

**UNIVERSITY OF MUMBAI**



**Revised Syllabus for F.Y.B.Sc.  
Program: B.Sc.  
Course :MICROBIOLOGY(USMB)**

(Credit Based Semester and Grading System with  
effect from the academic year 2014–2015)

## PREAMBLE

With the introduction of Credit based Semester and Grading System(CBSGS) and continuous evaluation consisting of components of Internal Assessment and External Assessment by the esteemed University from the academic year 2011-2012, the earlier existing syllabus of F.Y.B.Sc. Microbiology was restructured according to the CBSGS pattern for its implementation from 2011-2012.

Now the existing syllabus of F.Y.B.Sc. Microbiology is due for revision as per the CBSGS pattern for its implementation from the academic year 2014-2015.

While revising the syllabus, the sub- committee has taken utmost care to balance both the basic techniques and some of the advance techniques (as remaining will be introduced phase wise at S.Y.B.Sc. and T.Y.B.Sc level) in Microbiology. The concept of **Biosafety, Validation, Calibration and SOPs** has been introduced to make the learners aware about :-

- i. The biological hazards and safety measures
- ii. Importance of Validation and Calibration of Scientific equipments in industries and laboratories.
- iii. Writing of SOPs for instruments and their importance at work.

The unique chemistry of living systems results in large part from the remarkable and diverse properties of **Biomacromolecules**. Macromolecules from each of the four major classes may act individually in a specific cellular process, where as others associate with one another to form supramolecular structures. All of these structures are involved in important cellular processes. Since the arrival of information technology, biochemistry has evolved from an interdisciplinary role to becoming a core program for a new generation of interdisciplinary courses such as **bioinformatics and computational biochemistry**. Hence the module of macromolecules has been included in the revised syllabus to teach students the structure and function of biomolecules at an entry level with an objective to raise the student's awareness of the applicability of microcomputers in biochemistry as they go to the higher classes.

## F.Y.B.Sc Microbiology Syllabus (General Outline)

### Credit Based Semester & Grading System

**To be implemented from the Academic year 2014-15**

<b>Bachelor of Science in Microbiology</b>	<b>Duration: Six Semesters</b>	
	<b>SEMESTER I</b>	
	Theory	
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>USMB101</b>	<b>FUNDAMENTALS OF MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	History, Introduction & Scope Of Microbiology Prokaryotic Cell Structure, Biosafety In Microbiology	15 lectures.
<b>Unit-II</b>	Eukaryotic Cell Structure	15 lectures.
<b>Unit-III</b>	Macromolecules	15 lectures.
<b>USMB102</b>	<b>BASIC TECHNIQUES IN MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	Microscopy & Staining	15 lectures.
<b>Unit-II</b>	Control Of Microorganisms	15 lectures.
<b>Unit-III</b>	Microbial Nutrition, Cultivation, Isolation & Preservation	15 lectures.
<b>USMBP-1</b>	<b>PRACTICALS</b>	<b>2 Credits</b>
	<b>SECTION-1</b> <b>FUNDAMENTALS OF MICROBIOLOGY.</b> <b>(Practicals Based On Unit-I, II &amp; III Of USMB-101)</b>	<b>1 Credit (45 Periods)</b>
	<b>SECTION-2</b> <b>BASIC TECHNIQUES IN MICROBIOLOGY.</b> <b>(Practicals Based On Unit-I, II &amp; III Of USMB-102)</b>	<b>1 Credit (45 Periods)</b>
	<b>SEMESTER II</b>	

	<b>Theory</b>	
<b>USMB201</b>	<b>BASICS OF MICROBIOLOGY.</b>	<b>2 Credits (45 Lectures)</b>
<b>Unit-I</b>	Study Of Different Groups Of Microbes-I	15 lectures.
<b>Unit-II</b>	Study Of Different Groups Of Microbes-II	15 lectures.
<b>Unit-III</b>	Microbial Growth	15 lectures.
<b>USMB202</b>	<b>EXPLORING MICROBIOLOGY.</b>	<b>2 Credits (45 Lectures)</b>
<b>Unit-I</b>	Microbial Interactions	15 lectures.
<b>Unit-II</b>	Microbes & Human Health	15 lectures.
<b>Unit-III</b>	Advance Techniques In Microbiology & Instrumentation	15 lectures.
<b>USMBP-2</b>	<b>PRACTICALS</b>	<b>2 Credits</b>
	<b>SECTION-1 BASICS OF MICROBIOLOGY. (Practicals Based On Unit-I,II &amp; III Of USMB-201)</b>	<b>1 Credit (45 Periods)</b>
	<b>SECTION-2 EXPLORING MICROBIOLOGY. (Practicals Based On Unit-I,II &amp; III Of USMB-202)</b>	<b>1 Credit (45 Periods)</b>

