

AC 27/2/13
Item No. 4.6

UNIVERSITY OF MUMBAI



Syllabus for the sem V & VI
Program: B.Sc.
Course : Microbiology(USMB)

**(Credit Based Semester and Grading System with effect from
the academic year 2013–2014)**

PREAMBLE

Programme: B.Sc

Course : Microbiology (USMB)

(Semester –V & VI)

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, the existing syllabi of F.Y.B.Sc. and S.Y.B.Sc. Microbiology were restructured according to the CBSGS pattern and after the approval by the concerned authorities have been implemented from the academic years 2011-12 and 2012-13 respectively.

In accordance with the CBSGS pattern, the existing syllabus of T.Y.B.Sc Microbiology has been restructured and after the approval by the concerned authorities shall be implemented from the academic year 2013-14.

For restructuring the existing syllabi of T.Y.B.Sc Microbiology and Applied Component courses, sub-committees were formed with Dr. D.B. Thakare as the convener, BOS members as co-conveners and Head/ Senior teachers from affiliated colleges as members of these sub-committees.

As mentioned in the outline of the syllabus, all the 08 courses of theory and practicals (Semester V and VI together) are compulsory to the students offering Microbiology as a Single Major Subject (6 units pattern of the old course).

These courses are:

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

However, the students opting for Double Major Subject (3 Units pattern of the old course), shall have following 04 courses of theory and practicals (Semester V and VI) compulsory:

1. USMB-501 and USMB-601
2. USMB-502 and USMB-602

T. Y. B. Sc. MICROBIOLOGY THEORY

SEMESTER V

Course code	Title	Credits and Lects/Sem
USMB501	MICROBIAL GENETICS	2.5 credits (60 LECTURES)
Unit I	CLASSICAL GENETICS	15 lectures
Unit II	GENETIC EXCHANGE	15 lectures
Unit III	DNA REPLICATION	15 lectures
Unit IV	MUTATION AND REPAIR	15 lectures
USMB502	MEDICAL MICROBIOLOGY & IMMUNOLOGY-PART I	2.5 credits (60 LECTURES)
Unit I	MEDICAL MICROBIOLOGY – RESPIRATORY AND URINARY TRACT INFECTIONS	15 lectures
Unit II	MEDICAL MICROBIOLOGY – GASTROINTESTINAL AND CENTRAL NERVOUS SYSTEM INFECTIONS	15 lectures
Unit III	GENERAL IMMUNOLOGY	15 lectures
Unit IV	T CELLS , B CELLS AND IMMUNE RESPONSES	15 lectures
USMB503	MICROBIAL BIOCHEMISTRY- PART I	2.5 credits (60 LECTURES)
Unit I	SOLUTE TRANSPORT	15 lectures
Unit II	BIOENERGETICS & BIOLUMINESCENCE	15 lectures
Unit III	METHODS OF STUDYING METABOLISM, CATABOLIC PATHWAYS OF CARBOHYDRATES	15 lectures
Unit IV	CATABOLISM & ANABOLISM OF CARBOHYDRATES	15 lectures
USMB504	BIOPROCESS TECHNOLOGY-PART I	2.5 credits (60 LECTURES)
Unit I	UPSTREAM PROCESSING – Part 1 Media Preparation and strain improvement	15 lectures
Unit II	UPSTREAM PROCESSING – Part 2 Fermentation equipment and process monitoring	15 lectures
Unit III	TRADITIONAL INDUSTRIAL FERMENTATIONS – Part 1 Production of microbial cells and yeast fermentations	15 lectures
Unit IV	TRADITIONAL INDUSTRIAL FERMENTATIONS – Part 2 Production of primary and secondary metabolites	15 lectures

SEMESTER VI

Course code	Title	Credits and Lects/Sem
USMB601	rDNA technology, Bioinformatics & Virology	2.5 (60 LECTURES)
Unit I	RECOMBINANT DNA TECHNOLOGY	15 lectures
Unit II	BASIC TECHNIQUES & BIOINFORMATICS	15 lectures
Unit III	BASIC VIROLOGY	15 lectures
Unit IV	ADVANCED VIROLOGY	15 lectures
USMB602	MEDICAL MICROBIOLOGY & IMMUNOLOGY-Part II	2.5 (60 LECTURES)
Unit I	MEDICAL MICROBIOLOGY	15 lectures
Unit II	CHEMOTHERAPY	15 lectures
Unit III	IMMUNE SYSTEM IN HEALTH AND DISEASES-PART I	15 lectures
Unit IV	IMMUNE SYSTEM IN HEALTH AND DISEASES-PART II	15 lectures
USMB603	MICROBIAL BIOCHEMISTRY-PART II	2.5 (60 LECTURES)
Unit I	CATABOLISM OF LIPIDS & PROTEINS	15 lectures
Unit II	CATABOLISM OF NUCLEIC ACIDS, AROMATIC COMPOUNDS & ANABOLISM OF LIPIDS, PROTEINS AND NUCLEIC ACIDS	15 lectures
Unit III	METABOLIC REGULATION	15 lectures
Unit IV	PROKARYOTIC PHOTOSYNTHESIS & INORGANIC METABOLISM	15 lectures
USMB 604	BIOPROCESS TECHNOLOGY PART II	2.5 (60 LECTURES)
Unit I	DOWNSTREAM PROCESSING	15 lectures
Unit II	BIOINSTRUMENTATION AND QUALITY ASSURANCE	15 lectures
Unit III	ADVANCES IN BIOPROCESSES	15 lectures
Unit IV	BIOTECHNOLOGICAL PRODUCTS AND REGULATORY PRACTICES	15 lectures

T. Y. BSc. MICROBIOLOGY PRACTICAL SYLLABUS

SEMESTER V

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

SEMESTER VI

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

Each theory and practical period shall be of 48 minutes duration.

