AC Item No.

# UNIVERSITY OF MUMBAI

## Revised Syllabus for T.Y.B.Sc.
## Program: B.Sc.
## Course: Microbiology (USMB)

(Credit Based Semester and Grading System with effect from the academic year 2018 – 2019)

# PREAMBLE

The Choice Based Credit system was introduced by Mumbai University from 2016 - 2017. The process was initiated by restructuring the F.Y.B.Sc. syllabus and the paper pattern according to the CBCS pattern and its implementation in the same year i.e. 2016 - 17.

This was followed by revision of S.Y.B.Sc. syllabus and paper pattern in the year 2017 - 2018.

The revised S.Y.B.Sc. syllabus gave an opportunity to the Microbiology students to opt for Paper III of any subject other than Microbiology. Likewise S.Y.B.Sc. students of other subjects could opt for Microbiology Paper III. This gave them the option to choose from diversity of applied sciences.

In continuation with this, the T.Y.B.Sc. syllabus is being revised in the year 2018 - 2019. The existing paper pattern will also be accordingly revised.

Keeping in tune with the revised syllabus, the committee has ensured that there is a continuous flow of information and latest advances in the subject imparted to the students. Hence some of the modules of the earlier syllabus have been upgraded, while some new modules have been added to the syllabus in order to bridge the knowledge gap of the learner from S.Y.B.Sc. to T.Y.B.Sc.

The syllabus is aimed at equipping the students with basic knowledge in various branches of Microbiology such as Microbial Genetics, Molecular Biology, Virology, Medical Microbiology, Immunology, Microbial Biochemistry and Industrial Microbiology. Additionally, it also makes students aware of interdisciplinary sciences such as Bioinformatics and Bioinstrumentation.

In all, the students offering Microbiology as a single major subject that is Six units pattern, will study eight courses of theory and practicals compulsory during Semester V and Semester VI together, while students opting for double major subject that is Three units pattern, will have four courses of theory and practicals compulsory during Semester V and Semester VI together.

The courses for six units will comprise of the following:

1) USMB 501 and USMB 601
2) USMB 502 and USMB 602
3) USMB 503 and USMB 603
4) USMB 504 and USMB 604

The courses for three units will comprise of the following:

1) USMB 501 and USMB 601
2) USMB 502 and USMB 602

The approach towards designing this syllabus has been to retain the classic concepts of Microbiology as well as keeping abreast with the latest discoveries in Microbiology and other interdisciplinary fields.

In conclusion, the revised syllabus aims at inculcating a spirit of learning and kindling curiosity towards the subject in the minds of learners, resulting in their pursuit of higher education in Microbiology.

# T.Y.B.Sc. MICROBIOLOGY THEORY

# (SEMESTER V)

| COURSE CODE | TITLE | CREDITS AND LECTURES / SEM |
|---|---|---|
| **USMB501** | **Microbial Genetics** | **2.5 Credits (60 Lectures)** |
| Unit I | DNA Replication | 15 Lectures |
| Unit II | Transcription, Genetic Code & Translation | 15 Lectures |
| Unit III | Mutation and Repair | 15 Lectures |
| Unit IV | Genetic Exchange & Homologous Recombination | 15 Lectures |
| | | |
| **USMB502** | **Medical Microbiology & Immunology: Part - I** | **2.5 Credits (60 Lectures)** |
| Unit I | Bacterial Strategies for Evasion and Study of a Few Diseases | 15 Lectures |
| Unit II | Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological agent, Pathogenesis, Laboratory Diagnosis and Prevention. | 15 Lectures |
| Unit III | General Immunology - I | 15 Lectures |
| Unit IV | General Immunology - II | 15 Lectures |
| | | |
| **USMB503** | **Microbial Biochemistry: Part - I** | **2.5 Credits (60 Lectures)** |
| Unit I | Biological Membranes & Transport | 15 Lectures |
| Unit II | Bioenergetics & Bioluminescence | 15 Lectures |
| Unit III | Methods of Studying Metabolism & Catabolism of Carbohydrates | 15 Lectures |
| Unit IV | Fermentative Pathway & Anabolism of Carbohydrates | 15 Lectures |

| | | |
|---|---|---|
| **USMB504** | **Bioprocess Technology: Part - I** | **2.5 Credits (60 Lectures)** |
| Unit I | Upstream Processing - I | 15 Lectures |
| Unit II | Upstream Processing - II | 15 Lectures |
| Unit III | Fermentation Modes, Equipments and Instruments | 15 Lectures |
| Unit IV | Traditional Industrial Fermentations | 15 Lectures |