**F.Y.B.Sc Microbiology: Detail Syllabus**

**Credit Based Semester & Grading System**

**To be implemented from the academic year 2014-15**

<b>Bachelor of Science in Microbiology</b>	<b>Duration: Six Semesters</b>	
	<b>SEMESTER I</b>	
	<b>Theory</b>	
<b>Course Code</b>	<b>Title</b>	<b>Credits</b>
<b>USMB101</b>	<b>FUNDAMENTALS OF MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	<b>1.1 History, Introduction &amp; Scope Of Microbiology</b> a. Discovery of microorganisms b. Conflict over spontaneous generation c. Golden Age Of Microbiology-Koch Postulate, Medical Microbiology, Immunology d. Development of industrial microbiology and microbial ecology e. Scope and relevance of microbiology f. Future of microbiology	4 lectures.
	<b>1.2 Biosafety In Microbiology</b> a. Means of laboratory infection b. Potentially hazardous procedures c. Responsibility d. Risk Assessment e. Restricted access f. Safety equipments g. Immunization and medical records h. Training of personnel i. Laboratory procedures j. Levels of Containment	2 lectures
	<b>1.3 Prokaryotic Cell Structure and functions</b> a. Cell wall b. Cell membrane c. Components external to cell wall- Capsule, Slime layer, S layer Flagella, Pili, Fimbriae d. Cytoplasmic matrix-Inclusion bodies,	9 lectures

	<p>magnetosomes, ribosomes, gas vesicles  e. Nucleoid, Plasmids  f. Bacterial endospores and their formation</p>	
<b>Unit-II</b>	<p><b>Eukaryotic Cell Structure</b>  <b>2.1</b>  a. Overview of Eucaryotic cell structure  b. The plasma membrane and membrane Structure  c. Cytoplasmic matrix, microfilaments, intermediate filaments, and microtubules  d. Organelles of the Biosynthetic-secretory and endocytic pathways –Endoplasmic reticulum &amp; Golgi apparatus. Definitions of Lysosome, Endocytosis, Phagocytosis, Autophagy, Proteasome  e. Eucaryotic ribosomes  f. Mitochondria  g. Chloroplasts  h. Nucleus –Nuclear Structure  i. External Cell Coverings: Cilia And Flagella  j. Comparison Of Procaryotic And Eucaryotic Cells</p>	15 lectures.
<b>Unit-III</b>	<p><b>Macromolecules</b>  <b>3.1 Chemical foundations:</b>  a. Biomolecules as compounds of carbon with a variety of functional groups.  b. Universal set of small molecules.  c. Macromolecules as the major constituents of cells.  d. Configuration and Conformation with definitions and suitable examples only.  e. Types of Stereoisomers and importance of stereoisomerism in biology.  f. Types of bonds and their importance: Electrovalence, covalent, ester, phosphodiester, thioester, peptide, glycosidic  <b>3.2 Water- Structure, properties in brief.</b>  <b>3.3 Carbohydrates:</b>  Definition, Classification, Biological role.  Monosachharides, oligosaccharides (maltose, cellobiose, sucrose, lactose) and polysaccharide (starch, glycogen, peptidogycan, cellulose)  <b>3.4 Lipids:</b>  Fatty acids as basic component of lipids and their classification (Lehninger), nomenclature, storage lipids and structural lipids. Types of lipids with general structure of each and mention examples.  <b>3.5 Amino acids &amp; proteins:</b></p>	<p>2 lectures</p> <p>1 lecture  4 lectures</p> <p>3 lectures</p> <p>3 lectures</p>

