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.

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART-I (USMB-502)

LEARNING OBJECTIVES

The course in medical microbiology has been designed to help students to build on the basic information regarding host defence mechanisms that they have gained in S.Y.B.Sc. It has been designed to highlight the most important areas of medical microbiology i.e. etiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases The students have achieved a basic understanding of Innate Immunity and Host defence mechanisms in their lower classes and Immunology that forms an integral part of Medical Microbiology has been designed to help understand the ability of our immune system to defend against invading pathogens in a logical fashion. This includes our ability to defend against microorganisms by understanding the concepts of Humoral and Cellular Immunity (innate immunity) the tissues and organs of the immune system types of antigens we encounter and very importantly, the different types of antigen-antibody reactions.

LEARNING OUTCOMES: The students should be able to

- Give details of the virulence factors and other features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, and therefore modes of prophylaxis of these diseases

- Comment on the methods of diagnosis of the disease.
- Conceptualize how the adaptive immune responses coordinate to fight invading pathogens and the organs and tissue involved
- Discuss the role of antigen in initiating the immune response
- Correlate the structure & functions of immunoglobulin
- Understand the importance of cytokines, MHC, APCs, Cytokines, and the role in adaptive immunity.
- Understand the various antigen –antibody reactions

MEDICAL MICROBIOLOGY AND IMMUNOLOGY: PART I

(USMB-502): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Bacterial Strategies for Evasion and Study of a Few Diseases	**15 L**	**15**
1.1. Study of virulence mechanisms in bacteria 1.1.1. Pathogenicity islands 1.1.2. Bacterial virulence factors 1.1.2.1. Adherence factors 1.1.2.2. Invasion of host cells and tissues 1.1.3. Toxins 1.1.3.1. Exotoxins 1.1.3.2. Exotoxins associated with diarrhoeal diseases and food poisoning 1.1.3.3. LPS of gram negative bacteria 1.1.4. Enzymes 1.1.4.1. Tissue degrading enzymes 1.1.4.2. IgA1 proteases 1.1.5. Antiphagocytic factors 1.1.6. Intracellular pathogenicity 1.1.7. Antigenic heterogeneity 1.1.8. The requirement for iron	**5 L**	
1.2. Study of A Few Infectious Diseases of the Respiratory Tract (wrt. Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only) 1.2.1. *S. pyogenes* infections 1.2.2. Influenza 1.2.3. Tuberculosis 1.2.4. Pneumonia caused by *K .pneumoniae*	**8 L**	
1.3. Study of urinary tract infections	**2L**	

Unit II: Study of few diseases (wrt. Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)		**15 L**	**15**
2.1	**Study of skin infections**	**7 L**	
2.1.1	Pyogenic skin infections caused by *Pseudomonas* and *S. aureus*		
2.1.2	Leprosy		
2.1.3	Fungal infections- Candidiasis		
2.1.4	Viral Infections- Herpes simplex		
2.2	**Study of gastrointestinal tract infections**	**8 L**	
2.2.1	Infections due to Enteropathogenic *E.coli* strains		
2.2.2	Enteric fever- *Salmonella*		
2.2.3	Shigellosis		
2.2.4	Rotavirus diarrhoea		
2.2.5	Dysentery due to *Entamoeba histolytica*		
Unit III: General Immunology – I		**15 L**	**15**
3.1.	**Organs and tissues of the immune system:**	**4 L**	
3.1.1	Primary lymphoid organs - structure and function of Thymus and Bone marrow		
3.1.2	Secondary lymphoid organs – structure and function of Spleen**,** Lymph node**,** Mucosa associated lymphoid tissues, Bronchus associated lymphoid tissue, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue		
3.2	**Antigens**	**5 L**	
3.2.1	Immunogenicity versus antigenicity: Concepts - Immunogenicity, Immunogen, Antigencity, Antigen, Haptens. Haptens as valuable research and diagnostic tools		
3.2.2	Factors that influence immunogenicity - Foreignness, Molecular size, Chemical composition, Heterogeneity, Susceptibility of antigen to be processed and presented, Contribution of the biological system to immunogenicity Genotype of the recipient, Immunogen dosage, Route of administration		
3.2.3	Adjuvants		
3.2.4	Epitopes / antigen determinants - General concept, Characteristic properties of B - cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells		
3.2.5	Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens		
3.3	**Immunoglobulins**	**6 L**	
3.3.1	Immunoglobulins – basic structure of Immunoglobulins, heterodimer; types of heavy and light chains; constant and		

