R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Programme In Microbiology

T.Y.B.Sc. [Sem-V &VI]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Programme	**B.Sc. [Microbiology]**
Level	UG
No of Semesters	06
Year of Implementation	**2023-24**
ProgrammeSpecific Outcomes (PSO)	1] Learner shall know the various branches of Microbiology. 2] Learner shall know the role of microorganism in day to day life. 3] Learner shall able to Understand and identify the various Microorganisms. 4] Learner shall able to isolate and propagate various microorganisms. 5] Learner shall able to control microbial growth. 6] Learner shall know the fermentation of various fermented food products and industrial products by using microorganisms. 7] Learner should know the importance of microorganisms in infectious diseases.
Relevance of PSOs to the local, regional, national, and global developmental needs	Microorganism's role in nature is indispensable. They involved in biodegradation, Fermentation, Antibiotic production, etc. Likewise some are involved in disease generation too. Therefore the understanding of microorganisms becomes essential to propagate or to control its number. As microorganism is responsible for food spoilage, food borne diseases so the maintenance of quality standard high is important from local level to global level. With respect to this learner should know the branches of microbiology. As microorganisms are ubiquitous so learner should know the role of microorganism in day to day life. There are millions of different microbes present on earth so identification of those microbes is globally important. In addition to that such identification skills has great importance in an infectious diseases control. Industrial fermentation processes requires pure culture of microbes so the knowledge of isolation of pure culture and its propagation is essential. Contamination by unwanted microbes is a worldwide problem. Learners must know the methods of microbial growth control. The various decontamination methods is not only locally important but also it is globally essential. In a sterilized/controlled conditions only a good quality fermented food product can be prepared by specific microorganisms. Therefore learners should know skill and knowledge of such fermentation processes. Summarizing, graduates of B.Sc. Microbiology program will be informed citizens who can understand and apply basic microbiological technique at local to global level. It will be able to pursue wide range of careers including biological and life science research in higher educational institutions as well as careers in public health, clinical research, food, pharmaceutical and biotechnological industries.

T.Y.B.Sc. Microbiology Syllabus (General Outline)

(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

(SEMESTER VI)

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

Syllabus for T. Y. B. Sc. Microbiology Semester V

From the year 2023-24

Name of the Course	Microbial Genetics
Course Code	USMB501
Class	T.Y.B.Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial genetics is a subject area within microbiology and genetic engineering. Microorganisms have been used to study many processes and have had applications in various areas of study in genetics The learning of microbial genetics provides technical expertise in micro or molecular biology techniques. Microbial genetics can identify microorganisms at species, strains or sub strains levels. Microbial genetics can also study unique microbial characteristics such as virulence, antibiotic resistance and various microbial metabolic pathways using genetic analysis.

Nomenclature: Microbial Genetics

Course Outcomes:

1- The learner will understand the sequence of events, mechanism, enzymes and proteins involved in replication of DNA in prokaryotes and eukaryotes.

2- The student will know the central dogma of biology its two-step transcription and translation, maturation of RNA.

3- The learner will know the concept of mutation, its types, causes and their effects. This module will also make them understand types of mutagens, damage to DNA due to mutagenesis, various mechanisms of DNA repair.

4- The student shall understand the various mechanisms of gene transfer in bacteria and genetic recombination

Curriculum:

USMB501 – Microbial Genetics			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	DNA Replication	1.1. Historical perspective - Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication 1.2. Prokaryotic DNA replication - Details of molecular mechanisms involved in Initiation, Elongation and Termination 1.3. Enzymes and proteins associated with DNA replication- Primase, Helicase, Topoisomerase, SSB, DNA polymerases, Ligases, 1.4. Eukaryotic DNA replication - Molecular details of DNA synthesis, replicating the ends of the chromosomes. 1.5. Rolling circle mode of DNA replication	15 (1)
2	Transcription, Genetic Code and Translation	2.1 Central Dogma: An Overview, Transcription process, Transcription in bacteria - Initiation of transcription at promoters, elongation of an RNA chain, termination of an RNA chain. 2.2 Transcription in Eukaryotes - Eukaryotic RNA polymerase, Transcription of protein- coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self-Splicing of Introns, 2.3 Genetic code - Nature of genetic code and characteristics of genetic code. 2.4 Translation process - Transfer RNA, structure of tRNA, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA , Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell.	15 (1)
3	Mutation and Repair	3.1 Mutation 3.1.1 Terminology: alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes.	15 (1)

		3.1.2 Fluctuation test. 3.1.3 Types of mutations: Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. 3.1.4 Causes of mutation: Natural/spontaneous mutation-- replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for: 3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. 3.1.4.2 Physical mutagen 3.1.4.3 Biological mutagen (only examples) 3.1.5 Ames test 3.1.6 Detection of mutants 3.2 DNA Repair 3.2.1 Mismatch repair, 3.2.2 Light repair 3.2.3 Repair of alkylation damage 3.2.4 Base excision repair 3.2.5 Nucleotide excision repair 3.2.6 SOS repair	
4	Genetic Exchange & Homologous Recombination	4.1 Genetic analysis of Bacteria 4.2 Gene transfer mechanisms in bacteria 4.2.1 Transformation 4.2.1.1 Introduction and History 4.2.1.2 Types of transformation in prokaryotes-- Natural transformation in *Streptococcus pneumoniae*, *Haemophilusinfluenzae*, and *Bacillus subtilis*. 4.2.1.3 Mapping of bacterial genes using transformation. 4.2.1.4 Problems based on transformation. 4.2.2 Conjugation 4.2.2.1 Discovery of conjugation in bacteria 4.2.2.2 Properties of F plasmid/Sex factor 4.2.2.3 The conjugation machinery 4.2.2.4 Hfr strains, their formation and mechanism of conjugation 4.2.2.5 F' factor, origin and behavior of F' strains, Sexduction. 4.2.2.6 Mapping of bacterial genes using conjugation (Wolman and Jacob experiment).	15 (1)

		4.2.2.7 Problems based on conjugation 4.2.3 Transduction 4.2.3.1 Introduction and discovery 4.2.3.2 Generalized transduction 4.2.3.3 Use of Generalized transduction for mapping genes 4.2.3.4 Specialized transduction 4.2.3.5 Problems based on transduction	

Learning Resources recommended:

Text books:

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

Reference books:

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

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Medical Microbiology & Immunology: Part – I
Course Code	USMB502
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Medical microbiology and immunology conducts biochemical assays including biochemical identification of microorganisms. It performs testing for water samples including bacteria identification and specs limits monitoring for microorganism in water samples. Medical microbiology participates in the validation of sterility testing in compliance with FDA guidelines. Immunologists can work as scientists or clinicians across different areas of biomedical research and in diverse clinical specialties ranging from allergy to cancer.