	<p>General structure and features of amino acids (emphasis on amphoteric nature) Classification by R-group, Uncommon amino acids and their functions</p> <p>Peptides and proteins- Definition and general features and examples with biological role.</p> <p>Primary, secondary, tertiary, quaternary structures of proteins- Brief outline.</p> <p><b>3.6 Nucleic acids:</b></p> <p>Nitrogenous bases- Purines , Pyrimidines</p> <p>Pentoses-Ribose, Deoxyribose, Nomenclature of Nucleosides and nucleotides, N-β-glycosidic bond, polynucleotide chain to show bonding between nucleotides (Phosphodiester bonds).</p> <p>Basic structure of RNA and DNA.</p>	2 lectures
<b>USMB102</b>	<b>BASIC TECHNIQUES IN MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	<b>Microscopy &amp; Staining</b>	15 lectures.
	<p><b>1.1 Microscopy</b></p> <p>History of microscopy, Optical spectrum, Lenses and mirrors:</p> <p>Simple and compound light microscope, Dark field Microscopy, Phase contrast</p> <p><b>1.2 Staining procedures</b></p> <ol style="list-style-type: none"> <li>Dyes and stains: Types, Physicochemical basis Fixatives, Mordants, Decolorizers</li> <li>Simple and differential staining</li> <li>Special staining (Cell wall, Capsule, Lipid granules ,Spores &amp; Metachromatic granules)</li> </ol>	
<b>Unit-II</b>	<b>Control Of Microorganisms</b>	15 lectures.
	<p><b>2.1 Definition</b> of frequently used terms &amp; Rate of microbial death, Factors affecting the effectiveness of antimicrobial agents &amp; Properties of an ideal disinfectant</p> <p><b>2.2 Evaluation of disinfectant</b> –Tube dilution &amp; Agar plate techniques, Phenol coefficient etc , Tissue toxicity index</p> <p><b>2.3 Physical methods of microbial control</b></p> <p><b>2.4 Chemical methods of microbial control -</b></p>	

	mechanism & advantages &disadvantages (if any) applications. Chemotherapeutic agents List types of agents active against various groups & mention the site of action (Detailed mode of action not to be done)	
<b>Unit-III</b>	<b>Microbial Nutrition,Cultivation,Isolation&amp; Preservation</b>	15 lectures.
	<b>3.1</b> Nutritional requirements – Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur and growth factors. <b>3.2</b> Nutritional types of microorganisms <b>3.3</b> Nutrient uptake mechanisms <b>3.4</b> Types of Culture media with examples <b>3.5</b> Isolation of microorganisms and pure culture techniques <b>3.6</b> Preservation of microorganisms <b>3.7</b> Culture Collection Centers	
<b>USMBP-1</b>	<b>PRACTICALS</b>	<b>2 Credits</b>
	<b>SECTION-1 FUNDAMENTALS OF MICROBIOLOGY.</b>	<b>1 Credit (45 Periods)</b>
<b>Unit-I</b>	<ol style="list-style-type: none"> <li>1. Assignment : Contribution of a Scientists in the field of Microbiology</li> <li>2. Handling corrosive chemical using rubber teat method for pipetting. Prevention of mouth pipetting and use of auto-pipettes.</li> <li>3. Discard of highly infectious pathogenic samples like T.B, sputum etc.</li> <li>4. Explain safety inoculation hood for infection inoculations and laminar air flow.</li> <li>5. On accidental spillage of/ breakage of culture containers-precautions to be taken.</li> <li>6. Demonstration of microbes in air, cough, on table surface, finger tips.</li> <li>7. Special staining: Cell wall, capsule, endospore, flagella, lipid, metachromatic granules.</li> </ol>	
<b>Unit-II</b>	<ol style="list-style-type: none"> <li>8. Demonstration: Phagocytosis, Mitochondria and Chloroplast</li> <li>9. Assignment: Eukaryotic organelles with electron Micrograph pictures</li> </ol>	
<b>Unit-III</b>	Qualitative detection : <ol style="list-style-type: none"> <li>10. Carbohydrates- Benedicts, Molisch’s test.</li> <li>11. Proteins, amino acids- Biuret, Ninhydrin.</li> </ol>	