SEMESTER V

Microbiology: Detail Syllabus

Course Code	Title	Lectures
USMB501	MICROBIAL GENETICS	2.5 Credits (60 Lectures)
<u>Unit I</u> <u>Classical Genetics</u>		<u>15 Lectures</u>
1.1. Branches of Genetics 1.1.a. Transmission genetics 1.1.1.b. Molecular genetics 1.1.c. Population genetics 1.1.d. Quantitative genetics		1 Lecture
1.2. Model Organisms 1.2.a. Characteristics of a model organism 1.2.b. Examples of model organisms used in study 1.2.c. Examples of studies undertaken using prokaryotic and eukaryotic model organisms.		1 Lecture
1.3. Plasmids 1.3.a. Physical nature 1.3.b. Detection and isolation of plasmids 1.3.c. Plasmid incompatibility and Plasmid curing 1.3.d. Cell to cell transfer of plasmids 1.3.e. Types of plasmids <ul style="list-style-type: none"> i. Resistance Plasmids, ii. Plasmids encoding Toxins and other Virulence Characteristics iii. col factor iv. Degradative plasmids 		5 Lectures
1.4. Transposable Elements in Prokaryotes 1.4.a. Insertion sequences 1.4.b. Transposons <ul style="list-style-type: none"> i. Types ii. Structure and properties iii. Mechanism of transposition iv. Transposon mutagenesis 1.4.c. Integrons		5 Lectures
1.5. Recombination in bacteria 1.5.a. General/Homologous recombination <ul style="list-style-type: none"> i. Molecular mechanism ii. Holliday model of recombination 		3 Lectures

1.5.b. Site –specific recombination	
<p><u>UNIT II</u> <u>Genetic Exchange</u></p> <p>2.1. Genetic analysis of bacteria</p> <p>2.2. Gene transfer mechanisms in bacteria</p> <p>2.2.a. Transformation</p> <ul style="list-style-type: none"> i. Introduction and History ii. Types of transformation in prokaryotes--Natural transformation in <i>Streptococcus pneumoniae</i>, <i>Haemophilus influenzae</i>, and <i>Bacillus subtilis</i> iii. Mapping of bacterial genes using transformation. iv. Problems based on transformation. <p>2.2.b. Conjugation</p> <ul style="list-style-type: none"> i. Discovery of conjugation in bacteria ii. Properties of F plasmid/Sex factor iii. The conjugation machinery iv. Hfr strains, their formation and mechanism of conjugation v. F' factor, origin and behavior of F' strains, Sexduction. vi. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). vii. Problems based on conjugation <p>2.2.c. Transduction</p> <ul style="list-style-type: none"> i. Introduction and discovery ii. Generalised transduction iii. Use of Generalised transduction for mapping genes iv. Specialised transduction v. Problems based on transduction 	<p><u>15 Lectures</u></p> <p>1 Lectures</p> <p>5 Lectures</p> <p>5 Lectures</p> <p>4 Lectures</p>
<p><u>UNIT III</u> <u>DNA replication</u></p> <p>3.1. Historical perspective— conservative, dispersive, semi-conservative, Bidirectional and semi-discontinuous</p> <p>3.2. Prokaryotic DNA replication – Details of molecular mechanism Involved in Initiation, Elongation and Termination</p> <p>3.3. Enzymes and proteins associated with DNA replication- primase, helicase, topoisomerase, SSB, DNA polymerases, ligases, Ter and Tus proteins</p>	<p><u>15 Lectures</u></p> <p>4 Lectures</p> <p>4 Lectures</p> <p>4 Lecture</p>

<p>3.4. Eukaryotic DNA replication-- Molecular details of DNA synthesis, replicating the ends of the chromosomes</p> <p>3.5. Rolling circle mode of replication</p>	<p>2 Lecture</p> <p>1 Lectures</p>
<p><u>Unit IV</u> <u>Mutation and Repair</u></p> <p>4.1. Mutation</p> <p>4.1.a. Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes</p> <p>4.1.b. Fluctuation test.</p> <p>4.1.c. 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.</p> <p>4.1.d. Causes of mutation: Natural/spontaneous mutation--replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for -</p> <ul style="list-style-type: none"> i. Chemical mutagens- base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents ii. Physical mutagen iii. Biological mutagen (only examples) <p>4.1.e. Ames test</p> <p>4.1.f. Detection of mutants</p> <p>4.2. DNA Repair</p> <p>4.2.a. Mismatch repair,</p> <p>4.2.b. Light repair</p> <p>4.2.c. Repair of alkylation damage</p> <p>4.2.d. Base excision repair</p> <p>4.2.e. Nucleotide excision repair</p> <p>4.2.f. SOS repair</p>	<p><u>15 Lectures</u></p> <p>1 Lectures</p> <p>1 Lecture</p> <p>1 Lectures</p> <p>4 Lectures</p> <p>1 Lectures</p> <p>1 Lectures</p> <p>5 Lectures</p>

USMB502	MEDICAL MICROBIOLOGY & IMMUNOLOGY-PART I	2.5 credits (60 LECTURES)
Unit	Title	No. of Lectures
I	Medical Microbiology – Respiratory and Urinary Tract Infections All infections are to be covered with respect to all details with emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, and Treatment.	15
1.1	URT(Upper Respiratory Tract infections)	
	<ul style="list-style-type: none"> a. Streptococcal Pharyngitis b. Diphtheria c. Measles:- Rubeola- Rubella Mumps 	5
1.2	LRT (Lower Respiratory Tract infections)	
	<ul style="list-style-type: none"> a. Tuberculosis b. Bacterial pneumonia c. Whooping cough 	7
1.3	UTI (Urinary Tract infections)	
	Pathogens & Factors Involved	3
II	Medical Microbiology – Gastrointestinal and Central Nervous System Infections	15
	GI (Gastrointestinal Tract Infections)	
2.1	<ul style="list-style-type: none"> a. Salmonella b. Shigella c. E.coli d. Rota virus e. Hepatitis A f. E.histolytica g. Food Poisoning: Staphylococcal, Botulism 	10
	CNS (Central Nervous System Infections)	

2.2	a. Tetanus b. Polio c. Bacterial Meningitis- Meningococcal, Pneumococcal and Haemophilus	5
III	General Immunology	15
3.1	Cells of immune system	
3.1.a.	T-cells, B-cells, NK-cells	2
3.2	Cytokines	3
3.2.a.	Properties and Functions	
3.2.b.	Cytokines secreted by Th1 and Th2 cells	
3.3	Antigen presenting cells	3
3.3.a.	Antigen presentation and processing pathways, (Cytosolic and Endocytic pathway)	
3.4	MHC complex and MHC Molecules.	3
3.4.a	Organization of MHC genes	
3.4.b.	Structure of class I and class II molecules	
3.4.c.	T cell antigen receptors and MHC molecules.	
3.5	Complement System	4
3.5.a.	Complement components and notations	
3.5.b.	Complement activation (classical pathway, Alternate pathway, Lectin pathway)	
3.5.c.	Biological consequences of complement activation	
IV	T Cells , B Cells and Immune Responses	15
4.1	T cells	6
4.1.a	Receptors, structure and organization	
4.1.b.	T cell development and maturation, positive and negative selection	
4.1.c	T cell activation- TCR Coupled Signaling pathway, Costimulatory signals,	
4.1.d.	T cell differentiation- Generation of effector and memory cells,	
4.2	B cells	4
4.2.a.	Receptors----structure & organization	
4.2.b.	B cell development and maturation	
4.2.c	B cell activation and differentiation – i)Thymus dependent and independent antigens, ii) B cell activating signals, iii) Role of Th cells in Humoral response, formation of T – B conjugates, CD40 / CD40L interaction, Th cell cytokine signals.	

