

**PROCEEDINGS OF THE MEETING OF B.O.S. (UG) IN MICROBIOLOGY AND  
BIOTECHNOLOGY**

The meeting of the B.O.S. (UG) in Microbiology and Biotechnology was held on **18<sup>th</sup> June, 2014** in the Department of Microbiology and Biotechnology, Bangalore University, Bangalore. At the outset, the Chairman welcomed the members and initiated the proceedings.

Agenda-1

The Credit Based Semester Scheme for B.Sc. in Microbiology and Biotechnology, the Syllabus (theory and practical) and Scheme of examination for I, II, III & IV Semesters were finalized and approved.

Agenda-2

The panel of examiners for UG Microbiology and Biotechnology (both external and internal) was modified and approved for the year 2014-15.

Agenda-3

The B.O.S. approved the list for the formation of B.O.E. (UG) in Microbiology and Biotechnology for the year 2014-15.

The meeting concluded with the Chairman thanking all the members for their co-operation.

Members present:

1. Dr. Shastri P. S
2. Dr. Jyotsna B. S
3. Dr. Bharathi
4. Smt. Pushpalatha. T
5. Dr. Vijaya. B
6. Dr. ShanthiIyer
7. Dr. S.K. Sarangi

**B.Sc. CREDIT BASED SEMESTER SCHEME  
MICROBIOLOGY (PART 2)  
SCHEME OF INSTRUCTIONS AND CREDITS**

Paper No.	Title of the paper	Type of paper	Hours/Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
<b>I Semester</b>								
MBT-101	Basic Microbiology	T	4	3	30	70	100	2
MBP-102	Basic Microbiology	P	3	3	15	35	50	1
<b>Total Marks and Credits for I semester</b>							150	3

Paper No.	Title of the paper	Type of paper	Hours/Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
<b>II Semester</b>								
MBT-201	Microbial Taxonomy & Culture Techniques	T	4	3	30	70	100	2
MBP-202	Microbial Taxonomy & Culture Techniques	P	3	3	15	35	50	1
<b>Total Marks and Credits for II semester</b>							150	3

Paper No.	Title of the paper	Type of paper	Hours/Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
<b>III Semester</b>								
MBT-301	Microbial Physiology & Microbial Genetics	T	4	3	30	70	100	2
MBP-302	Microbial Physiology & Microbial Genetics	P	3	3	15	35	50	1
<b>Total Marks and Credits for III semester</b>							150	3

<b>Paper No.</b>	<b>Title of the paper</b>	<b>Type of paper</b>	<b>Hours/ Week</b>	<b>Duration of Exam (Hours)</b>	<b>IA</b>	<b>Exam</b>	<b>Total Marks</b>	<b>Credits</b>
<b>IV Semester</b>								
MBT-401	Molecular biology and Recombinant DNA Technology	T	4	3	30	70	100	2
MBP-402	Molecular biology and Recombinant DNA Technology	P	3	3	15	35	50	1
<b>Total Marks and Credits for IV semester</b>							150	3

<b>Paper No.</b>	<b>Title of the paper</b>	<b>Type of paper</b>	<b>Hours/ Week</b>	<b>Duration of Exam (Hours)</b>	<b>IA</b>	<b>Exam</b>	<b>Total Marks</b>	<b>Credits</b>
<b>V Semester</b>								
MBT-501	Agricultural & Environ. Microbiology	T	4	3	30	70	100	2
MBT-502	Food & Dairy Microbiology	T	4	3	30	70	100	2
MBP-503	Agricultural & Environ. Microbiology	P	3	3	15	35	50	1
MBP-504	Food & Dairy Microbiology	P	3	3	15	35	50	1
<b>Total Marks and Credits for V semester</b>							300	6

Paper No.	Title of the paper	Type of paper	Hours/Week	Duration of Exam (Hours)	IA	Exam	Total Marks	Credits
<b>VI Semester</b>								
MBT-601	Immunology & Medical Microbiology	T	4	3	30	70	100	2
MBT-602	Industrial Microbiology & Microbial Technology	T	4	3	30	70	100	2
MBP-603	Immunology & Medical Microbiology	P	3	3	15	35	50	1
MBP-604	Industrial Microbiology & Microbial Technology	P	3	3	15	35	50	1
<b>Total Marks and Credits for VI semester</b>							300	6