	12. Nucleic acid detection by DPA and Orcinol.	
	<b>SECTION-II BASIC TECHNIQUES IN MICROBIOLOGY.</b>	<b>1 Credit (45 Periods)</b>
<b>Unit-I</b>	<ol style="list-style-type: none"> <li>1. Parts of a microscope,</li> <li>2. Micrometry</li> <li>3. Dark field and Phase contrast : Demonstration</li> <li>4. Monochrome and differential staining procedures, Gram staining&amp; Negative Staining.</li> </ol>	
<b>Unit-II</b>	<ol style="list-style-type: none"> <li>5. Introduction to Laboratory equipments, disinfection &amp; discarding techniques in laboratory</li> <li>6. Methods of preparation of glasswares for Sterilization (Pipettes, Petri Plates, Plastic wares, Flasks, Micropipettes, microtitre plates) &amp; Control of micro organisms using moist heat &amp; dry heat sterilization (Sterilization of Dry powders, Rubber gloves, Bandages, Screw capped tubes, Sterilizable plasticwares)</li> <li>7. Effect of UV Light, Desiccation, surface tension, Osmotic Pressure, heavy metals(Oligodynamic action)</li> <li>8. Effect of dyes, phenolic compounds and chemotherapeutic agents( disc inhibition method)</li> <li>9. Evaluation of Disinfectant by Coupon Method</li> </ol>	
<b>Unit-III</b>	<ol style="list-style-type: none"> <li>10. Preparation of Culture Media: <ol style="list-style-type: none"> <li>a. Liquid medium(Nutrient Broth)</li> <li>b. Solid Media(Nutrient agar ,Sabourauds agar)</li> <li>c. Preparation of slant ,butts &amp; plates</li> </ol> </li> <li>11. Inoculation techniques and Study of Growth: <ol style="list-style-type: none"> <li>a. Inoculation of Liquid Medium</li> <li>b. Inoculation of Solid Media(Slants, Butts and Plates)</li> <li>c. Study of Colony Characteristics of Bacteria</li> <li>d. Study of Motility (Hanging Drop Preparation)</li> </ol> </li> <li>12. Use of Differential &amp; Selective Media: (MacConkey &amp; Salt Mannitol Agar)</li> <li>13. Determination of Optimum growth conditions: <ol style="list-style-type: none"> <li>a)Temperature, b) pH</li> </ol> </li> </ol>	

	<b>SEMESTER II Theory</b>	
<b>USMB201</b>	<b>BASICS OF MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	<p><b>Study Of Different Groups Of Microbes-I</b></p> <p><b>1.1 Viruses:</b>  a) Historical highlights, General properties of viruses, prions, viroids  b) Structure of viruses-capsids, envelopes, genomes,  c) Reproduction - general features, Cultivation of viruses- overview  d) Bacteriophages: Structure and Life cycle of T4 phage. Lytic cycle. Lysogeny</p> <p><b>1.2 Rickettsia, Coxiella, Chlamydia, Mycoplasma:</b>  general features, medical significance</p> <p><b>1.3 Actinomycetes:</b> General features of Nocardia and Streptomyces Importance: ecological, commercial and medical</p> <p><b>1.4 Archaeobacteria:</b> Introduction- Major Archaeal physiological groups Archaeal cell wall, lipids and membranes, Ecological importance</p>	<p>7 lectures</p> <p>3 lectures</p> <p>2 lectures</p> <p>3 lectures</p>
<b>Unit-II</b>	<p><b>Study Of Different Groups Of Microbes-II</b>  Classification, Morphological characteristics, cultivation, reproduction and significance</p> <p><b>2.1 Protozoa-</b> Major Categories of Protozoa Based on motility, reproduction. Medical importance of Protozoa Life cycle of Entamoeba</p> <p><b>2.2 Algae -</b> Characteristics of algae : morphology, Pigments, reproduction Cultivation of algae. Major groups of Algae –an overview. Biological and economic importance of Algae. Differences between Algae and Cyanobacteria</p> <p><b>2.3 Fungi and Yeast-</b> Characteristics: structure, Reproduction. Cultivation of fungi and yeasts. Major fungal divisions- overview. Life cycle of yeast Biological and economic importance</p> <p><b>2.4 Slime molds and Myxomycetes</b></p>	<p>4 lectures</p> <p>5 lectures</p> <p>5 lectures</p> <p>1 lecture</p>