4.3	Humoral response	3
4.3. a.	Induction of Humoral response, Primary and secondary responses	
4.3. b.	Germinal centers and antigen induced B cell differentiation	
4.3. c	Affinity maturation and somatic hyper mutation, Ig diversity, class switching	
4.3.d	Generation of plasma cells and memory cells, synthesis, assembly and secretion of immunoglobulins.	
4.4	Cell mediated effector response	2
4.4.a	Generation and target destruction by Cytotoxic T cells.	
4.4.b	Killing mechanism of NK cells.	
4.4.c	Antibody dependent cell cytotoxicity (ADCC)	

Course Code	Title	Lectures
USMB503	MICROBIAL BIOCHEMISTRY (Part- I)	2.5 Credits (60 Lectures)
<u>UNIT I</u> <u>SOLUTE TRANSPORT</u>		<u>15 Lectures</u>
1.1 Methods of studying solute transport 1.2 Role of membrane in solute transport 1.3 Mechanism for uptake of solutes <ul style="list-style-type: none"> a. Passive diffusion b. Facilitated diffusion c. Active transport- Primary active transport- Shock sensitive system (eg. Histidine uptake model, Maltose uptake), Secondary active transport (Uniport, Antiport, Symport) d. Group translocation e. Other examples of solute transport- Iron transport: A special problem, assembly of proteins in to membranes and protein export 		2 Lectures 2 Lecture 8 Lectures 3 Lectures
<u>UNIT II</u> <u>BIOENERGETICS & BIOLUMINESCENCE</u>		<u>15 Lectures</u>
2.1 Bioenergetics (13 lectures) <ul style="list-style-type: none"> a. Electron transport chain: components, complexes and functions of Mitochondrial ETC , Prokaryotic ETC [Organotroph – <i>E. coli</i> - aerobic and anaerobic(only schematic), Lithotroph – <i>Nitrosomonas</i> (Only schematic)] b. Oxidative phosphorylation by Chemiosmotic coupling hypothesis c. Structure of bacterial ATP synthase & Mitochondrial ATP synthase, Mechanism by Rotational catalysis d. Other modes of generation of electrochemical energy- Oxalate formate exchange, Decarboxylases dependent ion transport (for <i>K. pneumoniae</i>), End product efflux, ATP hydrolysis (enlist the mechanisms without detailing) e. Calculation of energetics of glycolysis, TCA and Beta oxidation of fatty acid (palmitic acid) – balance sheet to be given with efficiency calculation f. Bacteriorhodopsin: Photo cycle & significance 		13 Lectures 2 Lectures
2.2 Bioluminescence Introduction, ETC, Significance,/ Application		
<u>UNIT III</u> METHODS OF STUDYING METABOLISM & CATABOLISM OF CARBOHYDRATES		

<p>3.1 Methods of studying metabolism</p> <p>a. Use of biochemical mutants, Isotopic labeling, (Including radiorespirometry with reference to EMP&ED), sequential induction technique</p> <p>3.2 Catabolism of Carbohydrates</p> <p>a. Breakdown of polysaccharides – glycogen, starch, cellulose</p> <p>b. Breakdown of oligosaccharides – lactose, maltose, sucrose</p> <p>c. Utilization of monosaccharides – fructose, galactose, mannose</p> <p>d. Major pathways- Glycolysis (EMP), HMP Shunt, ED pathway, Phosphoketolase pathway (pentose phosphoketolase), <i>Bifidobacterium</i> pathway</p> <p>e. Citric acid cycle, anaplerotic reactions, glyoxylate bypass, Incomplete TCA in anaerobic bacteria</p>	<p>2 lectures</p> <p>13 lectures</p>
<p><u>UNIT IV</u> CATABOLISM & ANABOLISM OF CARBOHYDRATES</p> <p>4.1 Catabolism of Carbohydrates - Other modes of fermentations in microorganisms: alcohol, mixed acid, butanediol, butyric acid, butanol-acetone, propionic acid (Acrylate pathway).</p> <p>4.2 Amphibolic pathways: role of EMP and TCA cycle</p> <p>4.3 Anabolism of Carbohydrates</p> <p>a. Gluconeogenesis</p> <p>b. Biosynthesis of glycogen</p> <p>c. Biosynthesis of Peptidoglycan</p>	<p><u>15 Lectures</u></p> <p>7 lectures</p> <p>1 lecture</p> <p>7 lectures</p>

Course Code	Title	Lectures
USMB 504	BIOPROCESS TECHNOLOGY – Part I	2.5 Credits (60 Lectures)
<u>UNIT I</u> <u>UPSTREAM PROCESSING – Part 1 : Media Preparation and strain improvement</u>		<u>15 Lectures</u>
1.1. Industrial Strains 1.1.a. Strain improvement (One example of each method of strain improvement for primary and secondary metabolite)		7 Lectures
1.2. Fermentation Media Design 1.2.a. Buffers, precursors, steering agents, inducers, inhibitors, antifoam agents, trace elements, Animal cell culture media		3 Lectures
1.3. Asepsis and Sterilization 1.3.a. Sterilization & maintenance of aseptic conditions - vessels, medium, additives, air		5 Lectures
<u>UNIT II</u> <u>UPSTREAM PROCESSING – Part 2 : Fermentation equipment and process monitoring</u>		<u>15 Lectures</u>
2.1. Fermentation Equipments 2.1.a. Mode of operation (Batch, fed-batch, semi-continuous, continuous, SSF) 2.1.b. Power Input for mixing (mechanical, hydrodynamic and pneumatic) 2.1.c. Types of fermentors - typical constructional features and their importance in the specific processes. <ul style="list-style-type: none"> i. Mechanical - Waldhof fermenter, trickling generator ii. Hydrodynamic- deep-jet fermenter iii. Pneumatic - air-lift fermenter, bubble-cap fermenter, acetator, cavitator. iv. Animal cell culture reactors. v. Photo-bioreactor, tower and packed tower fermenters, 		10 Lectures
2.2. Process parameter monitoring and control 2.2.a. Temperature, flow, pressure, dissolved oxygen, foam, inlet and exit gases, pH		5 Lectures
<u>UNIT III</u> <u>TRADITIONAL INDUSTRIAL FERMENTATIONS – Part 1 : Production of microbial cells and yeast fermentations</u>		<u>15 Lectures</u>
3.1. Beer –Ale and Lager 3.2. Wine –Red and white 3.3. Vinegar (acetator) 3.4. Alcohol from molasses 3.5. Mushrooms (Agaricus bisporus) 3.6. Baker's and Brewer's yeast		