**N.B.**

**I. Each theory period shall be of 48 minutes duration. Theory component shall have 240 instructional periods plus 240 notional periods per semester which is equal to 384 learning hours. For theory component the value of One Credit is equal to 38.40 learning hours.**

**II. Each practical period shall be of 48 minutes duration. Practical component shall have 240 instructional periods plus 60 notional periods per semester which is equal to 240 learning hours. For practical component the value of One Credit is equal to 40 learning hours.**

# T.Y.B.SC. MICROBIOLOGY THEORY (SEMESTER V)

# MICROBIAL GENETICS (USMB-501)

## LEARNING OBJECTIVES

**Microbial Genetics (USMB-501)** is a course in Genetics for T.Y.B.Sc. undergraduate students in Semester V that deals with various concepts of Genetics.

The learning objectives include the following:

1. **DNA Replication:** The learner will understand the events occurring in both Prokaryotic and Eukaryotic DNA replication, with a focus on the involvement of Proteins and Enzymes at the cellular level. The topic will also include the assembly of Eukaryotic chromosome.
2. **Transcription, Genetic Code and Translation:** This module aims at the learner understanding the basis of gene expression and the Central Dogma and the molecular basis of protein synthesis in Prokaryotes and Eukaryotes. The module deals with the structure and properties of different forms of RNA, maturation of RNA and RNA splicing.
3. **Mutation and DNA repair:** The molecular basis and types of mutation, their cause, effect and DNA repair is studied. The basic concepts related to molecular biology are explained.
4. **Genetic exchange:** This module includes the study of various mechanisms of gene transfer in bacteria. It also provides insight into the mechanisms of genetic recombination. The module deals with the Genetics of bacteria and bacteriophages, development of new strains and genetic mapping.
5. **Practicals**
   The laboratory techniques and experiments based on these topics will give students hands on competence in fundamental molecular biology experiments.

## LEARNING OUTCOMES:

- **DNA Replication**: The learner will understand the sequence of events, mechanism, enzymes and proteins involved in replication of DNA in prokaryotes and eukaryotes.
- **Transcription, Genetic Code and Translation:** The student will know the central dogma of biology its two-step transcription and translation, maturation of RNA.
- **Mutation and DNA repair**: The learner will know the concept of mutation, its types, causes and their effects. This module will also make them understand types of mutagens, damage to DNA due to mutagenesis, various mechanisms of DNA repair.
- **Genetic exchange**: The student shall understand the various mechanisms of gene transfer in bacteria and genetic recombination.
- **Practicals**: The students will acquire skill to perform the laboratory techniques and experiments based on the above topics.

# MICROBIAL GENETICS (USMB-501): DETAIL SYLLABUS

| Title | Lectures / Semester | Notional Periods |
|---|---|---|
| **Unit I: DNA Replication** | **15 L** | **15** |
| **1.1. Historical perspective -** Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication. | **3 L** | |
| **1.2. Prokaryotic DNA replication -** Details of molecular mechanisms involved in Initiation, Elongation and Termination | **4 L** | |
| **1.3. Enzymes and proteins associated with DNA replication**- Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, Ter and Tus proteins. | **3 L** | |
| **1.4. Eukaryotic DNA replication -** Molecular details of DNA synthesis, replicating the ends of the chromosomes assembling newly replicated DNA into nulcleosomes**.** | **4 L** | |
| **1.5. Rolling circle mode of DNA replication** | **1 L** | |
| **Unit II: Transcription, Genetic Code and Translation** | **15 L** | **15** |
| **2.1 Central Dogma: An Overview, Transcription process, Transcription in bacteria -** Initiation of transcription at promoters, elongation of an RNA chain, termination of an RNA chain | **3 L** | |
| **2.2 Transcription in Eukaryotes -** Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing | **5 L** | |
| **2.3 Genetic code -** Nature of genetic code and characteristics of genetic code. | **2 L** | |
| **2.4 Translation process -** Transfer RNA, structure of tRNA, tRNA genes, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA , Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell. | **5 L** | |
| **Unit III: Transcription, Genetic Code and Translation** | **15 L** | **15** |
| **3.1 Mutation**<br>3.1.1 **Terminology:** alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes | **1 L** | |