**Internal assessment:**

**Theory : (30)**

- (a) Tests – 10
- (b) Assignments - 15
- (c) Attendance - 05

**Practical : (15)**

- (a) Tests – 10
- (b) Class Records - 05

# Syllabus for B.Sc. MICROBIOLOGY

(Credit Based Semester Scheme)

## SEMSESTER-I

### MBT 101- BASIC MICROBIOLOGY

Total hours:52.

#### Unit 1. Introduction, History and Scope of Microbiology

1. Microbes and origin of life 10 Hour
2. History and scope of Microbiology as a modern science.
3. Branches of Microbiology
4. Contribution of Scientists to the field of Microbiology- Antony Von Leewenhoek, Edward, Jenner, LazaroSpallanzani, Louis Pasteur, Joseph Lister, Robert Koch, Alexander Flemming and Iwanovsky.

#### Unit 2. Instruments used in Microbiology

8 Hours

##### Microscopy

1. Principles of Microscopy- resolving power, numerical aperture, working distance and magnification.
2. Principles of photomicrography.
3. Working principles and applications of
  - a) Dark field microscope
  - b) Phase contrast microscope
  - c) Fluorescence Microscope
  - e) Electron Microscopy- TEM and SEM

#### Unit 3. Analytical techniques

5 Hours

Working principles and applications of – Centrifuge, Ultracentrifuge, Spectrophotometer, Chromatography (Paper and TLC).

#### Unit 4. Stains and Staining Techniques

7 Hours

1. Nature of dyes
2. Physical and chemical theories of staining
3. Staining techniques –principle, procedure and applications of
  - a) Simple staining – negative staining
  - b) Differential Staining- Grams and acid fast staining
  - c) Structural staining – cell wall, endospore, flagella and capsular staining

#### Unit 4. Sterilization Techniques

12 Hours

1. Definition of terms-sterilization, disinfectant, antiseptic, sanitizer, germicide, microbicidal agents, micro biostatic agents and antimicrobial agent.
2. Evaluation antimicrobial chime agents-Tube dilution and agar plate techniques-well method and disk plate method.
- 3.Physical methods of control-Principle, construction and application of most heat sterilization Boiling, Pasteurization, Fractional sterilization-Tyndallization and Moist heat under pressure autoclave. Dry heat sterilization-Incineration and hot air oven. Filtration –Diatomaceous earth filter, seitz filter, membrane filter and laminar air flows Radiation Ionizing radiation y rays and non-ionizing radiation- UV-rays
4. Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, Quaternary ammonium compounds and sterilizing gases as antimicrobial agents. Selection of a chemical agent for practical applications.

## Unit 5. Antibiotics and other chemotherapeutic agents

10 Hours

1. Definition and classification of antibiotics.
2. Characteristics of antibiotics that qualify them as chemotherapeutic agents.
3. Mode of action of antimicrobial agents- a brief account.
4. Antimicrobial spectrum of antibiotics and mode of action of the following antibiotics
  - a) **Antibacterial**- Penicillins, Cephalosporins, Bacitracin, Polymyxins, Streptomycin, chloramphenicol, tetracyclines and Vancomycin
  - b) **Antifungal**- Nystatin and cyclohexamide
  - c) **Antiviral**- Acyclovir (nucleoside)
  - d) **Synthetic** Chemotherapeutic agents- Nalidixic acid
5. Development of Resistance to antibiotics- a brief account.