		variable regions, Immunoblobulin domains-hinge region. Basic concepts - hypervariable region, complementarity - determining regions (CDRs), framework regions (FRs) and their importance.		
	3.3.2	Immunoglobulin classes and biological activities - Immunogloublin G, Immunogloublin M, Immunogloublin A, Immunogloublin E, Immunogloublin D, (including diagrams)		
	3.3.3	Antigenic determinants on immunoglobulins – isotypes, allotypes, idiotypes**.**		
	3.3.4	Immunoglobulin Superfamily		
		Unit IV: General Immunology – II	**15 L**	**15**
4.1	**Cytokines**		**2 L**	
	4.1.1	Concepts - cytokines, lymphokines, monokines, interleukines, chemokines.		
	4.1.2	Properties of cytokines		
	4.1.3	Attributes of cytokines		
	4.1.4	Biological functions of cytokines		
4.2	**Major histocompatibility complex**		**3 L**	
	4.2.1	Introduction		
	4.2.2	Three major classes of MHC encoded molecules		
	4.2.3	The basic structure and functions of Class I and Class II MHC Molecules		
	4.2.4	Peptide binding by Class I and Class II MHC molecule		
4.3	**Antigen presenting cells**		**3 L**	
	4.3.1	Types of APC's		
	4.3.2	Endogenous antigens: The cytosolic pathway		
	4.3.3	Exogenous antigens: The endocytic pathway		
4.4	**Antigen Antibody reactions**		**7 L**	
	4.4.1	Precipitation reaction - Immunoelectrophoresis		
	4.4.2	Agglutination reactions - haeme-agglutination, bacterial agglutination, passive agglutination, agglutination inhibition.		
	4.4.3	Radioimmunoassay (RIA),		
	4.4.4	Enzyme Linked Immunosorbent Assay - indirect, competitive and sandwich ELISA		
	4.4.5	Immunofluorescence- Direct and indirect.		
	4.4.6	Western blotting.		

Course Code: USMB502

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th Edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition
3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Kuby Immunology, 6th Edition, W H Freeman and Company
6. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
7. Fahim Khan, Elements of Immunology, Pearson Education

Reference books / Internet references:

1. Kuby Immunology, 7th edition, W H Freeman and Company
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
3. Baron Samuel , Medical Microbiology, 4th edition
4. http://www.ncbi.nlm.nih.gov/books/NBK7627/
5. http://www.macmillanlearning.com/catalog/static/whf/kuby/

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART - II

(USMB-602)

LEARNING OBJECTIVES

Medical microbiology encompasses the etiology, transmission, pathogenesis, clinical manifestations, laboratory diagnosis, prophylaxis, and treatment of various diseases that are most common to humans through which the students build on the basic information regarding host defence mechanisms that they have gained in S.Y.B.Sc. A separate unit is based on chemotherapy that is available for infectious agent and the misuse of antibiotic in generation of multiple resistance strains. Immunology is an integral part of Medical Microbiology and this course is designed for T.Y.B.Sc. Microbiology students, on the assumption that the students have achieved a basic understanding of Innate Immunity and Host Defence

mechanisms. The course has been designed to help understand the ability of our immune system to defend against invading pathogens in a logical fashion. This includes the role of T and B cells and their role in obtaining acquired immunity. It also includes the role of immunoheamatology in blood transfusion and very importantly, can we prevent pathogens from infecting us (vaccination) and the production and use of monoclonal antibodies.

LEARNING OUTCOMES:

- Give details of the virulence factors and morphological and cultural features of the pathogen
- Correlate these virulence factors with the pathogenesis and clinical features of the disease
- Comment on the mode of transmission, and modes of prophylaxis of these diseases
- Given a few key clinical features, identify the likely causative agent.
- Comment on the methods of diagnosis of the disease.
- Understand the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral & Cell Mediated Immunity Acquire an understanding of the role of immune system in disease:
- Understand the activation of complement system
- Apply the concept of immunity to prevention of disease by development of vaccines

MEDICAL MICROBIOLOGY & IMMUNOLOGY: PART - II

(USMB-602): DETAIL SYLLABUS

Title	Lectures / Semester	Notional Periods
Unit I: Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	**15 L**	**15**
1.1 Study of vector-borne infections - Malaria	**2 L**	
1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea	**8 L**	
1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Meningococcal meningitis	**5 L**	