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|---|---|---|---|
| 3.1.2 **Fluctuation test.** | **1 L** | |
| 3.1.3 **Types of mutations:** Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. | **3 L** | |
| 3.1.4 **Causes of mutation:** Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for:<br>3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents.<br>3.1.4.2 Physical mutagen<br>3.1.4.3 Biological mutagen (only examples) | **4 L** | |
| 3.1.5 **Ames test** | **1 L** | |
| 3.1.6 **Detection of mutants** | **1 L** | |
| **3.2 DNA Repair**<br>3.2.1 Mismatch repair,<br>3.2.2 Light repair<br>3.2.3 Repair of alkylation damage<br>3.2.4 Base excision repair<br>3.2.5 Nucleotide excision repair<br>3.2.6 SOS repair | **4 L** | |
| **Unit IV: Genetic Exchange & Homologous Recombination** | **15 L** | **15** |
| **4.1 Genetic analysis of Bacteria** | **1 L** | |
| **4.2 Gene transfer mechanisms in bacteria**<br>4.2.1 Transformation<br>4.2.1.1 Introduction and History<br>4.2.1.2 Types of transformation in prokaryotes--Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis*.<br>4.2.1.3 Mapping of bacterial genes using transformation.<br>4.2.1.4 Problems based on transformation. | **3 L** | |
| 4.2.2 Conjugation<br>4.2.2.1 Discovery of conjugation in bacteria<br>4.2.2.2 Properties of F plasmid/Sex factor<br>4.2.2.3 The conjugation machinery<br>4.2.2.4 Hfr strains, their formation and mechanism of conjugation<br>4.2.2.5 F' factor, origin and behavior of F' strains, | **5 L** | |

| | | | |
|---|---|---|---|
| | Sexduction.<br>4.2.2.6 Mapping of bacterial genes using conjugation (Wolman and Jacob experiment).<br>4.2.2.7 Problems based on conjugation | | |
| | 4.2.3 Transduction<br>4.2.3.1 Introduction and discovery<br>4.2.3.2 Generalized transduction<br>4.2.3.3 Use of Generalized transduction for mapping genes<br>4.2.3.4 Specialized transduction<br>4.2.3.5 Problems based on transduction | **3 L** | |
| **4.3** | **Recombination in bacteria**<br>4.3.1 General/Homologous recombination<br>4.3.2 Molecular basis of recombination<br>4.3.3 Holliday model of recombination (Single strand DNA break model only)<br>4.3.4 Enzymes required for recombination<br>4.3.5 Site –specific recombination | **3 L** | |

# MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART-I

# TEXT BOOKS AND REFERENCE BOOKS

# (SEMESTER V)

### Course Code: USMB501

**Text books:**


1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. D. Nelson and M. Cox, (2005), "Lehninger's Principles of biochemistry", 4th edition, Macmillan worth Publishers.
5. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
6. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
7. Prescott, Harley and Klein, "Microbiology", 7th edition Mc Graw Hill international edition.
8. Robert Weaver, "Molecular biology", 3rd edition. Mc Graw Hill international edition.
9. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing
10. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.


**Reference books:**


1. Benjamin Lewin, "Genes IX", Jones and Bartlett publishers.
2. JD Watson, "Molecular biology of the gene", 5th edition.

# T.Y.B.Sc. MICROBIOLOGY THEORY

# (SEMESTER VI)

| COURSE CODE | TITLE | CREDITS AND LECTURES / SEM |
|---|---|---|
| **USMB601** | **rDNA Technology, Bioinformatics & Virology** | **2.5 Credits (60 Lectures)** |
| Unit I | Recombinant DNA Technology | 15 Lectures |
| Unit II | Applications of rDNA Technology & Bioinformatics | 15 Lectures |
| Unit III | Regulation & Basic Virology | 15 Lectures |
| Unit IV | Advanced Virology | 15 Lectures |
| | | |
| **USMB602** | **Medical Microbiology & Immunology: Part - II** | **2.5 Credits (60 Lectures)** |
| Unit I | Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention. | 15 Lectures |
| Unit II | Chemotherapy of Infectious Agents | 15 Lectures |
| Unit III | Immunology - I | 15 Lectures |
| Unit IV | Immunology – II | 15 Lectures |
| | | |
| **USMB603** | **Microbial Biochemistry: Part - II** | **2.5 Credits (60 Lectures)** |
| Unit I | Lipid Metabolism & Catabolism of Hydrocarbons | 15 Lectures |
| Unit II | Metabolism of Proteins and Nucleic Acids. | 15 Lectures |
| Unit III | Metabolic Regulation | 15 Lectures |
| Unit IV | Prokaryotic Photosynthesis & Inorganic Metabolism | 15 Lectures |
| | | |
| **USMB604** | **Bioprocess Technology: Part - II** | **2.5 Credits (60 Lectures)** |
| Unit I | Downstream Processing | 15 Lectures |
| Unit II | Advances in Bioprocess Technology | 15 Lectures |
| Unit III | Quality Assurance, Quality Control, Instrumentation and Bioassay | 15 Lectures |
| Unit IV | Industrial Fermentations | 15 Lectures |

