experimental work (Minor) | 10 | 10 |
| 3. Chromatographic separation | 10 | 10 |
| 4. Spotting (three from each paper) | 15 | 15 |
| 5. Viva-Voce | 10 | 10 |
| 6. Practical Record | 10 | -- |
| Total | 65 | 65 |
| For B.Sc. Part III | | |
| 1. Experimental work (Major) | 12 | 20 |
| 2. Experimental work (Minor) | 08 | 10 |
| 3. | | |
| a. Blood cell counting by haemocytometer | 05 | 05 |
| b. Determine the blood group of human blood sample | 05 | 05 |
| 4. Spotting - (two from each paper) | 15 | 15 |
| 5. Viva-Voce | 10 | 10 |
| 6. Practical Record | 10 | -- |
| Total | 65 | 65 |

Teaching and Examination scheme for
Bachelor in Microbiology
Session 2018-19 Examination 2019

Part-I

| Paper code | Paper Name | Lect/week | Exam Hours | Max Marks | Min. Pass Marks (36%) |
|--------------------|---------------------------------------|-----------|------------|------------|-----------------------|
| Theory Papers | | | | | |
| BSCM 101 | General Microbiology | 3 | 3 | 45 | 16 |
| BSCM 102 | Microbial Structure and Growth | 3 | 3 | 45 | 16 |
| BSCM 103 | Microbial Biochemistry | 3 | 3 | 45 | 16 |
| Aggregate | | | | | 48 |
| Practical | | | | | |
| | Practical Based on Paper I,II and III | | 5 | 65 | 24 |
| Grand Total | | | | 200 | 72 |

Part-II

| Paper code | Paper Name | Lect/week | Exam Hours | Max Marks | Min. Pass Marks (36%) |
|--------------------|----------------------------------|-----------|------------|------------|-----------------------|
| Theory Papers | | | | | |
| BSCM 201 | | 3 | 3 | 45 | 16 |
| BSCM 202 | | 3 | 3 | 45 | 16 |
| BSCM 203 | | 3 | 3 | 45 | 16 |
| Aggregate | | | | | 48 |
| Practical | | | | | |
| | Practical Based on Theory papers | 3 | 5 | 65 | 24 |
| Grand Total | | | | 200 | 72 |

Part-III

| Paper code | Paper Name | Lect/week | Exam Hours | Max Marks | Min. Pass Marks (36%) |
|--------------------|--|-----------|------------|------------|-----------------------|
| Theory Papers | | | | | |
| BSCM 201 | | 3 | 3 | 45 | 16 |
| BSCM 202 | | 3 | 3 | 45 | 16 |
| BSCM 203 | | 3 | 3 | 45 | 16 |
| Aggregate | | | | | 48 |
| Practical | | | | | |
| | Practical Based on BSCM 201, BSCM 202 & BSCM 203 | 3 | 5 | 65 | 24 |
| Grand Total | | | | 200 | 72 |

B.Sc. Part-1 Examination 2019

BSCM 101: GENERAL MICROBIOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

History of Microbiology, Origin and evolution of life, Contribution of Pioneers with special reference to Leeuwenhoek, Pasteur, Jenner and Koch, Contribution of Indian microbiologists.

Unit-II

Scope of Microbiology, Microbiology of human health (short description of causal agent, pathogenesis and diagnosis of Typhoid, Cholera, Influenza, Herpes, Malaria and Ringworm), General account of beneficial and harmful Microbes.

Unit-III

Prokaryotic and Eukaryotic cell, Classification of bacteria: phylogenetic and phenetic classification, numerical taxonomy, Hierarchical taxa, Nomenclature and taxonomy of bacteria, , General account of cyanobacteria and archaebacteria.

Unit-IV

General properties of virus, Classification of virus, ICTV-scheme for viral classification based on genome, morphology and host properties, Identification of Viruses, General account of bacteriophages: structure, replication and transmission.

Unit-V

Classification and general account of algae, Structure and reproduction of, *Euglina*, *Volvox*, *Laminaria* and *Fucus*. Classification and general account of fungi, Structure and reproduction of Slime moulds, *Mucor*, *Synchytrium*, *Curvularia*, *Aspergillus*, *Penicillium*.