## SEMESTER I

### MBP 102- BASIC MICROBIOLOGY

*Total Units: 15*

1. Safety measures in Laboratory. 1 unit
2. Study of compound microscope- Construction, working, principle, care to be taken while using the microscope. Use of oil immersion objective. 1 unit
3. Study of instruments-Autoclave, hot air oven. Laminar air flow bench, calculation of NA (Numerical Aperture), RP (Resolving Power) and colony counter, inoculation loop and needle, Incubator, centrifuge, pH meter, Seitz filter, membrane filter and colorimeter/spectrophotometer. 4 units
4. Cleaning and sterilization of glassware. 2 units
5. Study of aseptic techniques-preparation of cotton plugs for test tubes and pipettes, wrapping of petri-plates and pipettes, transfer of media and inoculum. 2 units
6. Staining of bacteria-
  - a) Simple staining methylene blue staining
  - b) Gram staining
  - c) Structural staining-cell wall, endospore staining and capsule staining 5 unitsStudents have to submit of 3 bacterial slides (permanent) for the examination.

### Practical Examination Scheme

(35 marks)

#### Major:

Staining techniques/Microscopy/Sterilization

(20 marks)

#### Minor:

Media formulation/Analytical techniques/Temporary slides/Spotters

(15 marks)

**Record:**To be submitted

### REFERENCES:

1. Aneja K.R. Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New Age International, New Delhi.
2. Atlas R.M. *Microbiology- Fundamentals and applications*, Macmillan Publishing Company, New York.

3. Benson Harold J. Microbiological Application, WCB McGraw-Hill of India Private Limited.
4. Brock T.D. and Madigan M.T, *Biology of Microorganisms*, Prentice Hall of India Private Limited.
5. Narayanan P., *Essentials of Biophysics*, New Age International, New Delhi.
6. Pelczar M.J., Chan E.C.S. and Krieg N.R., *Microbiology*, McGraw Hill Book Company, New York.
7. Prescott Lansing M., Harley John P. and Klein Donald A., *Microbiology*, WCBMcGraw-Hill New York.
8. Salle A.J. *Fundamental Principles of Bacteriology*, Tata McGraw-Hill Publishing Company Limited, New Delhi.
9. Stanier R.Y., Ingraham J.L., *General Microbiology*, Prentice Hall of India Private Limited, New Delhi.

## **SEMSESTER-II**

### **MBT 201 – MICROBIAL TAXONOMY AND CULTURE TECHNIQUES**

*Total hours: 52.*

#### **Unit 1. The Microbial World-The study of various groups of microorganisms.**

1. Study of Viruses 19 Hours
  - a) Early developments of virology
  - b) Principles of viral taxonomy
  - c) General structure and properties of viruses
  - d) Virus Purification and assay
  - e) Study of Cyanophages and Mycophages
  - f) Structure, reproduction, cultivation and significance of Bacteriophage (T4 and lambda)  
Plant viruses (TMV)  
Animal viruses (HIV and Herpes Virus)
  - g) Prions and Virioids – Nature and significance
2. Comparison of the three domains of organisms: Bacteria, Archaea, Eucarya (tabular and diagrammatic)
3. Study of Bacteria
  - a) Size, Shape and arrangement of bacterial cells
  - b) Fine structure, composition and function of Eubacterial cell wall, cell membrane, cytoplasm, nucleoside, flagella, Pili/fimbriae, slime layer, capsule, spores and cysts
  - c) Classification of Bacteria-Brief account of major characteristics used in bacterial classification.
4. a. Classification, Morphology, Cultivation, Reproduction and significance of:
  - i) Rickettsia
  - ii) Chlamydia
  - iii) Mycoplasma
  - iv) Actinomycetes
  - b. General characteristics, classification, cell structure and reproduction of Cyano bacteria (type study of Anabaena and Spirulina). Parallelism between bacteria and cyano bacteria
  - c. Brief account of Archaea
  - d. Fungi – Ultrastructure of fungal cell. Salient features, classification, reproduction and significance of major groups of fungi (phycomycetes, Ascomycetes, Basidiomycetes, and

Deuteromycetes).