3.7. Probiotic foods & nutraceuticals	
3.8. Vaccines -General Manufacturing aspects and quality control	
<u>UNIT IV</u> <u>TRADITIONAL INDUSTRIAL FERMENTATIONS – Part 2 :</u> <u>Production of primary and secondary metabolites</u> 4.1. Penicillins and semisynthetic penicillins 4.2. Streptomycin 4.3. Vitamin B12 from Propionibacterium 4.4. Glutamic Acid (direct) 4.5. Citric acid - Stationary culture 4.6. Biotransformation of Steroids 4.7. Amylase enzyme production (Solid state fermentation)	<u>15 Lectures</u>

Semester V

Practicals

Course code: USMBP05

[Practicals Based on USMB501, Credits -1.5, Lectures- 60]

1. UV survival curve – determination of exposure time leading to 90% reduction
2. Isolation of mutants using UV mutagenesis
3. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant
4. Isolation and detection of plasmid DNA.
5. Preparation of competent cells and transformation
6. Genetics problems.

Course code: USMBP05

[Practical Syllabus Based on USMB502, Credits: 1.5, Lectures : 60]

1. Schematic /diagrammatic representation of each system/condition as per the theory syllabus (Respiratory, Urinary, Gastro-intestinal, Central Nervous Systems, Bacteremia,)
2. “Diagnostic Cycle” of any one infection of each of the above systems (viz., in upper respiratory tract: Pharyngitis)
3. Samples of various forms/procedures used for diagnostic tests - Request forms, Test-reports, (Results, Panic report, alert report) to be drawn or attached in the journal.
4. Tabulation of:
 - A. Types of samples, containers, specimens, with reference to the symptoms/ infections.
 - B. Transport media with reference to samples/suspected pathogen.
 - C. Collection and Processing of samples in various infections.
 - D. Primary isolation of suspected pathogens in different infections with reference to pathological samples.

- E. Rapid tests for identification of pathogens e.g. oxidase, catalase, staining (Acid fast, Metachromatic granules, Capsule)
- F. Minimum biochemical media for identification of the pathogens listed in the syllabus i.e. *S. aureus*, *S. pyogenes*, *E. coli*, *Klebsiella spp(any one)*., *Salmonella spp(any one)*., *Shigella spp(any one)*.,, *Proteus spp(any one)*., *Pseudomonas spp.(any one)*.
- G. List of samples to be used with the above:
- i. **URT**: Nasal swab, pus,
 - ii. **LRT** : sputum,
 - iii. **GIT**: Faeces, Rectal swab,
 - iv. **UTI**: Urine,
 - v. **Bacteraemia**: Blood,
 - vi. **CNS**: CSF.
5. Case study and problem solving for identification of the pathogen with reference to each of the infections (Include approach writing, suspected organisms, requirements for the identification tests and their justification rapid tests).
6. Differential Blood Count.

Course code: USMBP06

[Practical Syllabus Based on USMB503, Credits: 1.5, Lectures: 60]

- a. Isolation of bioluminescent bacteria from fish
- b. Study of biochemical pathway and study of endproducts of enzymes in characterization of microorganisms
 - i. Detection of lysine decarboxylase enzyme
 - ii. Oxidative and fermentative utilization of glucose by microbes
 - iii. Phosphatase activity detection-qualitative & quantitative
 - iv. Detection of penicillinase activity
 - v. Detection of homo and mixed acid fermentation
- c. Isolation of mitochondria and assay for ETC activity

Course Code : USMBP - 6 [Practical Syllabus Based on USMB504 Semester V

Credits : 1.5,Lectures : 60]

Practicals Based on USMB 504

1 Chemical estimation of Penicillin

- 2 Bioautography.
- 3 Isolation of lactic acid bacteria from Probiotic foods
- 4 Sugar and alcohol tolerance of *Saccharomyces cerevesiae*
- 5 Ethanol productions from jaggery
 - a. Chemical estimation of sugar by Cole's Method
 - b. Estimation of Alcohol produced by dichromate method
 - c. Efficiency of fermentation
- 6 Visits:
 - A. Antibiotic production plant or Pharmaceutical Industry.
 - B. Vaccine Production plant (Animal/ Human).

Semester V: Text Books and References

USMB501: Text books

1. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., 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 ed., Macmillan worth Publishers.
5. M.Madigan, J.Martinko, J.Parkar, (2009), "Brock Biology of microorganisms", 12th ed., 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 edn. Mc Graw Hill international edition.
9. Nancy Trun and Janine Trempy, (2004), "Fundamental bacterial genetics", Blackwell Publishing

Reference books:

1. Benjamin Lewin, "Genes IX", , Jones and Bartlett publishers.
2. JD Watson, "Molecular biology of the gene", , 5th edn.
3. Snustad, Simmons, "Principles of genetics", 3rd edn. John Wiley & sons, Inc.

USMB502: TEXT BOOKS

UNIT I and II

1. Ananthanarayan and Paniker, (2009), "Textbook of Microbiology", 8th Edition. Universal Press
2. Cedric Mims et al, " Medical Microbiology", 3rd Edition Mosby
3. Prescott, Harley, Klein, "Microbiology",. 6th/7th Edition McGraw Hill
4. Konemann, "Diagnostic Microbiology", 5th and 6th Edition. Lippincott
5. Teri Shors Jones "Understanding Viruses" Bartlett Publisher

UNIT III and IV

1. Richard A. Goldsby, Janis Kuby, "Immunology", , 6th and 7th Edition. W. H.Freeman and company.
2. Fahim Halim Khan, "The elements of Immunology",. Pearson Education.