BSCM 102: MICROBIAL STRUCTURE AND GROWTH

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

Structure and organization of bacteria, Capsule, cell wall, cytoplasmic membrane, nucleoid, Ribosome, endospores, cytoplasmic inclusions, flagellum, pilli, protoplast and spheroplast, binary fission. Gram positive and negative bacteria, staining techniques; simple and differential.

Unit-II

Structure of viruses, symmetry, nucleocapsid, envelop, nature of nucleic acids in viruses, general methods for cultivation of viruses, Viroids and Prions.

Unit-III

Microbial Growth and multiplication; Growth curve and kinetics of bacteria, nutritional requirements, culture media, factors affecting growth; Physical and chemical measurement of Microbial growth. Chemostat and turbidostat.

Unit-IV

Nucleic acid; types, structure and function. Plasmids; col, F and R plasmid. Transposons. Types of DNA; A, B, Z. Types of RNA; mRNA, tRNA, rRNA.

Unit-V

Pure cultures of bacteria, isolation methods, control of growth of microorganisms, Sterilization, disinfection, antisepsis, Physical and chemical methods of control, autoclave, hot air oven techniques, antibiotics etc and preservation of microbial culture.

BSCM 103: MICROBIAL BIOCHEMISTRY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

Biochemistry of Microbes: Chemical elements, Structure of atoms, Molecules and chemical bonds, Chemical reactions, Molecules of living systems. Concepts of thermodynamics; Enthalpy, Entropy, Gibb's free energy.

Unit-II

Structure, classification and functions of: Carbohydrates (mono, di, and polysaccharides), Lipids (fatty acids; (saturated, unsaturated) and glycerides), Amino acids and proteins (Primary, secondary and tertiary).

Unit-III

Structure, classification and functions of nucleotides, nucleic acids. Brief outline of nucleotide biosynthesis.

Unit-IV

Biochemistry of enzymes: Classification specificity; Lock and Key model and induced fit model, isolation, purification; chromatographic methods. Kinetics; Michaelis-Menten equation, Lineweaver-Burk equation and inhibition; Competitive, Uncompetitive and Mixed. Allosteric Enzymes.

Unit-V

Major catabolic pathways; Embden-Meyerhof pathway, Entner-Doudoroff pathway, Krebs cycle, Electron transport chain. Gluconeogenesis. Oxidative and substrate level phosphorylation.

PRACTICALS:

1. Introduction of Microbiology laboratory.
2. Study of Microscope
3. Sterilization techniques.
4. Preparation of culture media.
5. Isolation of bacteria using spread plate and streak plate method.
6. Culture of non-pathogenic and pathogenic bacteria.
7. Determine pH of a solution using pH meter.
8. Buffer preparation.
9. Enumeration of bacterial culture by serial dilution and plating.
10. Preparation of smear.
11. Simple staining.
12. Gram staining

13. Estimation of Carbohydrates (Glucose).
14. Estimation of Lipids.
15. Estimation of Proteins.
16. Identification of Fungal and Algal microbes.

Marking schemes:

There shall be a practical examination of five hours duration and the distribution of marks shall be as follows:

| Students | Regular Ex. | |
|---|--------------------|-----------|
| 1. Culture, Staining and identification of non pathogenic and pathogenic bacteria | 10 | 15 |
| 2 Identification of Fungal and algal Microbes | 10 | 10 |
| a. Estimation of Glucose/Proteins/fats | 05 | 10 |
| b. Enumeration of bacterial numbers | 05 | 05 |
| 3. Spotting's-(10) | 15 | 15 |
| 4. Viva-Voce | 10 | 10 |
| 5. Practical Record | 10 | - |
| Total | 65 | 65 |

Reference:

1. Ronald M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Llonas Miller (1986). Basic Experimental Microbiology Prentics Hall.
2. Robert F. Boyed (1964) General Microbiology. Times Mirror/Mobsey/College Pub.
3. Pelczer MJ: Chan ECS and krieg NR Microbiology Fifth Education.
4. P.D. Sharma 2000: Microbiology. Rastogi Publications.
5. Alcamo IE 967. Fundamentals of microbiology 2nded. The Benjamin/ Cummings Publishing Co. Inc. California.
6. Norton CF 1986. Microbiology 2nded. The Benjamin/Cummings Publishing Col. Inc. California.
7. Wilinon JF 1986, Introduction to Microbiology (Basic Microbiology series Vol. 1) 3rd ed. Black Well, Oxford