Nomenclature: Medical Microbiology & Immunology: Part - I

Course Outcomes:

1- The learners will correlate these virulence factors with the pathogenesis and clinical features of the disease

2- The learners will study the mode of transmission, method of diagnosis and modes of prophylaxis of these diseases

3- The learners will understand the importance of cytokines, MHC, APCs, Cytokines, and the role in adaptive immunity.

4- The learners will understand the various antigen –antibody reactions

Curriculum:

USMB502 – Medical Microbiology & Immunology: Part - I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Bacterial Strategies for Evasion and Study of a Few Diseases	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 diarrheal 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 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. Pneumonia caused by *K .pneumoniae* 1.3. Study of urinary tract infections	15 (1)
2	Study of few diseases (w.r.t. Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)	2.1 Study of skin infections 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 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	15 (1)
3	General Immunology – I	3.1. Organs and tissues of the immune system: 3.1.1 Primary lymphoid organs - structure and	15 (1)

		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 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 3.3 Immunoglobulins 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. 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. (Only concept) 3.3.4 Immunoglobulin Superfamily	
4	General Immunology – II	4.1 Cytokines 4.1.1 Concepts - cytokines, lymphokines, monokines, interleukines, chemokines.	15 (1)

		4.1.2 Properties of cytokines 4.1.3 Attributes of cytokines 4.1.4 Biological functions of cytokines 4.2 Major histocompatibility complex 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 4.3.1 Types of APC's 4.3.2 Endogenous antigens: The cytosolic pathway (Diagram only) 4.3.3 Exogenous antigens: The endocytic pathway (Diagram only) 4.4 Antigen Antibody reactions 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.	

Learning Resources recommended:

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, 1 st& 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/

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Microbial Biochemistry: Part - I
Course Code	USMB503
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial biochemistry gains the molecular knowledge in virology, pharmacology and toxicology. It also provides a knowledge of data analysis, marketing and scientific communication. The study helps you to observe things from a completely new perspective to get them translated into new opportunities.

Nomenclature: Microbial Biochemistry: Part – I

Course Outcomes:

1- The learner will understand the architecture of the membrane and how solute is transported inside the cell.

2- The learner will understand the electron transport chains in prokaryotes and mitochondria and the mechanism of ATP synthesis.

3- The learner will understand experimental aspect of studying catabolism, anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.

4- The learner will understand various other pathways that produce different end products.

Curriculum:

USMB503 – Microbial Biochemistry: Part – I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Biological Membranes & Transport	1.1 Composition and architecture of membrane 1.1.1 Lipids and properties of phospholipid membranes 1.1.2 Integral & peripheral proteins & interactions with lipids 1.1.3 Permeability 1.1.4 Aquaporins 1.1.5 Mechanosensitive channels 1.2 Methods of studying solute transport 1.2.1 Use of whole cells 1.2.2 Liposomes 1.2.3 Proteoliposomes 1.3 Solute transport across membrane 1.3.1 Passive transport and facilitated diffusion by membrane proteins 1.3.2 Co-transport across plasma membrane - (Uniport, Antiport, Symport) 1.3.3 Active transport & electrochemical gradient 1.3.4 Ion gradient provides energy for secondary active transport 1.3.4.1 Lactose transport 1.3.5 ATPases and transport (only Na-K ATPase) 1.3.6 Shock sensitive system – Role of binding proteins 1.3.6.1 Maltose uptake (Diagram and description) 1.3.6.2 Histidine uptake (Diagram and description) 1.3.7 Phosphotransferase system 1.3.8 Schematic representation of various membrane transport systems in bacteria. 1.4 Other examples of solute transport: 1.4.1 Iron transport: A special problem 1.4.2 Assembly of proteins into membranes and protein export 1.4.3 Bacterial membrane fusion central to many biological processes	15 (1)
2	Bioenergetics & Bioluminescence	2.1 Biochemical mechanism of generating ATP: Substrate-Level Phosphorylation, Oxidative Phosphorylation & Photophosphorylation 2.2 Electron transport chain 2.2.1 Universal Electron acceptors that transfer	15 (1)

		electrons to E.T.C. 2.2.2 Carriers in E.T.C. 2.2.2.1 Hydrogen carriers – Flavoproteins, Quinones 2.2.2.2 Electron carriers – Iron Sulphur proteins, Cytochromes. 2.2.3 Mitochondrial ETC 2.2.3.1 Biochemical anatomy of mitochondria 2.2.3.2 Complexes in Mitochondrial ETC 2.2.3.3 Schematic representation of Mitochondrial ETC. 2.3 Prokaryotic ETC 2.3.1 Organization of electron carriers in bacteria 2.3.1.1 Generalized electron transport pathway in bacteria 2.3.1.2 Different terminal oxidases 2.3.2 Branched bacterial ETC 2.3.3 Pattern of electron flow in *E. coli* - aerobic and anaerobic 2.4 ATP synthesis 2.4.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential (definition of Standard reduction potential) 2.4.2 Free energy released during electron transfer from NADH to O2 2.4.3 Chemiosmotic theory (only explanation) 2.4.4 Structure & function of Mitochondrial ATP synthase 2.4.5 Structure of bacterial ATP synthase 2.4.6 Mechanism by Rotational catalysis 2.4.7 Inhibitors of ETC, ATPase and uncouplers 2.5 Other modes of generation of electrochemical energy 2.5.1 ATP hydrolysis 2.5.2 Oxalate formate exchange 2.5.3 End product efflux, Definition, Lactate efflux 2.5.4 Bacteriorhodopsin: - Definition, function as proton pump and significance	
3	Methods of Studying Metabolism & Catabolism of Carbohydrates	3.1 Experimental Analysis of metabolism 3.1.1 Goals of the study 3.1.2 Levels of organization at which metabolism is studied 3.1.3 Metabolic probes. 3.1.4 Use of radioisotopes in biochemistry	15 (1)