3.. Pathak, S., Palan U, “Immunology Essential and Fundamental” ,2nd Edition.

Capital Publishing company.(3rd edition Ref.)

4. Ian R. Tizard, “Immunology, An Introduction”, 4th - Edition, Saunders college publishing

USMB503 : Text books

1. Stanier.R.Y., Ingrahm,J.L., Wheelis, M.L., Painter, R.R.,(1987) General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn , Stmpf, P. K., Bruening, G. R. H.(1987) Outlines of Biochemistry, 5th edition, John Wiley & sons
3. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D, Cox, M,(2005), Lehninger Principles of biochemistry,4th edition, W. H. Freeman and Company

Reference books:

1. Voet, D & Voet, J. G., (2004), Biochemistry, 3rd edition, John Wiley& Sons Inc
2. Zubey, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
3. Zubey, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers

USMB504 Text Books

1. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Stanbury P. F., Whitaker A. & Hall--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Crueger W. and Crueger A. 2000 "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
4. Prescott and Dunn's "Industrial Microbiology".1982 4th Edition, McMillan Publishers
5. Ratledge & B. Kristinsen 2nd edn 2006. "Basic Biotechnology". Cambridge University Press.

Reference Books

1. Pepler, H. J. and Perlman, D. (1979), "Microbial Technology". Vol 1 & 2, Academic Press
2. Agrawal A. K. and P. Parihar 2005. "Industrial Microbiology"- Fundamentals and Application AGRIBIOS (India)
3. H. A. Modi, 2009. "Fermentation Technology" Vols 1 & 2, Pointer Publications, India
4. Okafor Nkuda 2007 "Modern Industrial Microbiology and Biotechnology", Science Publications Enfield, NH, USA.

SEMESTER VI

Microbiology: Detail Syllabus

Course Code	Title	Lectures
USMB601	Recombinant DNA technology, Bioinformatics & Virology	2.5 Credits (60 Lectures)
<p><u>Unit I</u></p> <p><u>Recombinant DNA technology</u></p> <p>1.1. Basic steps in Gene Cloning.</p> <p>1.2. Cutting and joining DNA molecules--Restriction and modification systems, restriction endonucleases, DNA ligases</p> <p>1.3. Vectors 1.3.a. Plasmids as cloning vectors. The plasmid vectors, pBR322 vector 1.3.b. Cloning genes into pBR322 1.3.c. Phage as cloning vectors, cloning genes into phage vector 1.3.d. Cosmids 1.3.e. Shuttle vectors 1.3.f. YAC</p> <p>1.4. Methods of transformation</p> <p>1.6. Applications of recombinant DNA technology</p>		<p><u>15 Lectures</u></p> <p>2 Lectures</p> <p>3 Lectures</p> <p>3 Lectures</p> <p>2 Lectures</p> <p>3 Lectures</p> <p>2 Lectures</p>
<p><u>Unit II</u></p> <p><u>Basic Techniques & Bioinformatics</u></p> <p>2.1. Basic techniques 2.1.a. Southern, Northern and Western blotting. 2.1.b. Autoradiography</p> <p>2.2. Screening and selection methods for identification and isolation of recombinant cells</p> <p>2.3. PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)</p> <p>2.4. Bioinformatics 2.4.a. Introduction i. Definition, aims, tasks and applications of</p>		<p><u>15 Lectures</u></p> <p>3 Lectures</p> <p>2 Lectures</p> <p>2 Lectures</p> <p>8 Lectures</p>

<p>Bioinformatics.</p> <p>ii. Database, tools and their uses -</p> <ul style="list-style-type: none"> ➤ Importance, Types and classification of databases ➤ Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. ➤ Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D. Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. <p>2.4.b. Brief introduction to Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation,</p> <p>2.4.c. Sequence alignment-- global v/s local alignment, FASTA, BLAST.</p> <p>2.4.d. Genomics- structural, functional and comparative genomics.</p> <p>2.4.e. Proteomics- structural and functional proteomics.</p>	
<p><u>Unit III</u></p> <p><u>Basic Virology</u></p> <p>3.1. Viral architecture-</p> <p>3.1.a. Capsid, viral genome and envelope</p> <p>3.1.b. Structure of TMV, T4, Influenza virus, HIV.</p> <p>3.2. Viral classification</p> <p>3.3. The viral replication cycle- attachment, penetration, uncoating, types of viral genome and their replication, assembly, maturation and release. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail</p> <p>3.4. Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals</p>	<p><u>15 Lectures</u></p> <p>3 Lectures</p> <p>1 Lectures</p> <p>8 Lectures</p> <p>3 Lectures</p>
<p><u>Unit IV</u></p> <p><u>Advanced Virology</u></p> <p>4.1. Visualization and enumeration of virus particles</p> <p>4.1.a. Measurement of infectious units</p> <ul style="list-style-type: none"> i. Plaque assay ii. Fluorescent focus assay iii. Infectious center assay iv. Transformation assay v. Endpoint dilution assay. <p>4.1.b. Measurement of virus particles and their components</p> <ul style="list-style-type: none"> i. Electron microscopy ii. Atomic force microscopy iii. Haemagglutination 	<p><u>15 Lectures</u></p> <p>8 Lectures</p>

iv. Measurement of viral enzyme activity.	
4.2. Regulation of lytic and lysogenic pathway of lambda phage	3 Lectures
4.3. Role of viruses in cancer	2 Lectures
4.4. Prions and viroids	2 Lectures