<b>Unit-III</b>	<b>Microbial Growth.</b> <b>3.1</b> a. Definition of growth, Mathematical Expression, Growth curve b. Measurement of growth c. Direct microscopic count – Breed’s Petroff – Hauser counting chamber, Haemocytometer. d. Viable count – Spread plate and Pour plate technique e. Measurements of cell constituents. f. Turbidity measurements – Nephelometer and spectrophotometer techniques g. Measurements of cell constituents h. Synchronous growth, Continuous growth (Chemostat and Turbidostat) i. Growth yield j. Influence of environmental factors on growth. k. Microbial growth in natural environment. l. Counting viable non-culturable organisms-Quorum sensing techniques	15 lectures.
<b>USMB202</b>	<b>EXPLORING MICROBIOLOGY.</b>	<b>2 Credits (45 lectures)</b>
<b>Unit-I</b>	<b>Microbial Interactions</b>	15 lectures.
	<b>1.1 Types of Microbial Interactions</b> Mutualism, Cooperation, Commensalisms, Predation Parasitism, Amensalism, Competition <b>1.2 Human Microbe Interactions .</b> a) Normal flora of the human body : Skin, Nose & Nasopharynx, Oropharynx, Respiratory tract, Eye, External ear, Mouth, Stomach, Small intestine, Large intestine, Genitourinary tract . b) Relationship between microbiota & the host . c) Gnotobiotic animals <b>1.3 Microbial associations with vascular plants</b> a) Phyllosphere b) Rhizosphere & Rhizoplane c) Mycorrhizae d) Nitrogen fixation : Rhizobia, Actinorhizae, Stem Nodulating Rhizobia e) Fungal & Bacterial endophytes f) Agrobacterium & other plant pathogens	
<b>Unit-II</b>	<b>Microbes &amp; Human Health</b>	15 lectures.
	<b>2.1 Difference between infection &amp; disease.</b> Important terminology: Primary infection, secondary infection, contagious infection, occupational disorder,	

	<p>clinical infection, subclinical infection, Zoonoses, genetic disorder, vector borne infection.</p> <p><b>2.2 Factors affecting infection:</b>  Microbial factors: adherence, invasion, role of virulence factors in invasion, colonization &amp; its effects.  Host factors: natural resistance, species resistance, racial resistance.</p> <p><b>2.3 Individual resistance:</b> Factors influencing individual resistance: Age, nutrition, personal hygiene, stress, hormones, Addiction to drugs/ alcohol. Interaction between Microbes &amp; host is dynamic.</p> <p><b>2.4 Host defence against infection:</b>  i) First line of Defense: for skin, respiratory tract, gastrointestinal tract, genitourinary tract, eyes.  ii) Second line of infection: Biological barriers: Phagocytosis, Inflammation  iii) Third line of infection: Brief introduction to antibody mediated &amp; cell mediated immunity.</p> <p><b>Microbiology By Pelczar &amp; Reid</b></p>	
<b>Unit-III</b>	<b>Advance Techniques In Microbiology &amp; Instrumentation</b>	15 lectures.
	<p><b>3.1</b> Electron Microscope: TEM, SEM,  <b>3.2</b> Contrast enhancement for electron microscope  <b>3.3</b> Fluorescent Microscope, Confocal Microscope  <b>3.4</b> pH meter, Ph meter Validation and calibration  <b>3.5</b> Colorimeter  <b>3.6</b> Validation and calibration of Autoclave &amp; Hot air Oven  <b>3.7</b> Concepts: Laminar air flow systems, Walk in Incubators, Biosafety cabinets, Industrial autoclaves</p>	
<b>USMBP-2</b>	<b>PRACTICALS</b>	<b>2 Credits</b>
	<b>SECTION-1 BASICS OF MICROBIOLOGY.</b>	<b>1 Credit (45 lectures)</b>
<b>Unit-I</b>	<ol style="list-style-type: none"> <li>Spot assay and plaque assay of Bacteriophage (Demonstration)</li> <li>Slide Culture technique (Actinomycetes)</li> </ol>	
<b>Unit-II</b>	<ol style="list-style-type: none"> <li>Isolation of yeast, cultivation of other fungi Cultivation on Sabourauds agar</li> </ol>	

	<ul style="list-style-type: none"> <li>4. Static &amp; Shaker Cultures</li> <li>5. Fungal Wet mounts &amp; Study of Morphological Characteristics :Mucor,Rhizopus,Aspergillus, Penicillium,</li> <li>6. Permanent slides of Algae, Protozoa (Demonstration)</li> </ul>	
<b>Unit-III</b>	<ul style="list-style-type: none"> <li>7.Growth curve (Demonstration) only in complex media.</li> <li>8.Breed's Count</li> <li>9.Haemocytometer</li> <li>.. 10.Viable count: Spread plate and pour plate</li> <li>11.Brown's opacity</li> <li>12.Effect of pH and temperature on growth</li> <li>13. Measurement of cell dimensions- Micrometry</li> </ul>	
	<b>SECTION-2 EXPLORING MICROBIOLOGY.</b>	<b>1 Credit (45 lectures)</b>
<b>Unit-I</b>	<ul style="list-style-type: none"> <li>1. Normal flora of the Skin&amp; Saliva</li> <li>2. Slide Culture technique -Nocardia</li> <li>3. Wet Mount of Lichen</li> <li>4. Bacteroid Staining&amp; Isolation of Rhizobium</li> <li>5. Azotobacter isolation &amp; staining</li> </ul>	
<b>Unit-II</b>	<ul style="list-style-type: none"> <li>6.Study of virulence factors – Enzyme Coagulase</li> <li>7.Study of virulence factors – Enzyme Hemolysin</li> <li>8.Study of virulence factors – Enzyme Lecithinase</li> </ul>	
<b>Unit-III</b>	<ul style="list-style-type: none"> <li>9.Use of standard buffers for calibration and determination of pH of a given solution</li> <li>10.Determination of <math>\lambda_{max}</math> &amp; Verification of Beer Lambert's law</li> <li>11.Determination &amp; efficiency of Autoclave, Hot air oven , LAF</li> <li>12.Writing of SOP's for Instruments</li> <li>13.Visit to a Microbiology laboratory in a research Institute</li> </ul>	