		3.1.4.1 Pulse labeling 3.1.4.2 Assay and study of radiorespirometry to differentiate EMP & ED 3.1.5 Use of biochemical mutants 3.2 Catabolism of Carbohydrates 3.2.1 Breakdown of polysaccharides - Glycogen, Starch, Cellulose 3.2.2 Breakdown of oligosaccharides - Lactose, Maltose. 3.2.3 Utilization of monosaccharides - Fructose, Galactose 3.2.4 Major pathways – (with structure and enzymes) 3.2.4.1 Glycolysis (EMP) 3.2.4.2 HMP Pathway - Significance of the pathway 3.2.4.3 ED pathway 3.2.4.4 TCA cycle - Action of PDH, Significance of TCA 3.2.4.5 Incomplete TCA in anaerobic bacteria 3.2.4.6 Anaplerotic reactions 3.2.4.7 Glyoxylate bypass 3.3 Amphibolic role of EMP; Amphibolic role of TCA cycle 3.4 Energetics of Glycolysis, TCA and ED pathway – Balance sheet only. Format as in Lehninger (2.5 ATP/NADH and 1.5 ATP / FADH2) (Based on this format make balance sheet for Glycolysis - Lactic acid and Alcohol fermentation and for ED pathway.	
4	Fermentative Pathway & Anabolism of Carbohydrates	4.1 Fermentative pathways (with structures and enzymes) 4.1.1 Lactic acid fermentation 4.1.1.1 Homofermentation 4.1.1.2 Heterofermentation 4.1.2 Bifidum pathway 4.1.3 Alcohol fermentation 4.1.3.1 By ED pathway in bacteria 4.1.3.2 By EMP in yeasts 4.2 Other modes of fermentation in microorganisms 4.2.1 Mixed acid 4.2.2 Butanediol 4.2.3 Butyric acid 4.2.4 Acetone-Butanol 4.2.5 Propionic acid (Acrylate and succinate	15 (1)

		propionate pathway) 4.3 Anabolism of Carbohydrates 4.3.1 General pattern of metabolism leading to synthesis of a cell from glucose. 4.3.2 Sugar nucleotides 4.3.3 Gluconeogenesis (only bacterial) 4.3.4 Biosynthesis of glycogen 4.3.5 Biosynthesis of Peptidoglycan	

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
2. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley &Sons. New York.
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. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry. 4th edition, W. H. Freeman and Company
6. Rose, A.H. (1976) Chemical Microbiology, 3rd edition. Butterworth-Heinemann
7. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
8. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
9. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Bioprocess Technology: Part – I
Course Code	USMB504
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Bioprocess technology is a part of industrial microbiology, which conducts environmental monitoring on manufacturing facility. Industrial microbiologists study and solve problems related to industrial production processes. Industrial microbiologists may responsible for research, product testing, quality control, product development and genetic engineering. It also supports and prepared protocol for startup and annual environmental monitoring for new facilities, environmental testing and disposition of microbial samples. It participates in the internal audits on microbiology test methods and activities to identify improvement opportunities.

Nomenclature: Bioprocess Technology: Part - I

Course Outcomes:

1- The learner shall study the applications of microbes and its strain improvement in Industrial Microbiology.

2- The learner shall understand design media, growth conditions and techniques for producing and recovering different types of products of commercial value.

3- The learner shall study the design of bioreactors for different applications and its process parameters.

4- Learner will be well-versed with the containment and levels of containment.

Curriculum:

USMB504 – Bioprocess Technology: Part – I			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Upstream Processing – I	1.1 Introduction 1.1.1 An introduction to fermentation processes 1.1.2 The range of fermentation processes 1.1.3 The Component parts of a fermentation process 1.2 Screening methods 1.2.1 Primary and secondary screening 1.2.2 High throughput screening methods 1.3 Strain improvement 1.3.1 The improvement of industrial microorganisms 1.3.2 The selection of induced mutants synthesizing improved levels of primary metabolites 1.3.3 The isolation of induced mutants producing improved yields of secondary metabolites. 1.4 Preservation of cultures 1.4.1 Preservation of industrially important organisms 1.4.2 Quality control of preserved stock 1.4.2.1. Development of a master culture bank (MCB)	15 (1)
2	Upstream Processing – II	2.1 Fermentation media formulation and raw materials 2.1.1 Media formulation 2.1.2 Raw materials for fermentation media 2.2 The development of inocula for industrial fermentations 2.2.1 Introduction 2.2.2 Development of inocula for unicellular bacterial process 2.2.3 Development of inocula for mycelial process 2.3 Sterilization and achievement of aseptic conditions 2.3.1 Introduction 2.3.2 Methods of batch sterilization 2.3.3 The design of continuous sterilization process 2.3.4 Sterilization of the Fermenter 2.3.5 Sterilization of the Feeds 2.3.6 Sterilization of the liquid wastes 2.3.7 Filter Sterilization 2.3.8.1 Filter sterilization of fermentation media, 2.3.8.2 Filter sterilization of air 2.4 Scale up and scale down of fermentation	15 (1)
3	Fermentation Modes, Equipments and Instruments	3.1 Modes of fermentation 3.1.1 Batch, continuous and fed batch fermentation 3.1.2 Solid substrate fermentation 3.2 Design of fermenter	15 (1)