# T.Y.B.SC. MICROBIOLOGY THEORY (SEMESTER V)

# rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY (USMB-601)

## LEARNING OBJECTIVES

**rDNA technology, Bioinformatics and Virology, USMB 601** is a course for T.Y.B.Sc. in Semester VI Microbiology students which deal with the following:

1. **The rDNA technology:** This module deals with the basic steps in gene cloning, vectors, model organisms, methods of transformation and screening and identification of recombinant cells.
2. **Application of rDNA technology and Bioinformatics:** This module will empower the student to understand the basic techniques in Recombinant DNA technology along with their applications. Bioinformatics is the basic tool in understanding Cells at the genomic and proteomic levels. Inclusion of Bioinformatics in this module will empower the learner with insilico analytical techniques.
3. **Gene Regulation and Basic Virology:** This module will make the students understand the genetic basis of regulation and operon control through the involvement of regulatory proteins. The study of Basic Virology will emphasise on the structure, classification and general modes of replication of viruses.
4. **Advanced Virology:** This module deals with basic structure and life cycle of different viruses and cultivation of viruses. It also comprises of basic study on Prions, Viriods and viruses causing cancer.

## LEARNING OUTCOMES:

- **r DNA technology:** This module will make the student understand the methods to construct recombinant DNA molecules, also know the tools required like vectors, restriction enzymes etc.
- **Application of rDNA technology and Bioinformatics**: The learner will know about applications of r DNA technology, through bioinformatics the student will understand the use of databases and software tools for understanding biological data.
- **Gene Regulation and Basic Virology:** The student will know about gene expression in prokaryotes, operon as a unit of gene regulation, regulation of gene expression in prokaryotes and bacteriophages. The student will also understand about general structure, life cycle and classification of viruses.
- **Advanced Virology:** The learner will understand the basic structure and life cycle of different viruses and their cultivation. The student will get basic knowledge on Prions, Viriods and viruses causing cancer.
- **Practicals**: The students will acquire skill to perform the laboratory techniques and experiments based on the above topics. The students will understand computational biology and insilico analytical techniques.

# rDNA TECHNOLOGY, BIOINFORMATICS & VIROLOGY

## (USMB-601): DETAIL SYLLABUS

| Title | Lectures / Semester | Notional Periods |
|---|---|---|
| **Unit I: Recombinant DNA Technology** | **15 L** | **15** |
| **1.1 Branches of Genetics**<br>1.1.1 Transmission genetics<br>1.1.2 Molecular genetics<br>1.1.3 Population genetics<br>1.1.4 Quantitative genetics | **1 L** | |
| **1.2 Model Organisms**<br>1.2.1 Characteristics of a model organism<br>1.2.2 Examples of model organisms used in study<br>1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms | **2 L** | |
| **1.3 Plasmids**<br>1.3.1 Physical nature<br>1.3.2 Detection and isolation of plasmids<br>1.3.3 Plasmid incompatibility and Plasmid curing<br>1.3.4 Cell to cell transfer of plasmids<br>1.3.5 Types of plasmids<br>1.3.6 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Colfactor, Degradative plasmids | **2 L** | |
| **1.4 Transposable Elements in Prokaryotes**<br>1.4.1 Insertion sequences<br>1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition, Integrons | **2 L** | |
| **1.5 Basic steps in Gene Cloning.** | **1 L** | |
| **1.6 Cutting and joining DNA molecules** - Restriction and modification systems, restriction endonucleases, DNA ligases | **3 L** | |
| **1.7 Vectors**<br>1.7.1 Plasmids as cloning vectors. plasmid vectors, pBR322 vector<br>1.7.2 Cloning genes into pBR322<br>1.7.3 Phage as cloning vectors, cloning genes into phage vector<br>1.7.4 Cosmids<br>1.7.5 Shuttle vectors<br>1.7.6 YAC<br>1.7.7 BAC | **3 L** | |
| **1.8 Methods of transformation** | **1 L** | |