Type study of Rhizopus, Aspergillus, Penicillium, Yeast, Agaricus and Fusarium.

e. Protozoa-General features, classification and significance. 18 Hours

## Unit 2. Culturing of microorganisms

1. Culture media-Synthetic and non-Synthetic-solid, liquid and semi-solid media, Special Media. Enriched, selective, transport, differential, maintenance and enrichment media.
2. Methods of isolation of bacteria, fungi-Serial dilution, pour plate, spread plate and streak plate.
3. Maintenance of pure cultures.
4. Cultivation of anaerobic bacteria-Anaerobic jar method.

## Unit 3 Microbial growth 15 Hours

1. Nutritional requirements of microorganisms-Macronutrients, micronutrients and growth factors. Nutritional types of microorganisms: Autotrophs and heterotrophs, phototrophs and chemotrophs.
2. Physical factors affecting growth of microorganisms: Temperature, pH and Oxygen.
3. Multiplication in bacteria-binary fission, budding and fragmentation.
4. Bacterial growth curve, synchronous growth.
5. Continuous cultivation-chemostat and turbidostat
6. Counting of bacteria-Viable count- SPC, Total count-DMC and turbidimetric estimation.

## SEMESTER II

### MBP202-MICROBIAL TAXONOMY AND CULTURE TECHNIQUES

*Total units: 15*

1. Preparation of media- Nutrient broth, Nutrient agar, Martin's Rose Bengal medium, Sabouraud's Agar. 2 units
2. Isolation of Bacteria and Fungi from soil 2 units
  - a) Preparation of serial dilutions.
  - b) Spread plate and pour plate techniques.
  - c) Streaking techniques for isolation and purification of Bacteria.
  - d) Study of colony characteristics of Bacteria.
  - e) Identification of Bacteria and Fungi.
3. Motility of Bacteria by hanging drop technique. 1 unit
4. Measurement of size of cells by micrometry 2 units
5. Counting of yeast cells and fungal spores using Haemocytometer. 2 units
6. Study of fungi-identification of fungi by tease-mount method using Lactophenol cotton blue 1 unit
7. Type study of Aspergillus, Pencillium, Yeast, Rhizopus and Fusarium (Specimens) 2 units
8. Demonstration of slide culture technique of fungi. 2 units
9. Study of protozoa- Amoeba, Paramaecium and Euglena. (Permanent slides)
10. Study of Blue green algae- Anabena and Spirulina. (Specimens) 1 unit

Students have to submit of two fungal and the Blue-green algae slide (permanent) for the examination.



## **Practical Examination Scheme**

(35 marks)

### **Major:**

Cell count/Motility/ Isolation techniques/Morphological characteristics

(20 marks)

### **Minor:**

Media formulation/Media components/Temporary slides/Spotters

(15 marks)

**Record:**To be submitted

### **References:**

1. Alexopoulos C.J. and Mims C.W., Introductory Mycology, New age International, New Delhi.
2. Aneja K.R., Experiments in Microbiology, Plant pathology, Tissue culture and Mushroom cultivation, New age International, New Delhi.
3. Atlas R.M., Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson Harold J., Microbiological Applications, WCB McGraw- Hill New York.
5. Bold H.C. and Wynne M.J., Introduction to Algae, Prentice Hall of India Private Limited New Delhi
6. Brock T.D. and Madigan M.T., Biology of Microorganisms, Prentice Hall of India Private Limited.
7. Mehrotra R.S. and Aneja K R., An Introduction to Mycology, New Age International, New Delhi.
8. Pelczar M J., Chan E.C.S. and Klein Donald A., Microbiology, McGraw Hill Book Company, New York.
9. Prescott Lansing M., Harley John P. and Klein Donald A., Microbiology, WCB McGraw-Hill New York.
10. Salle A J., Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Stanier R. Y., Ingraham J.L., General Microbiology, Prentice Hall of India Private Limited, New Delhi.