		3.2.1 Basic functions 3.2.2 Aseptic operation & Containment 3.2.3 Body construction 3.2.4 Agitator (impeller) – function, types, mechanical seal and magnetic drive 3.2.5 Baffles 3.2.6 The aeration system (sparger) - function and types 3.2.7 Valves (Globe, piston & needle) 3.2.8 Examples of fermenters - Stirred Tank Reactor, Air Lift, Deep Jet, Photobioreactor 3.3 Instrumentation and control 3.3.1 Introduction to sensors and its types 3.3.2 Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis.	
4	Traditional Industrial Fermentations	4.1 Wine – Red, White, Champagne and Sherry: Alcoholic fermentation, composition of grape juice, Sulphur dioxide addition, factors affecting wine fermentation, examples and role of yeasts involved in fermentation, malolactic fermentation, technological aspects of wine making- red, white, champagne, sherry, examples of aroma compounds of wine, types and examples of wine 4.2 Beer – Ale and Lager: Elements of brewing process, process details, use of cylindro-conical vessel, primary fermentation, continuous fermentation, aging and finishing, yeasts involved in fermentation. 4.3 Alcohol from Molasses: Introduction, biosynthesis of ethanol, production process- preparation of nutrient solution, fermentation, recovery by distillation. 4.4 Vinegar (acetic acid): Introduction, biosynthesis, production using generator, production using submerged fermenter, recovery. 4.5 Baker's yeast: Outline of production, yeast strains and their properties, factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature, preparation of substrate, fermentation, harvesting of yeast cells, production of compressed and active dry yeast. 4.6 Fungal amylase production: $\propto$ amylase- production from bacteria and fungi, β amylase and glucoamylase, concentration and purification.	15 (1)

Learning Resources recommended:

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. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol. 1 & 2, Academic Press
5. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India.
6. OkaforNduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
8. Microbiology", 2nd edition, Panima Publishing Corporation, New Delhi.
9. Prescott and Dunn's ''Industrial Microbiology'' (1982) 4th edition, McMillan Publishers

Reference books:

1. R. C. Dubey, 2005 A Textbook of ''Biotechnology'' S. Chand and Company, New Delhi.
2. H. A. Modi, 2009. ''Fermentation Technology'' Vol: 1 & 2, Pointer Publications, India
3. Practical Fermentation Technology by Brian Mcneil& Linda M. Harvey (2008).

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practical of USMB501 and USMB502
Course Code	USMBP05
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The microbial genetics and immunology practicals are based on the variety of knowledge related to replica plate technique, UV mutagenesis and identification of microorganisms. Replica plate methods allows each clone to be tested by a variety of methods while retaining a master plate form, which clones, can be picked. It performs testing for water samples including bacteria identification and specs limits monitoring for microorganism in water samples.

Nomenclature: Practical of USMB501 and USMB502

Course Outcomes:

1- The learner will acquire the practical skills of laboratory techniques based on UV mutagenesis and UV survival curve.

2- The learner will acquire the knowledge of identification of isolates obtained from pus, sputum, stool and urine.

Curriculum:

USMBP05 – Practical of USMB501 and USMB502		
Title	**Learning Points**	**No of Lectures**
Microbial Genetics	1. UV survival curve – determination of exposure time leading to 90% reduction 2. Isolation of mutants using UV mutagenesis 3. Gradient plate technique (dye resistant mutant) 4. Replica plate technique for selection & characterization of mutants – auxotroph & antibiotic resistant.	60(2)
Medical Microbiology & Immunology: Part - I	1. Acid fast staining. 2. Identification of Candida species using the germ tube test and growth on Chrom agar 3. Study of standard cultures *E. coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonallatyphi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus* 4. Identification of isolates obtained from pus, sputum, stool and urine by morphological, cultural and biochemical properties. 5. Antigen Preparation: O & H antigen preparation of Salmonella. Confirmation by slide agglutination	60(2)

Learning Resources recommended:

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. Robert Weaver, "Molecular biology", 3 rd edition. McGraw Hill international edition
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak &Palan, Immunology: Essential & Fundamental, 1 st& 3rd edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Practical of USMB503 and USMB504
Course Code	USMBP06
Class	T. Y. B. Sc.
Semester	V
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbial biochemistry gains the molecular knowledge in virology, pharmacology and toxicology. Industrial microbiologists study and solve problems related to industrial production processes. Industrial microbiologists may responsible for research, product testing, quality control, product development and genetic engineering. It also supports and prepared protocol for startup and annual environmental monitoring for new facilities, environmental testing and disposition of microbial samples.

Nomenclature: Practical of USMB503 and USMB504

Course Outcomes:

1- The learner will acquire the practical skills of laboratory techniques based on qualitative and quantitative assay of phosphatase.

2- The learner will acquire the hands on skill of alcohol fermentation and screening methods.

Curriculum:

USMBP06 – Practical of USMB503 and USMB504		
Title	**Learning Points**	**No of Lectures**
Microbial Biochemistry: Part – I	1. Isolation and study of Bioluminescent organisms 2. Study of oxidative and fermentative metabolism 3. Qualitative and Quantitative assay of Phosphatase 4. Study of Homo–Heterofermentations 5. Glucose detection by GOD/POD	60(2)
Bioprocess Technology: Part – I	1. Alcohol Fermentation 1.1. Preparation and standardization of yeast inoculums for alcohol fermentation 1.2. Laboratory Alcohol fermentation using jaggery medium, calculation of efficiency of fermentation. 2. Determine the alcohol tolerance for yeast. 3. Determine the sugar tolerance for yeast. 4. Chemical estimation of sugar by Cole's ferricyanide method 5. Chemical estimation of alcohol 6. Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative). 7. Primary screening for antibiotic producers using Wilkin's agar overlay method. 8. Industrial Visit	60(2)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley &Sons. New York.
3. Wilson and Walker, 4th edition Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.
4. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.
6. Crueger W. and Crueger A. (2000) "Biotechnology –"A Textbook of Industrial Microbiology.

Evaluation Pattern

C. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for T. Y. B. Sc. Microbiology Semester VI

From the year 2023-24

Name of the Course	rDNA Technology, Bioinformatics & Virology
Course Code	USMB601
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Microbes are ideally suited for biochemical and genetics studies. The rDNA technology allows scientist to insert, delete or modify specific genes of an organism's DNA in a precise and controlled manner. Recombinant DNA is also used to produce food additives and enzymes for the production of various food products. The rDNA technology provides technical expertise in micro or molecular biology techniques including real-time PCR and data analysis. It performs PCR, RT-PCR, real time RT-PCR. It utilizes PCR denature, anneal, elongate and amplification of a DNA fragment. DNA fingerprinting utilized for the identification purpose. Bioinformatics helps the doctors to more accurately diagnose and treat diseases.