B.Sc. Part- II Examination, 2020

Scheme:

| Theory | Duration | Max | Min.Pass |
|--|------------------|------------|-----------------|
| Paper 1 | 3 Hrs. | 45 | 16 |
| Paper 2 | 3 Hrs. | 45 | 16 |
| Paper 3 | 3 Hrs. | 45 | 16 |
| | Aggregate | 48 | |
| Practical Based On Paper I,II and III 5 Hrs. | | 65 | 24 |

BSCM 201:MOLECULAR BIOLOGY AND MICROBIAL GENOMICS

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

History and concepts of Molecular Biology, Early history of Genetic engineering, Ethical issues, Structure and Properties of DNA and RNA.

Unit-II

Concepts of Central Dogma, DNA replication, Transcription, Translation, Genetic code, Reverse Transcription, Gene Regulation in Prokaryotes; lac operon and tryp operon.

Unit-III

Gene mutation, DNA Damage and Repair mechanism. Restriction endonucleases; , types, properties and uses. Cloning, PCR; types, functions. Taq polymerase, RFLP, RAPD.

Unit-IV

Methods of DNA, sequencing, DNA finger and foot printing, Genomic libraries, Gene cloning and cloning vectors (Plasmids and cosmids). Applications of genetic engineering.

Unit-V

Bacterial Genetics-Conjugation, transformation and transduction, Transposons, Lytic and Lysogenic development of T4 Phage and Phage λ (lambda).

BSCM 201: BIO-INSTRUMENTATION AND METHODOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

Microscopy- Principle and applications of bright field, Dark field, Phase contrast and Electron microscope.

Unit-II

Principle and applications of Colorimetry, Spectrophotometry, Nephelometry, Flame photometry, Electrophoresis; Horizontal and vertical. Isoelectric focusing.

Unit-III

Principle and applications of Paper Chromatography, Thin layer Chromatography, Adsorption Chromatography, ion exchange Chromatography, Affinity Chromatography and HPLC.

Unit-IV

Principle and applications of centrifugation, gradient, isopycnic, ultra centrifugation. Microfiltration and Ultrafiltration.

Unit-V

Application of computers in Microbiology-Taxonomy and Laboratory. Bioinformatics- Introduction, Primary and Secondary databases, Sequence elucidation for proteins and DNA by software. BLAST AND FASTA

BSCM 203: SOIL AND AGRICULTURAL MICROBIOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

Microscopy- Principle and applications of bright field, Dark field, Phase contrast and Electron microscope.

Unit-II

Principle and applications of Colorimetry, Spectrophotometry, Nephelometry, Flame photometry, Electrophoresis; Horizontal and vertical. Isoelectric focusing.

Unit-III

Principle and applications of Paper Chromatography, Thin layer Chromatography, Adsorption Chromatography, ion exchange Chromatography, Affinity Chromatography and HPLC.

Unit-IV

Principle and applications of centrifugation, gradient, isopycnic, ultra centrifugation. Microfiltration and ultrafiltration.

Unit-V

Application of computers in Microbiology-Taxonomy and Laboratory. Bioinformatics- Introduction, Primary and Secondary databases, Sequence elucidation for proteins and DNA by software. BLAST AND FASTA

PRACTICALS

1. Introduction of Microbiological Instruments.
2. Verification of Lambert- Beer law
3. Assessment of phosphate solubilizing activity of microbes.
4. Staining of bacteria- Spore and negative.
5. Isolation of Microorganisms from soil.

6. Isolation of Rhizospheremicroflora.
7. Study of Phylloplanemicroflora (leaf impression method).
8. Preparation of slides of N-fixing bacteria from root nodules.
9. Preparation of Buffers.
10. Preparation of Agarose gel Electrophoresis for DNA separation.
11. Paper chromatographic estimation of amino acid and plant pigments.
12. Calculation of pH of given sample using pH meter.
13. Identification of VAM.
14. Nucleic acid estimations.
15. Introduction to BLAST and FASTA.
16. Thin layer chromatography of amino acids and plant pigments.