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|---|---|---|---|
| | **Unit II: Applications of rDNA Technology & Bioinformatics** | **15 L** | **15** |
| **2.1** | **PCR**- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR) | **2 L** | |
| **2.2** | **Basic techniques**<br>2.2.1 Southern, Northern and Western blotting.<br>2.2.2 Autoradiography (explain the term | **2 L** | |
| **2.3** | **Screening and selection methods for identification and isolation of recombinant cells** | **2 L** | |
| **2.4** | **Applications of recombinant DNA technology:** Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals. | **4 L** | |
| **2.5** | **Bioinformatics**<br>2.5.1 Introduction<br>2.5.2 Definition, aims, tasks and applications of Bioinformatics.<br>2.5.3 Database, tools and their uses –<br>2.5.3.1 Importance, Types and classification of databases<br>2.5.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources.<br>2.5.3.3 Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG.<br>2.5.4 Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics- structural, functional and comparative genomics, Proteomics - structural and functional proteomics, Sequence alignment - global v/s local alignment, FASTA, BLAST (Different types of BLAST) | **5 L** | |
| | **Unit III: Regulation & Basic Virology** | **15 L** | **15** |
| **3.1** | **A) Lac operon and problems on Lac operon**<br>**B) Trp operon** | **7 L** | |
| **3.2** | **Regulation of lytic and lysogenic pathway of lambda phage** | **3 L** | |
| **3.3** | **Viral architecture -** Capsid, viral genome and envelope | **2 L** | |
| **3.4** | **Viral classification (Baltimore classification)** | **1 L** | |
| **3.5** | **Viral replication cycle** - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release. | **2 L** | |

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|---|---|---|---|
| | **Unit IV: Advanced Virology** | **15 L** | **15** |
| **4.1** | Structure of TMV, T4, Influenza virus, HIV. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail**.** | **5 L** | |
| **4.2** | **Cultivation of viruses**- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue | **3 L** | |
| **4.3** | **Visualization and enumeration of virus particles**<br>4.3.1 Measurement of infectious units<br>4.3.1.1 Plaque assay<br>4.3.1.2 Fluorescent focus assay<br>4.3.1.3 Infectious center assay<br>4.3.1.4 Transformation assay<br>4.3.1.5 Endpoint dilution assay.<br>4.3.2 Measurement of virus particles and their components<br>4.3.2.1 Electron microscopy<br>4.3.2.2 Atomic force microscopy<br>4.3.2.3 Haemagglutination<br>4.3.2.4 Measurement of viral enzyme activity. | **3 L** | |
| **4.4** | **Role of viruses in cancer:** Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus. | **2 L** | |
| **4.5** | **Prions:** Defination, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis | **1 L** | |
| **4.6** | **Viroids** | **1 L** | |

# TEXT BOOKS AND REFERENCE BOOKS

# (SEMESTER VI)

**Course Code: USMB601**

**Text books:**


1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. Prescott, Harley and Klein, "Microbiology",. 7th edition Mc Graw Hill international edition.
7. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
8. Teri Shors,.(2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
10. Robert Weaver, (2008), "Molecular biology", 3rd edition, Mc Graw Hill international edition.
11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th edition, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.
14. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.


**Reference books:**


1. Flint, Enquist, Racanillo and Skalka, "Principles of virology", 2nd edition. ASM press.
2. T. K. Attwood & D. J. Parry-Smith, (2003), "Introduction to bioinformatics", Pearson education
3. Benjamin Lewin, (9th edition), "Genes IX", Jones and Bartlett publishers.
4. JD Watson, "Molecular biology of the gene", 5th edition.