Nomenclature: rDNA Technology, Bioinformatics & Virology

Course Outcomes:

1- This module will make the student to understand the methods to construct recombinant DNA molecules, also know the tools required like vectors, restriction enzymes etc.

2- The learner will know about applications of rDNA technology, through bioinformatics the student will understand the use of databases and software tools for understanding biological data.

3- The student will know about gene expression in prokaryotes, operon as a unit of gene regulation, regulation of gene expression in prokaryotes and bacteriophages. The student will also understand about general structure, life cycle and classification of viruses.

4- The learner will understand the basic structure and life cycle of different viruses and their cultivation. The student will get basic knowledge on Prions, Viroid and viruses causing cancer.

Curriculum:

USMB601 – rDNA Technology, Bioinformatics & Virology			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Recombinant DNA Technology	1.1 Branches of Genetics 1.1.1 Transmission genetics 1.1.2 Molecular genetics 1.1.3 Population genetics 1.1.4 Quantitative genetics 1.2 Model Organisms 1.2.1 Characteristics of a model organism 1.2.2 Examples of model organisms used in study 1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms 1.3 Plasmids 1.3.1 Physical nature 1.3.2 Detection and isolation of plasmids 1.3.3 Plasmid incompatibility and Plasmid curing 1.3.4 Cell to cell transfer of plasmids 1.3.5 Types of plasmids 1.3.6 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Colfactor, Degradative plasmids 1.4 Transposable Elements in Prokaryotes 1.4.1 Insertion sequences 1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition, Integrons 1.5 Basic steps in Gene Cloning. 1.6 Cutting and joining DNA molecules - Restriction and modification systems, restriction endonucleases, DNA ligases 1.7 Vectors 1.7.1 Plasmids as cloning vectors. plasmid vectors, pBR322 vector 1.7.2 Cloning genes into pBR322 1.7.3 Phage as cloning vectors, cloning genes into phage vector 1.7.4 Cosmids 1.7.5 Shuttle vectors 1.7.6 YAC 1.7.7 BAC 1.8 Methods of transformation	15 (1)
2	Applications of rDNA Technology & Bioinformatics	2.1 PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real time quantitative PCR)	15 (1)

		2.2 Basic techniques 2.2.1 Southern, Northern and Western blotting. 2.2.2 Autoradiography (explain the term 2.3 Screening and selection methods for identification and isolation of recombinant cells 2.4 Applications of recombinant DNA technology: Site specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals. 2.5 Bioinformatics 2.5.1 Introduction 2.5.2 Definition, aims, tasks and applications of Bioinformatics. 2.5.3 Database, tools and their uses – 2.5.3.1 Importance, Types and classification of databases 2.5.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. 2.5.3.3 Protein sequence databases-PIR, SWISS-PROT, TrEMBL NRL-3D.Protein structure databases SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG. 2.5.4 Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, Genomics- structural, functional and comparative genomics, Proteomics - structural and functional proteomics, Sequence alignment - global v/s local alignment, FASTA, BLAST (Different types of BLAST)	
3	Regulation & Basic Virology	3.1 A) Lac operon and problems on Lac operon B) Trp operon 3.2 Regulation of lytic and lysogenic pathway of lambda phage 3.3 Viral architecture - Capsid, viral genome and envelope 3.4 Viral classification (Baltimore classification) 3.5 Viral replication cycle - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release.	15 (1)
4	Advanced Virology	4.1 Structure of TMV, T4, Influenza virus, HIV. Life cycle of T4 phage, TMV, Influenza Virus and HIV in detail.	15 (1)

		4.2 Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue 4.3 Visualization and enumeration of virus particles 4.3.1 Measurement of infectious units 4.3.1.1 Plaque assay 4.3.1.2 Fluorescent focus assay 4.3.1.3 Infectious center assay 4.3.1.4 Transformation assay 4.3.1.5 Endpoint dilution assay. 4.3.2 Measurement of virus particles and their components 4.3.2.1 Electron microscopy 4.3.2.2 Atomic force microscopy 4.3.2.3 Haemagglutination 4.3.2.4 Measurement of viral enzyme activity. 4.4 Role of viruses in cancer: Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus. 4.5 Prions: Defination, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis 4.6 Viroids	

Learning Resources recommended:

Text books:

1. Peter J. Russell (2006), "I Genetics-A molecular approach", 2nd edition.
2. Benjamin A. Pierce (2008), "Genetics a conceptual approach", 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), "Principles of genetics", Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), "Brock Biology of microorganisms", 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), "Genetics", Wadsworth Publishing Company.
6. Prescott, Harley and Klein, "Microbiology", 7th edition McGraw Hill international edition.
7. Edward Wagner and Martinez Hewlett, (2005) "Basic Virology", 2nd edition, Blackwell Publishing
8. Teri Shors, (2009), "Understanding viruses", Jones and Bartlett publishers.
9. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
10. Robert Weaver, (2008), "Molecular biology", 3rd edition, McGraw Hill international edition.

11. Primrose and Twyman, (2001), "Principles of gene manipulation and genomics", 6th edition, Blackwell Publishing
12. Arthur Lesk, (2009), "Introduction to Bioinformatics", 3rd edition, Oxford University Press
13. Snustad, Simmons, "Principles of genetics", 3rd edition. John Wiley & sons, Inc.
14. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.

Reference books:

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

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Medical Microbiology & Immunology: Part - II
Course Code	USMB602
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Medical microbiology performs antimicrobial effectiveness testing and other traditional microbiological testing to identify organisms and interpret the results. Tested process equipment and production areas for contamination and environmental pathogens to monitor the effectiveness of sanitation measures throughout the facility. Research focuses on the identification and characterization of bacterial pathogens. Immunologists are actively involved in the drug discovery process in pharmaceutical sector especially for the development of antibodies and vaccines. Immunologists are employed in a varied range of organization across different areas in science and medicine.

Nomenclature: Medical Microbiology & Immunology: Part - II

Course Outcomes:

1- The learners shall understand the virulence factors, morphological and cultural features of the pathogen and correlate these virulence factors with the pathogenesis and clinical features of the disease.

2- The learners shall understand clinical features of pathogens and identify the causative agent.