## **REFERENCES: USMB 101 & USMB 201**

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. Outlines of Biochemistry 5/E, Conn P. Stumpf, G. Bruening and R. Doi. John Wiley & Sons. New York 1995
9. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman andCompany. New York 2005
10. Microbiology An Introduction. 6<sup>th</sup> Edition. Tortora, Funke and Case. AddisonWeseley Longman Inc. 1998.

## **REFERENCES: USMB 102 & USMB 202**

1. Microbiology TMH 5th Edition by Michael J.Pelczar Jr., E.C.S. Chan ,Noel R. Krieg
2. A.J.Salle, Fundamental Principles of Bacteriology McGraw Hill Book Company Inc.1984
3. Cruikshank, Medical Microbiology , Vol -II
4. Prescott ,Hurley.Klein-Microbiology, 5th & 6th edition, International edition 2002 & 2006, McGraw Hill.
5. Michael T.Madigan&J.M.Martin,Brock ,Biology of Microorganisms 11th Ed. International edition 2006 Pearson Prentice Hall.

### Modality of Assessment:

#### Theory Examination Pattern:

A) Internal Assessment - 40%

40 marks.

#### Theory

40 marks

Sr No	Evaluation type	Marks
1	One Assignment/Case study/Project	10
2	One class Test (multiple choice questions / objective)	20
3	Active participation in routine class instructional deliveries(case studies/ seminars//presentation)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

B ) External examination - 60 %

#### Semester End Theory Assessment - 60%

60 marks

- i. Duration - These examinations shall be of **two hours** duration.
- ii. Theory question paper pattern :-
  1. There shall be **four** questions each of **15** marks. On each unit there will be one question & fourth one will be based on all the three units.
  2. All questions shall be compulsory with internal choice within the questions. Each question will be of **30** marks with options.
  3. Questions may be sub divided into sub questions a, b, c & d only, each carrying **seven & half** marks **OR** a, b, c, d, e & f only each carrying **five** marks and the allocation of marks depends on the weightage of the topic.

**Practical Examination Pattern:**

**(A) Internal Examination:-**

There will not be any internal examination/ evaluation for practicals.

**(B) External (Semester end practical examination) :- 50 Marks Per Section**

Sr.No.	Particulars	Marks	Total
1.	Laboratory work (Section-I + Section-II)	40 + 40 =	80
2.	Journal	05 + 05 =	10
3.	Viva	05 + 05 =	10

**PRACTICAL BOOK/JOURNAL**

**Semester I:**

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 Head / Co-ordinator / Incharge of the department ; failing which the student will not be allowed to appear for the practical examination.**

**Semester II**

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 Head / Co-ordinator / Incharge of the department ; failing which the student will not be allowed to appear for the practical examination.**



**Overall Examination and Marks Distribution Pattern**

**Semester I**

<b>Course</b>	<b>USMB-101</b>			<b>USMB-102</b>			<b>Grand Total</b>
	<b>Internal</b>	<b>External</b>	<b>Total</b>	<b>Internal</b>	<b>External</b>	<b>Total</b>	
<b>Theory</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>200</b>
<b>Practicals</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>100</b>

**Semester II**

<b>Course</b>	<b>USMB-201</b>			<b>USMB-202</b>			<b>Grand Total</b>
	<b>Internal</b>	<b>External</b>	<b>Total</b>	<b>Internal</b>	<b>External</b>	<b>Total</b>	
<b>Theory</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>200</b>
<b>Practicals</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>-</b>	<b>50</b>	<b>50</b>	<b>100</b>