Marking schemes:

There shall be a practical examination of five hours duration and the distribution of marks shall be as follows:

| Students | Regular | Ex. |
|-------------------------------------|----------------|------------|
| 1. Experimental work (Major) | 10 | 20 |
| 2. Experimental work (Minor) | 10 | 10 |
| 3. Chromatographic separation | 10 | 10 |
| 4. Spotting (three from each paper) | 15 | 15 |
| 5. Viva-Voce | 10 | 10 |
| 6. Practical Record | 10 | -- |
| Total | 65 | 65 |

Reference:

1. Ronald M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Llonas Miller (1986). Basic Experimental Microbiology Prentics Hall.
2. Robert F. Boyed (1964) General Microbiology. Times Mirror/Mobsy/College Pub.
3. Pelczer MJ: Chan ECS and krieg NR Microbiology Fifth Education.
4. P.D. Sharma 2000: Microbiology. Rastogi Publications.
5. Alcamo IE 967. Fundamentals of microbiology 2nded. The Benjamin/ Cummings Publishing Co. Inc. California.
6. Norton CF 1986. Microbiology 2nded. The Benjamin/Cummings Publishing Col. Inc. California.
7. Wilinon JF 1986, Introduction to Microbiology (Basic Microbiology series Vol. 1) 3rd ed. Black Well, Oxford

B.Sc. Part- III Examination, 2021

Scheme:

| Theory | Duration | Max | Min.Pass |
|---------------|-----------------|------------|-----------------|
| Paper I | 3 Hrs. | 45 | 16 |

| | | | |
|---------------------------------------|------------------|----|-----------|
| Paper II | 3 Hrs. | 45 | 16 |
| Paper III | 3 Hrs. | 45 | 16 |
| | Aggregate | | 48 |
| Practical Based On Paper I,II and III | 5 Hrs. | 65 | 24 |

BSCM 301: INDUSTRIAL AND APPLIED MICROBIOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45 **Duration: 3 Hrs**
Minimum Passing Marks: 16

Unit-I

General concepts of Industrial microbiology, Industrial strains, their sources, strategies for selection, improvement and maintenance, types of fermentation, Substrates for industrial fermentation, recent developments in industrial microbiology.

Unit-II

Design of a fermenter instrumentation and control, immobilization methods, adsorption, covalent linkages: advantages and disadvantages. Methods for recovery and purification of fermentation products (Downstream processing)

Unit-III

Food microbiology-Role of microbes in preparation of Sauerkraut, bread and pickles, Preservation of food, Sources of food spoilage, Food infection and intoxication, control of food borne microorganism, food adulteration and legislation, Microbes as food: Single cell protein, Mushroom production.

Unit-IV

Industrial production of organic acid (Lactic acid), Enzymes (Amylase), Alcohol (Ethanol), Antibiotics (Penicillin), Microbiology of milk, Preservation of milk and milk products, Production of fermented dairy Products-Acidophilus milk, cheese, yogurt.

Unit-V

Microbial production of vitamins-Riboflavin, Vaccines: genetic and recombinant vaccines, Alcoholic beverages (beer and wine), Vinegar, Bio-gums, Bio-chips and Bio-plastics, Intellectual Property rights in industrial microbiology.

BSCM 302: PARASITOLOGY AND CLINICAL MICROBIOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45 **Duration: 3 Hrs**
Minimum Passing Marks: 16

Unit-I

Parasitology-General concepts and protozoology : Introduction to parasitology classification- Host parasite relationships, mechanism of pathogenesis, transmission and life cycles of protozoa: *Entamoeba*, *Leishmania*, *Trypanosoma*, *Giardia* and *Plasmodium*.

Unit-II

Laboratory techniques in Parasitology: examination of feces for ova and cysts-worm burden, concentration methods, floatation and sedimentation techniques, staining by iron haematoxylin method, blood smear examinations- thick /thin smears, cultivation of protozoan parasites.