3- The learners shall 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.

4- The learners shall understand the activation of complement system.

Curriculum:

USMB602 – Medical Microbiology & Immunology: Part - II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Study of a Few Diseases with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention.	1.1 Study of vector-borne infections - Malaria 1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea 1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Meningococcal meningitis	15 (1)
2	Chemotherapy of Infectious Agents	2.1 Attributes of an ideal chemotherapeutic agent - Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MBC, etc. 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) 2.3 List of common antibiotics - used for treating viral, fungal and parasitic diseases. 2.4 Mechanisms of drug resistance - Its evolution, pathways and origin for ESBL, VRE, MRSA 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	15 (1)
3	Immunology - I	3.1 T cells 3.1.1 T Cell Receptor-structure (alpha-beta, gamma-delta TCR) 3.1.2 TCR-CD3 complex - structure and functions. Accessory molecules 3.1.3 T cell activation 3.1.3.1 TCR mediated signaling – Overview	15 (1)

		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) 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) 3.3 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 3.3.2.2 Signal transduction pathway activated by BCR overview 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 (only concept) 3.4.3.3 Generation of plasma cells and memory cells	
4	Immunology – II	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 4.2 Immunohaematology 4.2.1 Human blood group systems, ABO, secretors and non secretors, Bombay Blood	15 (1)

		group. Rhesus system and list of other blood group systems 4.2.2 Haemolytic disease of new born, Coombs test. 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.	

Learning Resources recommended:

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 DannessaDelost 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:

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/

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	Unit	Marks
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Microbial Biochemistry: Part – II
Course Code	USMB603
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In biochemistry has working area like research lab, product development, healthcare and forensics. To successfully gain employment in biochemistry, problem solving, data analysis, process creation and project management are the key skills. In addition, you will develop a deeper understanding of the fundamental processes of life at molecular and cellular levels

Nomenclature: Microbial Biochemistry: Part - II

Course Outcomes:

1- The learner will have an understanding of metabolism of lipids, fatty acids, nucleotides and amino acids.
2- The learner will have an understanding of catabolism of protein and aliphatic hydrocarbons.
3- The learner will have an understanding of regulation of metabolic process at various levels.
4- The learner will have an understanding of photosynthesis and metabolism of inorganic molecules with special reference to nitrate and sulfate.

Curriculum:

USMB603 – Microbial Biochemistry: Part – II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Lipid Metabolism & Catabolism of Hydrocarbons	1.1 Introduction to Lipids 1.1.1 Lipids –Definition, classification & functions 1.1.2 Types and role of fatty acids found in bacteria 1.1.3 Common phosphoglycerides in bacteria 1.1.4 Action of lipases on triglycerides /tripalmitate 1.2 Catabolism of Fatty Acids and PHB 1.2.1 Oxidation of saturated fatty acid by β oxidation pathway 1.2.2 Energetics of β oxidation of Palmitic acid 1.2.3 Oxidation of propionyl CoA by acrylyl-CoA pathway and methylcitrate pathway 1.2.4 PHB as a food reserve and its degradation 1.3 Anabolism of Fatty Acids & Lipids 1.3.1 Biosynthesis of straight chain even carbon saturated fatty acid (palmitic acid) 1.3.2 Biosynthesis of phosphoglycerides in bacteria 1.3.3 Biosynthesis of PHB 1.4 Catabolism of aliphatic hydrocarbons 1.4.1 Organisms degrading aliphatic hydrocarbons 1.4.2 Hydrocarbon uptake mechanisms 1.4.3 Omega oxidation pathway 1.4.3.1 Pathway in *Corynebacterium* and yeast 1.4.3.2 Pathway in *Pseudomonas*	15 (1)
2	Metabolism of Proteins and Nucleic Acids.	2.1 Protein / amino acid catabolism 2.1.1 Enzymatic degradation of proteins 2.1.2 General reactions of amino acids catalyzed by 2.1.2.1 Amino acid decarboxylases 2.1.2.2 Amino acid deaminases 2.1.2.3 Amino acid transaminases 2.1.2.4 Amino acid racemases 2.1.3 Metabolic fate of amino acids - Glucogenic and ketogenic amino acids 2.1.4 Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum*	15 (1)

		2.1.5 Fermentation of pair of amino acids - Stickland reaction (include enzymes) 2.2 Anabolism of amino acids 2.2.1 Schematic representation of amino acid families 2.2.2 Biosynthesis of amino acids of Serine family (Serine, Glycine and Cysteine) 2.3 Catabolism of Nucleotides 2.3.1 Degradation of purine nucleotides up to uric acid formation 2.3.2 Salvage pathway for purine and pyrimidine nucleotides 2.4 Biosynthesis of nucleotides 2.4.1 Nomenclature and structure of nucleotides 2.4.2 Role of nucleotides (high energy triphosphates) 2.4.3 Biosynthesis of pyrimidine nucleotides 2.4.4 Biosynthesis of purine nucleotides 2.4.5 Biosynthesis of deoxyribonucleotides	
3	Metabolic Regulation	3.1 Definition of terms and major modes of regulation 3.2 Regulation of enzyme activity 3.2.1 Noncovalent enzyme inhibition 3.2.1.1 Allosteric enzymes and feedback inhibition 3.2.1.2 Patterns of FBI, combined activation and inhibition 3.2.2 Covalent modification of enzymes 3.2.2.1 Monocyclic cascades 3.2.2.2 Examples of covalent modification(without structures) 3.2.2.3 Regulation of Glutamine synthetase 3.3 DNA binding proteins and regulation of transcription by positive & negative control 3.3.1 DNA binding proteins 3.3.2 Negative control of transcription: Repression and Induction 3.3.3 Positive control of transcription: Maltose catabolism in E. coli 3.4 Global regulatory mechanisms 3.4.1 Global control &catabolite repression 3.4.2 Stringent response 3.5 Regulation of EMP and TCA cycle - (Schematic and Regulation of Pryruvate dehydrogenase Complex)	15 (1)