## SEMESTER III

### MBT301 – MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

Total hours: 52

#### Unit 1. Microbial Physiology 32 Hours

1. Biomolecules – A brief account of the properties, classification and importance of carbohydrates, lipids and proteins. 3 Hours
2. Enzymes – Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes. 5 Hours
3. Bioenergetics – Free energy, ATP and its production, other high energy compounds. 3 Hours
4. Oxidation – Reduction reactions. 1 Hour
5. Energy yielding processes – Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H. 10 Hours
6. Fermentation – Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo, acetic acid, propionic acid, butyric acid, mixed acid and butanediol fermentation. 6 Hours
7. Bacterial photosynthesis – photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. 4 Hours

#### Unit – 2 Genetics

20 Hours

1. Genomic organisations in prokaryotes and eukaryotes. 2Hours
2. Nucleic acids: Chemical compositions of DNA & RNA, Watson & Crick model of DNA, Types of DNA: A,B,Z and H, Supercoiling of DNA . 3 Hours.
3. DNA replication in Prokaryotes : Semi, Coservative methods, Rolling circle model, origin of replication , , Primers and templates, replication fork, unidirectional and bidirectional (Theta model). 4 Hours.
4. Genetic recombination in bacteria: Conjugation, F<sup>+</sup> vs F<sup>-</sup> , Hfr + vs F<sup>-</sup>, F<sup>-</sup> vs F<sup>-</sup>, transformation: griffith's experiment and mechanism, transduction: generalized and specialized. 4 Hours.
5. Mutations- Molecular basis of mutation, spontaneous and induced mutations, detection and isolation of mutants (Replica plate method). 6 Hours.
6. Transposable elements – a brief account 1Hours.

## SEMESTER III

### MBP 302- MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS

Total units: 15

- |   |         |
|---|---------|
| 1. Determination of growth curve for fungi by colony diameter method.     | 2 units |
| 2. Biochemical tests used for the identification of bacteria.             | 8 units |
| a) IMViC  |         |
| b) Fermentation of glucose, sucrose, and lactose- acid and gas production |         |
| c) Mannitol motility test   |         |
| d) Starch hydrolysis  |         |
| e) Gelatin liquefaction test  |         |
| f) Catalase test  |         |
| g) Oxidase test   |         |
| 3. Estimation of reducing sugar glucose - by DNS method                   | 1 unit  |
| 4. Estimation of protein by Lowry's method                                | 1 unit  |
| 5. Effect of pH and temperature on bacterial growth                       | 2 units |
| 6. Charts on genetic recombination in bacteria                            | 1 unit  |
| Conjugation- $F^+$ v/s $F^-$ , $Hfr^+$ v/s $F^-$ , $F^-$ v/s $F^-$        |         |
| Transformation- Griffith's experiment and mechanism                       |         |
| Transduction- generalized and specialized                                 |         |

#### Practical Examination Scheme

(35 marks)

#### Major:

Estimation of Biomolecules

(20 marks)

#### Minor:

Growth curve/Biochemical tests/Spotters

(15 marks)

**Record:** To be submitted

#### REFERENCES:

1. Freifelder David, *Microbial Genetics*, Narosa Publishing House, New Delhi.
2. Gerald Karp, *Cell Biology*, McGraw Hill Book Company, New York.
3. Moat, A.G. and Froster, S.W., *Microbial Physiology*, John Wiley and Sons, New York.
4. Nelson David L. and Cox Michael M., *Lehninger Principles of Biochemistry*, MacMillan Press/Worth Publishers, New Delhi.
5. Pelczar, M.J., Chan, E.C.S. and Krieg, N.R., *Microbiology*, McGraw Hill Book Company, New York.
6. Prescott Lansing M., Harley John, P. and Klein Donald A., *Microbiology*, WCB McGraw-Hill, New York.
7. Salle, A.J., *Fundamental Principles of Bacteriology*, Tata McGraw-Hill Publishing Company Limited, New Delhi.
8. Stanier, R.Y., Ingraham, J.L., *General Microbiology*, Prentice Hall of India Private Limited, New Delhi.
9. Stickberger, M.W., *Genetics*, Prentice Hall of India Private Limited, New Delhi.
10. Voet, D. and Voet, J.G., *Biochemistry*, John Wiley and Sons, New York.

## SEMSESTER-IV

### MBT 401– MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

Total hours: 52.