# Modality of Assessment
# Assessment pattern for theory

**Scheme of Examination**

The learner's Performance shall be assessed by conducting the Semester End Examinations with 100% marks

**Semester End Theory Assessment - 100%** **100 marks**

1. Duration - These examinations shall be of **3 hours** duration.
2. Theory question paper pattern :-
   i. There shall be **five questions** each of **20** marks (with internal options)
   ii. Question one will be based on unit one, question two on unit two, question three on unit three and question four on unit four. Question five will have questions from all four units of the syllabus.
   iii. Each of the main questions one to four will be subdivided into two sub-questions "A" and "B". Sub-question "A" will have four questions (of 6 marks each) out of which any two will be attempted. Total marks allotted to sub-question "A" will be 12 marks. Sub-question "B" will be 'Do as directed (attempt eight out of twelve)'. Each question in Sub-question "B" will be of one mark each. Total marks allotted to "B" sub-question will be 8 marks. Main question five will have six questions (of 5 marks each) out of which any four will be attempted, total 20 marks.
   iv. All questions shall be **compulsory** with internal choice within the questions.
   v. The allocation of marks will depend on the weightage of the topic.

**Passing Standard:**

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course and 40% marks in **Semester End Examination (i.e. 40 out of 100) separately**, to pass the course and **minimum of Grade E** in each project, wherever applicable, to pass a particular semester.

**Practical Examination Pattern:**

**External (Semester end practical examination):-**

| Sr.No. | Particulars/ paper | Marks |
|---|---|---|
| 1. | Laboratory work | 40 |
| 2. | Journal | 05 |
| 3. | Viva | 05 |

**Semester V:**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and / or Report, a Lost Certificate should be obtained from the Head of the Department / Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.**

**Semester VI**

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

**In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from the Head of the Department/ Co-ordinator of the department; failing which the student will not be allowed to appear for the practical examination.**

**Overall Examination and Marks Distribution Pattern**

| Course code | Practical Syllabus | Credits & lectures |
|---|---|---|
| USMBP05 | Based on USMB501 and USMB502 of Semester V | Credits 3 (8 periods/week) = 120 periods/semester |
| USMBP06 | Based on USMB503 and USMB504 of Semester V | Credits 3 (8 periods/week) = 120 periods/semester |

## Semester V

| Course | USMB-501 | USMB-502 | USMB-503 | USMB-504 | Grand Total |
|---|---|---|---|---|---|
| **Theory** | **100** | **100** | **100** | **100** | **400** |
| **Practicals** | **50** | **50** | **50** | **50** | **200** |

## Semester VI

| Course | USMB-601 | USMB-602 | USMB-603 | USMB-604 | Grand Total |
|---|---|---|---|---|---|
| **Theory** | **100** | **100** | **100** | **100** | **400** |
| **Practicals** | **50** | **50** | **50** | **50** | **200** |

# T.Y.B.Sc. Microbiology Practicals: Semester-V

| Course code | Practical Syllabus | Credits & lectures |
|---|---|---|
| USMBP05 | Based on USMB501 and USMB502 of Semester V | Credits 3 (8 periods/week) = 120 periods/semester |
| USMBP06 | Based on USMB503 and USMB504 of Semester V | Credits 3 (8 periods/week) = 120 periods/semester |

# T.Y.B.Sc. Microbiology Practicals: Semester-VI

| Course code | Practical Syllabus | Credits & lectures |
|---|---|---|
| USMBP07 | Based on USMB601 and USMB602 of Semester VI | Credits 3 (8 periods/week) = 120 periods/semester |
| USMBP08 | Based on USMB603 and USMB604 of Semester VI | Credits 3 (8 periods/week) = 120 periods/semester |

**COURSE WISE CREDIT ASSIGNMENT UNDER THE FACULTY OF SCIENCE**

**Program: B.Sc.**
**Course: Microbiology (USMB)**

| **Course wise credit assignments under the faculty of science Type of Courses / Credits Assigned** | **First Year (Credit x No. of Courses )** | | **Second Year (Credit x No. of Courses )** | | **Third Year (Credit x No. of Courses )** | | **Total Credit Value** |
|---|---|---|---|---|---|---|---|
| | **First Semester** | **Second Semester** | **Third Semester** | **Fourth Semester** | **Fifth Semester** | **Sixth Semester** | |
| Core Courses (Theory) | 04x03 | 04x03 | 06x02 | 06x02 | 2.5x04 | 2.5x04 | 68 |
| Core Courses (Practicals) | 02x03 | 02x03 | 03x02 | 03x02 | 1.5x04 | 1.5x04 | 36 |
| Foundation course | 02x01 | 02x01 | 02x01 | 02x01 | | | 08 |
| Applied Component Courses (Theory) | | | | | 02x01 | 02x01 | 04 |
| Applied Component Courses (Practical) | | | | | 02x01 | 02x01 | 04 |
| **Total** | **20** | **20** | **20** | **20** | **20** | **20** | **120** |