	Unit II: Chemotherapy of Infectious Agents	**15 L**	**15**
2.1	**Attributes of an ideal chemotherapeutic agent** - Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc.	**2 L**	
2.2	**Mode of action of antibiotics on-** 2.2.1 Cell wall (Beta-lactams- Penicillin and Cephalosporins, Carbapenems) 2.2.2 Cell Membrane (Polymyxin and Imidazole) 2.2.3 Protein Synthesis (Streptomycin, Tetracycline and Chloramphenicol) 2.2.4 Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn) 2.2.5 Enzyme inhibitors (Sulfa drugs, Trimethoprim)	**8 L**	
2.3	**List of common antibiotics** - used for treating viral, fungal and parasitic diseases.	**1 L**	
2.4	**Mechanisms of drug resistance** - Its evolution, pathways and origin for ESBL, VRE, MRSA	**3 L**	
2.5	(i) Selection and testing of antibiotics for bacterial isolates by Kirby-Bauer method (ii) Methods that detect *S. aureus* resistance to methicillin, and determination of ESBL strains	**2 L**	
	Unit III: Immunology – I	**15 L**	**15**
3.1	**T cells** 3.1.1 T Cell Receptor-structure (alpha-beta, gamma-delta TCR) 3.1.2 TCR-CD_3 complex - structure and functions. Accessory molecules 3.1.3 T cell activation 3.1.3.1 TCR mediated signaling – Overview 3.1.3.2 Costimulatory signals 3.1.3.3 Superantigens induced T cell activation 3.1.4 T cell differentiation (Memory and Effector cells)	**4 L**	
3.2	**Cell mediated effector response** 3.2.1 General properties of effector T cells 3.2.2 Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway 3.2.3 Killing mechanism of NK cells 3.2.4 Antibody mediated cell cytotoxicity (ADCC)	**3 L**	
3.3	**B cells** 3.3.1 B cell receptor and co-receptor-structure and function 3.3.2 B cell activation and Differentiation 3.3.2.1 Thymus dependant and independent antigens	**4 L**	

	3.3.2.2 Signal transduction pathway activated by BCR-overview 3.3.2.3 Role T_H cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, T_H cells cytokine signals		
3.4	**Humoral Response** 3.4.1 Primary and secondary responses 3.4.2 In vivo sites for induction of Humoral response 3.4.3 Germinal centers and antigen induced B cell Differentiation 3.4.3.1 Cellular events within germinal centers- Overview 3.4.3.2 Affinity maturation, somatic hyper-mutation and class switching 3.4.3.3 Generation of plasma cells and memory cells	**4 L**	
	Unit IV: Immunology – II	**15 L**	**15**
4.1	**Vaccines** 4.1.1 Active and passive immunization 4.1.2 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines 4.1.3 Use of adjuvants in vaccine 4.1.4 New vaccine strategies 4.1.5 Ideal vaccine 4.1.6 Route of vaccine administration, Vaccination schedule	**7 L**	
4.2	**Immunohaematology** 4.2.1 Human blood group systems, ABO, secretors and non secretors, Bombay Blood group. Rhesus system and list of other blood group systems 4.2.2 Haemolytic disease of new born, Coombs test.	**3 L**	
4.3	**Complement System** 4.3.1 Functions and components of complement 4.3.2 Complement Activation—classical, alternative and lectin pathway 4.3.3 Biological consequences of complement activation	**3 L**	
4.4	**Monoclonal Antibodies** 4.4.1 Production and clinical uses	**2 L**	

TEXT BOOKS AND REFERENCE BOOKS

(SEMESTER VI)

Course Code: USMB602

Text books:

1. Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition, Lange publication
2. Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017

3. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker's, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria Dannessa Delost 2015
6. Prescott's microbiology 10th edition 2017
7. Kuby Immunology,4th and 6th edition, W H Freeman and Company
8. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
9. Fahim Khan, Elements of Immunology, Pearson Education

Reference books / Internet references:

1. Baron Samuel , Medical Microbiology, 4th edition
http://www.ncbi.nlm.nih.gov/books/NBK7627/
2. Kuby Immunology, 7th edition, W H Freeman and Company
http://www.macmillanlearning.com/catalog/static/whf/kuby/

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**