4	Prokaryotic Photosynthesis &Inorganic Metabolism	4.1 Photosynthesis 4.1.1 Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) 4.1.2 Photosynthetic pigments 4.1.3 Location of photochemical apparatus 4.1.4 Photochemical generation of reductant 4.2 Light reactions in: 4.2.1 Purple photosynthetic bacteria 4.2.2 Green sulphur bacteria 4.2.3 Cyanobacteria (with details) 4.3 Dark reaction 4.3.1 Calvin Benson cycle 4.3.2 Reductive TCA cycle 4.4 Inorganic Metabolism 4.4.1 Assimilatory pathways: 4.4.1.1 Assimilation of nitrate, 4.4.1.2 Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase 4.4.1.3 Biological nitrogen fixation (Mechanism for N2 fixation and protection of nitrogenase) 4.4.1.4 Assimilation of sulphate 4.4.2 Dissimilatory pathways: 4.4.2.1 Nitrate as an electron acceptor (Denitrification in *Paracoccusdenitrificans*) 4.4.2.2 Sulphate as an electron acceptor.	15 (1)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley & Sons. New York.
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. L. and M.M. Cox (2005), Lehninger, Principles of biochemistry, 4th edition, W. H. Freeman and Company.

6. G. Moat, J.W. Foster, M, P. Spector. (2002), Microbial Physiology, 4th edition, WILEY-LISS 7. Madigan, M.T. and J.M. Martinko2006. 11th edition, Brock Biology of Microorganisms. Pearson Prentice Hall.

Reference books:

1. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
2. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
3. Principles of Biochemistry, Lehninger, 5th edition, W. H. Freeman and Company

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Bioprocess Technology: Part – II
Course Code	USMB604
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Industrial microbiology used for the production of important substances, such as antibiotics, food products, enzymes, amino acids, vaccines and fine chemicals. Industrial microbiology trains junior microbiologists on microbiology test methods and lab procedures. The demonstrated good laboratory documentation skills and documentation requirements. It performs preparatory testing and anti-microbial preservative effectiveness testing on pharmaceutical products.

Nomenclature: Bioprocess Technology: Part - II

Course Outcomes:

1- The learners shall understand the actual process involved in fermentations of important products.

2- The learners shall understand knowledge of applications of animal and plant tissue culture techniques.

3- The learners shall understand the working of important instruments used in biochemical analysis and bioassay.

4- The students will learn the silent features of quality management and regulatory procedures.

Curriculum:

USMB604 – Bioprocess Technology: Part – II			
Unit	**Title**	**Learning Points**	**No of Lectures**
1	Downstream Processing	1.1 Recovery and purification 1.1.1 Introduction 1.1.2 Methods of DSP: Precipitation, Filtration, Centrifugation, Cell Disruption, Liquid-Liquid Extraction, Solvent Recovery, Chromatography, Membrane Processes, Drying, Crystallization, Whole Broth Processing 1.2 Effluent treatment – Introduction, Treatment process (Physical, chemical and biological)	15 (1)
2	Advances in Bioprocess	2.1 Animal biotechnology 2.1.1 Primary cell culture and established cell lines	15 (1)

	Technology	2.1.2 Basic principles 2.1.3 Growth media 2.1.4 Cell viability 2.1.5 Applications of cell culture: Vaccines, somatic cell fusion, valuable products. 2.2 Plant tissue culture 2.2.1 Introduction 2.2.2 Requirements for in vitro culture, Methods of plant cell and tissue culture 2.2.3 Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micropropogation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization. 2.2.4 Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance. 2.3 Immobilized enzyme and cells 2.3.1 Introduction and Definitions 2.3.2 Methods 2.3.3 Immobilized Enzyme Reactors 2.3.4 Applications	
3	Quality Assurance, Quality Control, and Bioassay	3.1 Quality assurance and quality control. 3.1.1 Definitions, Chemical and pharmaceutical products 3.1.2 Q.A and Q.C wrt.- Raw materials, method of manufacturing, in process items, finished products, label and labeling, packaging materials 3.1.3 Control of microbial contamination during manufacturing 3.2 Sterilization control and assurance. 3.3 Bioassay 3.3.1 Introduction 3.3.2 Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic 3.4 Intellectual property rights 3.5.1 Genesis, Role of WTO and TRIPS 3.5.2 Overview of patent system 3.5.3 Requirements for patentability 3.5.4 Patent Categories 3.5.5 Preliminary steps for patent applications 3.5.6 Patent Procedures 3.5.7 For biotech and microbiological products	15 (1)
4	Industrial Fermentations	4.1 Penicillin and semisynthetic penicillins: Introduction, biosynthesis and regulation,	15 (1)

		strain development, production methods. Semisynthetic penicillins: Examples, production, advantages 4.2 Aminoglycoside: Streptomycin: Aminoglycoside antibiotics, biosynthesis, regulation of biosynthesis, strain development, production method, recovery. 4.3 Vitamin B 12: Occurrence and economic significance, structure, biosynthesis, production based on media containing carbohydrates by*Propionibacteria* and *Pseudomonas*, recovery. 4.4 Citric acid: Introduction, strains used for production, biosynthesis, nutrient media, production processes- surface and submerged, product recovery. 4.5 Glutamic acid: Production strains, biosynthesis, effect of permeability on production, conditions of manufacturing, production process and recovery.	

Learning Resources recommended:

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. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. H. K. Das., "Text book of Biotechnology", 2nd and 3rd edition.
5. A textbook of biotechnology R. C. Dubey 4th edition. S. Chand.
6. H. A. Modi, (2009). ''Fermentation Technology'' Vol. 1 & 2, Pointer Publications, India
7. OkaforNduka (2007) ''Modern Industrial Microbiology and Biotechnology'', Science Publications Enfield, NH, USA.
8. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
9. Microbiology", 2 nd edition, Panima Publishing Corporation, New Delhi.
10. Prescott and Dunn's ''Industrial Microbiology'' (1982) 4th edition, McMillan Publishers.
11. Veerakumari L. "Bioinstrumentation", MJP Publisher
12. Pharmaceutical Microbiology, Hugo and Russell, 7 th edition, Blackwell Science.