Unit-III

Brief account of diseases caused by certain specific pathogens: *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Mycobacterium tuberculosis*, *Salmonella typhi*, *Vibrio cholerae*, HIV, Hepatitis virus. Collection and transport of appropriate clinical samples for diagnosis.

Unit-IV

Elements of chemotherapy, Principles, drugs microbes-host interaction, basic mechanism of drug action, drug resistance, major antimicrobial agents rapid test for antimicrobial susceptibility, general principles and clinical use of antimicrobial drugs.

Unit-V

Animal diseases: Epidemiology symptoms and diagnosis of Anthrax, foot and mouth diseases, Brucellosis, salmonellosis , disease of silkworm, Mastitis and hog cholera.

BSCM 303: VIROLOGY, SEROLOGY AND IMMUNOLOGY

Scheme of Examination

The question paper is divided into three Sections: A, B & C. Section A will consist of 10 questions (2 questions from each unit). Section B will consist of 10 questions (2 questions from each unit). Section C will consist of 5 questions (1 question from each unit)

Maximum Marks: 45

Duration: 3 Hrs

Minimum Passing Marks: 16

Unit-I

General Virology: brief outline on discovery of viruses, Nomenclature and classification, distinctive properties of viruses, morphology and ultra-structure, viroid

Unit-II

General methods of diagnosis and serology:- Haemagglutination, complement fixation, immunofluorescence methods, ELISA and radioimmunoassay.Cultivation of viruses, and plaque assay.

Unit-III

Historical background of immunology, innate and acquired immunity, humoral and cell mediated immunity, Organs and cells involved in immune response. T and B-cells.Antigens; Types and characteristics.

Unit-IV

Humoral immune response, immunoglobulin structure and properties, Monoclonal antibodies, antigen-antibody reactions, complement system.

Unit-V

Characteristics of T-cell and types of T-cell, cytokines, Hypersensitivity and its types, mechanism. Autoimmune diseases.

PRACTICALS

2. Acquaintance with Microbiology laboratory rules.
3. Preparation of different types of culture media for growing pathogenic microbes.
4. Study of Bacterial growth curve.
5. Study of slides of important pathogens.
6. Isolation of micro-organisms from sewage samples.
7. Alcohol production on laboratory scale by microbes.
8. Yogurt preparation by lactic acid bacterial.
9. Isolation and identification of common microorganisms spoiling food.
10. Preparation of fermented food (sauerkraut).
11. Determination of antibiotic resistance of bacteria.
12. Blood cell counting by Haemocytometer.
13. Determine the blood group of Human blood sample.
14. Demonstration of antigen-antibody interactions.
15. Enzyme linked immunoassay.

Marking schemes:

There shall be a practical examination of five hours duration and the distribution of marks shall be as follows:

| Students | Regular | Ex. |
|--|-----------|-----------|
| 1. Experimental work (Major) | 12 | 20 |
| 2. Experimental work (Minor) | 08 | 10 |
| 3. | | |
| a. Blood cell counting by haemocytometer | 05 | 05 |
| b. Determine the blood group of human blood sample | 05 | 05 |
| 4. Spotting's- (two from each paper) | 15 | 15 |
| 5. Viva-Voce | 10 | 10 |
| 6. Practical Record | 10 | -- |
| Total | 65 | 65 |

Reference:

1. Ronald M. Atlas, Alfred E. Brown, Kenneth W. Dobra, Llonas Miller (1986). Basic Experimental Microbiology Prentics Hall.

2. Robert F. Boyed (1964) General Microbiology. Times Mirror/Moby/College Pub.
3. Pelzor MJ: Chan ECS and krieg NR Microbiology Fifth Education.
4. P.D. Sharma 2000: Microbiology. RastogiPubactions.
5. Alcamo IE 967. Fundamentals of microbiology 2nded. The Benjamin/ Cummings Publishing Co. Inc. California.
6. Norton CF 1986. Microbiology 2nded. The Benjamin/Cummings Publishing Col. Inc. California.
7. Wilinson JF 1986, Introduction to Microbiology (Basic Microbiology series Vol. 1) 3rd ed. Black Well, Oxford.