COURSE CODE	MEDICAL MICROBIOLOGY AND IMMUNOLOGY- PARTII	2.5CREDITS
USMB602		(60 LECTURES)
Unit	Topic	No. of Lectures
1	Medical Microbiology All infections are to be covered with respect to all details with emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab Diagnosis, Prophylaxis, and Treatment.	15
1.1	Sexually Transmitted Diseases	
a.	HIV infection	
b.	Syphilis	
c.	Hepatitis B	6
1.2	Skin Infections	
a.	Pyogenic Staphylococcal& Streptococcal infections	
b.	Leprosy and Malaria	
c.	Pseudomonas	8
1.3	Emerging Infections	

a.	H1N1	
b.	Avian flu	1
II	Chemotherapy	15
2.1	Basics – a. History & development of chemotherapy b. General properties of antimicrobial agents c. Attributes of an ideal antimicrobial agent	1
2.2	Drug Resistance; Origin, Mechanisms & Transmission	3
2.3	Selection & Testing : (include E-test & Checker Board Assay)	2
2.4	Principal Groups of Antibacterial Agents & Mechanism of Action (Tabulation & Mechanism of action)- a. Cell wall inhibitors, b. Inhibitors of protein synthesis c. Inhibitors of Nucleic Acid synthesis, d. Cell membrane disruptors, e. Antimetabolites	6
2.5	Quality Assurance in Diagnostics- Concepts of Quality Assurance in Diagnostics	3
III	Immune System in Health and Diseases-Part I	15
3.1	Antigen-Antibody Reactions	7
	Precipitation, agglutination, passive agglutination, agglutination inhibition, Complement Fixation, Radioimmunoassay (RIA), Enzyme immunoassays (EIA), Immunofluorescence, western blot technique	
3.2	Vaccines	8
3.2.a.	Active and passive immunization	
3.2.b.	Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant vector vaccines, DNA vaccines,	
3.2.c.	Use of adjuvants in vaccine	

3.2.d.	New vaccine strategies	
3.2.e	Ideal vaccine	
3.2.f.	Route of vaccine administration, Vaccination schedule, Failures in vaccination.	
IV	Immune System in Health and Diseases-Part II	15
4.1	Immunohaematology	3
4.1.a.	Human blood group systems, ABO, secretors and non secretors, Bombay Blood group. Rhesus system and list of other blood group systems.	
4.1.b.	Haemolytic disease of new borne, Coombs test.	
4.2	Hypersensitivity	5
4.2.a.	Coombs and Gells classification	
4.2.b.	Type I to Type IV hypersensitivity, Mechanism and manifestation.	
4.3	Autoimmunity	2
4.3.a	Definition of immune tolerance	
4.3.b.	Definition Immune suppression and autoimmunity	
4.3.c.	Study of autoimmune diseases-Hashimoto's Thyroiditis, Autoimmune anemias, IDDM, Graves disease, SLE, Rheumatoid arthritis.	
4.4	Transplantation immunology	3
4.4.a.	Terms used to denote different types of transplants.	
4.4.b.	Types of graft rejection, Clinical manifestation of graft rejection	
4.4.c.	General and specific immunosuppressive therapy Only enlisting	
4.5	Monoclonal antibodies- Preparation, applications,	2

Course Code	Title	Lectures
USMB603	MICROBIAL BIOCHEMISTRY PART II	2.5 Credits (60 Lectures)
<u>UNIT I</u> <u>CATABOLISM OF LIPIDS & PROTEINS</u>		15 lectures
1.1 Lipid catabolism		6 Lectures
<ul style="list-style-type: none"> a. Oxidation of saturated fatty acid-β oxidation pathway b. Oxidation of propionic acid c. Oxidation of saturated aliphatic hydrocarbon (n-alkane)-Omega oxidation pathway- Pathway in <i>Corynebacterium</i> and yeast, Pathway in <i>Pseudomonas</i> d. Degradation of poly beta Hydroxyl butyrate 		
1.2 Protein catabolism		9 lectures
<ul style="list-style-type: none"> a. Enzymatic degradation of proteins b. Metabolic fate of amino acids (schematic only) c. Metabolism of single amino acids –Deamination, decarboxylation, and transamination d. Fermentation of single amino acids - Glutamic acid by <i>Clostridium glutamicum</i>, Alanine by <i>Clostridium propionicum</i> e. Fermentation of pair of amino acids (Stickland reaction) 		
<u>UNIT II</u> <u>CATABOLISM OF NUCLEIC ACIDS, AROMATIC COMPOUNDS & ANABOLISM OF LIPIDS, PROTEINS AND NUCLEIC ACIDS</u>		<u>15 Lectures</u>
2.1 Nucleic acid Catabolism		2 Lectures
<ul style="list-style-type: none"> a. Degradation of purine nucleotides up to uric acid formation b. Recycling of purines and pyrimidines nucleotides by salvage pathway 		
2.2 Catabolism of aromatic compounds		3 Lectures
<ul style="list-style-type: none"> a. Schematic representation for conversion of various aromatic compounds to catechol and protocatechuic acid b. Catabolism of catechol and protocatechuic acid by ortho and Meta cleavage 		
2.3 Anabolism of Lipids		3 lectures
<ul style="list-style-type: none"> a. Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) b. Biosynthesis of PHB 		
2.4 Anabolism of Proteins		1 lecture
<ul style="list-style-type: none"> a. Schematic representation of amino acid families b. Synthesis of amino acids of Serine family- Examples - serine, cysteine, glycine 		
2.5 Anabolism of Nucleic Acids		

Synthesis of ribonucleotides and deoxyribonucleotides	6 lecture
<u>UNIT III</u> METABOLIC REGULATION (15)	<u>15 Lectures</u>
<p>3.1 Cellular control mechanism acting at various levels of metabolism (tabulation only)</p> <p>3.2 Allosteric proteins – Role as enzymes (no kinetic study) and regulatory proteins (eg. Lac repressor, Ara repressor, CAP protein)</p> <p>3.3 Regulation of gene expression- Introduction to operon model and positive and negative regulation of operons</p> <p style="padding-left: 20px;">a. By DNA binding proteins eg. Lac operon, Ara operon, Catabolite repression</p> <p style="padding-left: 20px;">b. By Multiple Sigma Factors</p> <p>3.4 Regulation of enzyme activity (Enzyme inhibition / activation)</p> <p style="padding-left: 20px;">a. Mechanism of End-Product Inhibition End-Product Inhibition in branched pathways- Isofunctional enzymes, concerted feedback Inhibition, sequential feedback inhibition, Cumulative Feedback Inhibition, Combined activation and inhibition</p> <p style="padding-left: 20px;">b. Covalent modification of regulatory of enzymes – Glutamine synthetase system of <i>E.coli</i></p> <p style="padding-left: 20px;">c. Regulation by proteolytic cleavage</p> <p>3.5 Regulation of EMP & TCA.</p>	<p>3 Lectures</p> <p>5 Lectures</p> <p>4 Lectures</p> <p>3 lectures</p>
<u>UNIT IV</u> <u>PROKARYOTIC PHOTOSYNTHESIS & INORGANIC METABOLISM</u>	<u>15 Lectures</u>
<p>4.1 Prokaryotic photosynthesis</p> <p style="padding-left: 20px;">a. The phototrophic prokaryotes (Oxygenic phototrophs, Anoxygenic phototrophs examples only)</p> <p style="padding-left: 20px;">b. Photosynthetic pigments and photosynthetic apparatus</p> <p style="padding-left: 20px;">c. Light reactions of purple photosynthetic bacteria, green sulphur bacteria (only schematic) and cyanobacteria (with details)</p> <p style="padding-left: 20px;">d. Dark reaction: Calvin Benson cycle and reductive TCA</p> <p>4.2 Inorganic Metabolism</p> <p style="padding-left: 20px;">a. Assimilatory pathways- Assimilation of nitrate, Ammonia fixation, Biological nitrogen fixation (Mechanism for N₂ fixation and protection of nitrogenase), Assimilation of sulphate</p> <p style="padding-left: 20px;">b. Dissimilatory pathways- Nitrate as an electron acceptor</p>	<p>7 Lectures</p> <p>8 lectures</p>