#### Unit 1. Molecular Biology

20 Hours

1. Types of RNA and their functions. 3 Hours
2. Protein Synthesis in Prokaryotes- Ribosomes, types of RNA involved transcription, translation, and mechanism of protein synthesis, and protein inhibitors. 6 Hours
3. Gene Structure and expression. 4 Hours
4. Regulation of gene expression in prokaryotes- The operon concept, Induction and repression, The lac operon. Tryptophan operon, Catabolic repression and Attenuation. 7 Hours

#### Unit 2. Recombinant DNA technology

32 Hours

1. History and fundamentals of r-DNA technology 1 Hour
2. Tools for r-DNA technology-DNA manipulative enzymes. Restriction enzymes, Ligases and other DNA modifying enzymes 4 Hours
3. Gene cloning vectors-Salient features, Plasmids- properties, types pBR322 and pUC18 and pUC18 series vectors, bacteriophages-  $\lambda$  and M 13, Cosmids-properties. 6 Hours
4. Vectors for plants: *Agrobacterium tumifaciens* 2 Hour
5. Vectors for Animals: SV 40 1 Hour
6. In vitro construction of r-DNA molecules: Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). 1 Hour
7. Cutting of DNA molecules- Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters. 2 Hour
8. Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, *Agrobacterium* mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment. 4 Hours
9. Screening and selection of recombinant host cells: Insertional inactivation. *In situ* colony/DNA hybridization, and immunological techniques. 3Hours
10. Molecular Techniques -
  - a) Electrophoresis
  - b) Blotting techniques
  - c) PCR and its applications
  - d) RFLP5 Hours
11. Applications of Genetic Engineering
  - a) Medicine: Gene therapy
  - b) Agriculture: nif gene cloning2 Hours
12. Potential hazards and safe guards of genetic engineering 1 Hour

## SEMESTER-IV

### MBP 402– MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

*Total Units: 15.*

- |  |        |
|--|--------|
| 1. Preparation of buffers-citrate and phosphate buffers.                             | 1unit  |
| 2. Estimation of DNA by Diphenylamine method.  | 1unit  |
| 3. Estimation of RNA by Orcinol method.  | 1unit  |
| 4. Determination of MIC of antimicrobial agents.                                     | 2units |
| 5. Evaluation of antimicrobial antibiotic sensitivity tests-paper disc plate method. | 2units |
| 6. Development of antibiotic resistance in bacteria.                                 | 1unit  |
| 7. Isolation of plasmid DNA from bacteria and separation by gel electrophoresis.     | 2units |
| 8. Restriction digestion of DNA.   | 2units |
| 9. In vitro DNA ligation.  | 2units |
| 10. Charts on genetic engineering.   | 1unit  |
| a) pBR 322   |        |
| b) pUC 18 and 19   |        |
| c) SV 40   |        |
| d) Bacteriophages- Lambda  |        |
| e) Gene cloning  |        |
| f) Selection of recombinants by replica plate technique.                             |        |

#### **Practical Examination Scheme**

(35 marks)

#### **Major:**

Estimation of DNA,RNA/Isolation of Genomic and Plasmid DNA

(20  
marks)

#### **Minor:**

Preparation of Buffers/Digestion/Ligation/Vectors/Antibiotic resistance/Spotters

(15  
marks)

**Record:** To be submitted

#### **REFERENCES:**

1. Gerald Karp, Cell Biology, McGraw Hill Book Company, New York.
2. Nelson David L. and Cox Michael M. Lehninger Principles of Biochemistry, Macmillan Press/Worth Publishers, New Delhi.
3. Pelozar M.J. Chan E.C.S and Krieg N.R. Microbiology McGraw Hill Book Company, New York.
4. Prescott Lansing M. Harley John P. and Klein Donald A. Microbiology, WCB McGraw-Hill New York.
5. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw-Hill Publishing Company Limited, New Delhi.
6. Stanier R.Y. Ingrnam J.L. General Microbiology, Prentice Hall of India Private Limited New Delhi.
7. Watson James D. Recombinant DNA, Scientific American Books, New York.