<p>(Denitrification in <i>Paracoccus denitrificans</i>), Sulphate as an electron acceptor</p> <p>c. Lithotrophy - Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron.</p>	
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Course Code	Title	Lectures
USMB 604	BIOPROCESS TECHNOLOGY (Part- II)	2.5 Credits (60 Lectures)
<u>UNIT I</u> <u>DOWNSTREAM PROCESSING</u>		15 Lectures
1.1. Fermentation Product Recovery 1.1.a. Criteria for choice of recovery process 1.1.b. Biomass separation from fermentation media i. Precipitation ii. Filtration, filter aids, plate frame and rotary vacuum filters iii. Centrifugation - Cell aggregation and flocculation, 1.1.c. Cell Disruption for intracellular products 1.1.d. Solvent extraction and recovery 1.1.e. Chromatography—Ion exchange 1.1.f. Membrane processes 1.1.g. Drying 1.1.h. Crystallization 1.1.i. Whole broth processing		10 Lectures
1.2. Industrial Effluent Treatment 1.3. Fermentation Economics - Isolation, strain improvement, market potential, equipment, media, air sterilization, temperature control, aeration and agitation, recovery, water recycling, effluent treatment		3 Lectures 2 Lectures
<u>UNIT II</u> <u>QUALITY ASSURANCE AND BIOINSTRUMENTATION</u>		15 Lectures
2.1. Quality Assurance 2.1.a. Definitions---GMP, QA, QC 2.1.b. QC of raw materials, in-process items, finished products, packaging materials, labels 2.1.c. Sterility assurance and testing 2.1.d. Microbiological Assays		5 Lectures
2.2. Bioinstrumentation – Principles, working and applications of 2.2.a. Spectroscopic techniques 2.2.f. Spectrophotometry (U.V., Visible, I. R) 2.2.g. Fluorimetry 2.2.h. Flame photometry 2.2.i. Radioisotopes and autoradiography		10 Lectures

<p><u>UNIT III</u> <u>ADVANCES IN BIOPROCESSES</u></p> <p>3.1. Animal Cell Cultivation and applications 3.1.a. Animal Cell Lines 3.1.b. Methods of cultivation and establishment of cell lines 3.1.c. Large scale cultivation procedures 3.1.d. Applications in production of tPA, Blood factor viii and erythropoietin</p> <p>3.2. Plant Tissue Culture 3.2.a. Methods of cultivation of organ culture, callus culture and cell suspension culture 3.2.b. Application in Agriculture (Disease resistant plants, virus free plants) Horticulture (Micropropagation) Industry (secondary metabolites production), Transgenic plant (Insect resistant plants)</p> <p>3.3. Synthesis of Nanomaterials by Biological methods and Applications in biotechnology and medical field</p>	<p><u>15 Lectures</u></p> <p>6 Lectures</p> <p>6 Lectures</p> <p>3 Lectures</p>
<p><u>UNIT IV</u> <u>BIOTECHNOLOGICAL PRODUCTS AND REGULATORY PRACTICES</u></p> <p>4.1. Enzyme Technology 4.1.a. Enzyme Immobilization methods 4.1.b. Applications in therapeutic uses, Analytical uses and Industrial uses</p> <p>4.2. Commercial Products from Recombinant Microorganisms - Indigo, Bioflavours, Melanin, Biopolymer, Polyhydroxyalkanoate, Rubber, Recombinant proteins of high value</p> <p>4.3. Intellectual Property Rights 4.3.a. Introduction to IPR – What is intellectual property? Genesis of IPR (WIPO, GATT, TRIPs) 4.3.b. Types of intellectual property – i. Patents ii. Copyright iii. Trademark iv. Trade secret v. Plant varieties protection act 4.3.c. Patents – i. Patent system terminologies ii. Categories of patents iii. Preparation of patent ▪ Criteria for patenting ▪ Patent specification – standard format ▪ Typical patenting procedure ▪ Rights of a patentee iv. Uses of patent system</p>	<p><u>15 Lectures</u></p> <p>6 Lectures</p> <p>4 Lectures</p> <p>5 Lectures</p>

Semester VI – Practicals

Course Code: USMBP07

[Practical Syllabus Based on USMB601 Credits: 1.5, Lectures: 60]

1. Isolation of genomic DNA of *E. coli*
2. Enrichment of coliphages, phage assay (pilot & proper).
3. Restriction analysis.
4. PCR (Demo)
5. Western Blot.(Demo)
6. Bioinformatics practical
 - A. Off Line Practical
 - i. Familiarity with your computer
 - ii. Installation of representative software for off line use – SPDBV and Bioedit
 - iii. Visualizing and manipulating Protein structure database files using SPDBV
 - iv. Sequence Alignment, dot plot, phylogenetic tree building exercise using Bioedit
 - B. On Line Practical
 - i. Visiting NCBI and EMBL websites & list services available, software tools available and databases maintained
 - ii. Visiting & exploring various databases mentioned in syllabus and
 - a. Give comparative account
 - b. Using BLAST and FASTA for sequence analysis
 - c. Fish out homologs for given specific sequences (by teacher – decide sequence of some relevance to their syllabus and related to some biological problem e.g. evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology – list can be really long and should be generated with the help of students while teaching topics in genetics, biochemistry, bioinformatics through out the year – illustrating power of informatics tools in biology)
 - d. Understand every item mentioned in the report generated, its significance and use in interpretation of results as well as limitations of the results.
7. Animal cell culture (demo)

Course Code: USMBP07

[Practical Syllabus Based on USMB602 Credits: 1.5, Lectures: 60]

1. Catalase, oxidase and biochemical identification tests for *S. aureus*, *S. pyogenes*, *Pseudomonas aeruginosa*.
2. Perform quality control tests of media, reagents, stains and equipment used in the syllabus - QC slips, for samples, reagents, stains, media, equipment validation.
3. Kirby-Bauer method for AST.
4. Synergistic activity of antibiotics.
5. E test (Demonstration).

6. Acid fast staining for *M. leprae*.
7. Determination of Isoagglutinin titre.
8. Blood Grouping, Direct & Reverse Typing. ABO & Rh grouping.
9. Coombs test – direct method.
10. Preparation of Typhoid vaccine and sterility checking
11. Antigen – Antibody Reactions: Agglutination – Widal (Demonstration); TRUST Antigen

Course Code: USMBP08

[Practical Syllabus Based on USMB603 Semester VI Credits: 1.5, Lectures: 60]

- a. Isolation of phenol degraders and estimation of residual phenol by 4-amino antipyrine method
- b. Estimation of β -galactosidase activity in induced and non-induced cells of *E. coli*
- c. To study catabolite regression by diauxic growth curve.
- d. Protein estimation by Lowry's method
- e. Estimation of uric acid

Course Code: USMBP - 8 [Practical Syllabus Based on USMB604 Semester VI

Credits : 1.5, Lectures : 60]

1. Bioassay of Penicillin and Vitamin B12.
2. Sterility testing of injectable (D/W ampoules)
3.
 - a. Estimation of BOD
 - b. COD from distillery effluent.
4. Immobilization of enzyme---preparation of alginate-enzyme/culture beads
5. Qualitative and quantitative activity estimation of enzyme / culture beads , viable count of bead culture.
6. Plant tissue culture (Demonstration)
7. Visits
 - A. Antibiotic production plant or Pharmaceutical Industry or Research
 - B. Application of Recombinant DNA in Industrial Production

Semester VI: Text Books and References

USMB 601: Text books:

1. Peter J. Russell (2006), "Genetics-A molecular approach", 2nd ed.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd ed., 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 ed., 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, (), "Molecular biology", , 3rd edn. Mc Graw Hill international edition.
11. Primrose and Twyman, (), "Principles of gene manipulation and genomics", 7th ed, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd Edition, Oxford University Press

Reference books:

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

USMB 602: TEXT BOOKS:

UNIT I and II

1. Ananthanarayan and Paniker, (2009), "Textbook of Microbiology", 8th Edition.Universal Press
2. Cedric Mims et al, " Medical Microbiology", 3rd Edition Mosby
3. Prescott, Harley, Klein, "Microbiology",. 6th Edition McGraw Hill
4. Konemann, "Diagnostic Microbiology", 5th and 6th Edition. Lippincott
5. Teri Shors Jones "Understanding Viruses" Bartlett Publisher

UNIT III and IV

1. Richard A. Goldsby, Janis Kuby, "Immunology", , 5th and 6th Edition. W. H.Freeman and company.
2. Fahim Halim Khan, "The elements of Immunology",. Pearson Education.

3. Pathak, S., Palan U, "Immunology Essential and Fundamental", 2nd Edition. Capital Publishing Company.
4. Ian R. Tizard, "Immunology, An Introduction", 4th - Edition, Saunders college publishing.

USMB 603: Text books:

1. Stanier.R.Y., Ingrahm,J.L., Wheelis, M.L., Painter, R.R.,(1987) General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn , Stmpf, P. K., Bruening, G. R. H.(1987) Outlines of Biochemistry, 5th edition, John Wiley & sons
3. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
4. White, D., (1995), The Physiology and Biochemistry of Prokaryotes, 3rd edition, Oxford University Press
5. Nelson, D, Cox, M,(2005), Lehninger Principles of biochemistry,4th edition, W. H. Freeman and Company

Reference books

1. Voet, D & Voet, J. G., (2004), Biochemistry, 3rd edition, John Wiley& Sons Inc
2. Zubey, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
3. Zubey, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers

USMB 604 Text Books:

1. Casida L. E., "Industrial Microbiology" 2009 Reprint, New Age International (P) Ltd, Publishers, New Delhi
2. Glick B.R. & Pasternak J. J., 2003, "Molecular Biotechnology, Principles and Applications of Recombinant DNA", 3rd Edition, ASM Press, Washington, USA
3. Stanbury P. F., Whitaker A. & Hall--S. J., 1997, "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
4. Crueger W. and Crueger A. 2000 "Biotechnology -"A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing Corporation, New Delhi.
5. Ratledge & B. Kristinsen 2nd edn 2006. "Basic Biotechnology". Cambridge University Press
6. R. C. Dubey, 2005 A Textbook of "Biotechnology" S. Chand and Company, New Delhi
7. Indu Shekar Thakur 2006 "Industrial Biotechnology" Problems and Remedies, I K International Pvt Ltd
8. S. K. Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing Co.
9. William and Wilson*

Reference Books

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology". Vol 1 & 2, Academic Press.
2. U. Satyanarayana 2005. "Biotechnology". Books and Allied (P) Ltd

3. Agrawal A. K. and P. Parihar 2005. "Industrial Microbiology"- Fundamentals and Application AGRIBIOS (India)
4. H. A. Modi, 2009. "Fermentation Technology" Vols 1 & 2, Pointer Publications, India
5. Okafor Nkuda 2007 "Modern Industrial Microbiology and Biotechnology", Science Publications Enfield, NH, USA.

Modality of Assessment:

Theory Examination Pattern:

A) **Internal Assessment - 40% marks.**

40

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 and half hours duration.
- ii. Theory question paper pattern :-
 1. There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units.
 2. All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
 3. Questions may be sub divided into sub questions a, b, c & d only, each carrying **six** marks **OR** a, b, c, d, e & f only each carrying **four** 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) :-

Sr.No.	Particulars	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 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 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

Semester V

Course	USMB-501			USMB-502			USMB-503			USMB-504			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200

Semester VI

Course	USMB-601			USMB-602			USMB-603			USMB-604			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practicals	-	50	50	-	50	50	-	50	50	-	50	50	200