Reference books:

1. Peppler, H. J. and Perlman, D. (1979), "Microbial Technology''. Vol 1 & 2, Academic Press.
2. Williams, Bryan L; Wilson, 2 nd edition." A Biologist's guide to principles and techniques of practical biochemistry" Baltimore: University Park Press, 1981.
3. Wilson, Keith, 1936-; Goulding, Kenneth H, 3 rd edition., A Biologist's guide to principles and techniques of practical biochemistry" London ; Baltimore : E. Arnold, 1986.
4. Wilson and Walker, "Principles and techniques of practical biochemistry" 5 th edition.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practical of USMB601 and USMB602
Course Code	USMBP07
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	The rDNA technology provides technical expertise in micro or molecular biology techniques including real-time PCR and data analysis. It performs PCR, RT-PCR, real time RT-PCR. It utilizes PCR denature, anneal, elongate and amplification of a DNA fragment. DNA fingerprinting utilized for the identification purpose. Research focuses on the identification and characterization of bacterial pathogens. Immunologists are actively involved in the drug discovery process in pharmaceutical sector especially for the development of antibodies and vaccines.

Nomenclature: Practical of USMB601 and USMB602

Course Outcomes:

1- The students will acquire skill to perform the laboratory techniques and experiments based on isolation of genomic DNA.

2- The students will understand computational biology and insilico analytical techniques.

3- The students will acquire skill to perform determination of MBC of an antibiotic and blood grouping.

Curriculum:

USMBP07 – Practical of USMB601 and USMB602		
Title	**Learning Points**	**No of Lectures**
rDNA Technology, Bioinformatics & Virology	1. Isolation of genomic DNA of E. coli and measurement of its concentration by UV-VIS. 2. Enrichment of coliphages, phage assay (pilot & proper). 3. Restriction digestion of lambda phage /any plasmid DNA (Demo) 4. Beta galactosidase assay 5. Bioinformatics practicals 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. Using BLAST and FASTA for sequence analysis	60(2)

	b. 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) c. Six frame translation of given nucleotide sequence d. Restriction analysis of given nucleotide sequence e. Pair-wise alignment and multiple alignment of a given protein sequences f. Formation of phylogenetic tree 6. Animal cell culture (Demo)	
Medical Microbiology & Immunology: Part - II	1. Demonstration of malarial parasite in blood films (Demo) 2. Selection and testing of antibiotics using the Kirby-Bauer method 3. Determination of MBC of an antibiotic. 4. Blood grouping – Direct & Reverse typing 5. Coomb's Direct test 6.Determination of Isoagglutinin titer 7. Demonstration experiments - Widal, VDRL	60(2)

Learning Resources recommended:

Text books:

1. Prescott, Harley and Klein, "Microbiology",. 7th edition McGraw Hill international edition.
2. S.Ignacimuthu, (2005), "Basic Bioinformatics", Narosa publishing house.
3. Robert Weaver, (2008), "Molecular biology", 3rd edition, McGraw Hill international edition.
4. Kuby Immunology, 6th Edition, W H Freeman and Company
5. Pathak &Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
6. Fahim Khan, Elements of Immunology, Pearson Education.

Evaluation Pattern

E. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

F. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Name of the Course	Practical of USMB603 and USMB604
Course Code	USMBP08
Class	T. Y. B. Sc.
Semester	VI
No of Credits	4
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	To successfully gain employment in biochemistry, problem solving, data analysis, process creation and project management are the key skills. Industrial microbiology used for the production of important substances, such as antibiotics, food products, enzymes, amino acids, vaccines and fine chemicals.

Nomenclature: Practical of USMB603 and USMB604

Course Outcomes:

1- The learner will acquire the practical skills of screening of microorganisms producing lipase, PHB and protease.

2- The students will acquire skill to perform detection of enzymes which play an important role in amino acid and nitrate metabolism.

3- The students will acquire skill to perform quantitative detection of important metabolic products such as protein and uric acid.

4-The learner will acquire the practical skills and techniques involved in running a bioassay, immobilization of cells & sterility testing.

Curriculum:

USMBP08 – Practical of USMB603 and USMB604		
Title	**Learning Points**	**No of Lectures**
Microbial Biochemistry: Part - II	1. Detection of PHB producing bacteria 2. To study catabolite repression by diauxic growth curve. 3. Protein estimation by Lowry's method 4. Estimation of uric acid 5. Qualitative and Quantitative assay of Protease 6. Qualitative detection of Lipase 7.Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity 8. Study of Lithotrophs – Nitrosification and Nitrification	60(2)
Bioprocess Technology: Part - II	1. Bioassay of an antibiotic (Ampicillin / Penicillin) 2. Bioassay of Cyanocobalamin. 3. Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count. 4. Plant tissue culture – Callus culture (Demo). 5. Sterility testing of injectable. 6. Chemical estimation of Penicillin 7. Estimation of phenol. 8. Industrial Visit	60(2)

Learning Resources recommended:

Text books:

1. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd.
2. Conn, E.E., P. K. Stumpf, G. Bruening and R. Y. Doi. 1987. Outlines of Biochemistry, 5 th edition, 1987. John Wiley & Sons. New York.
3. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology.
4. Casida L. E., "Industrial Microbiology" (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
5. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd edition, Aditya Books Pvt. Ltd, New Delhi.

Evaluation Pattern

G. Internal Evaluation

Method	Marks
Journal	20
Viva	10
Class performance	10
Total	**40**

H. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Chairperson,
(Dr. Nitin Potdar)
BoS, Microbiology

R.P. Gogate College of Arts & Science and R.V. Jogalekar College of Commerce, Ratnagiri (Autonomous)

Bachelor of Science (B.Sc.) Program In Microbiology - Applied Component

[Medical Laboratory Technology]

T. Y. B. Sc. [Sem-V & VI]

Course Structure

Under Choice Based Credit System (CBCS)

To be implemented from Academic Year- 2023-2024

Name of Programme	**B.Sc. Microbiology AC[Medical Laboratory Technology]**
Level	UG
No of Semesters	02
Year of Implementation	**2023-24**
ProgrammeSpecific Outcomes (PSO)	1] Learner shall know the various branches of MLT 2]Learner shall know the role of pathology tests in day to day life. 3] Learner shall able to carry out various laboratory tests.
Relevance of PSOs to the local, regional, national, and global developmental needs	In the era of modern technology, health care delivery system involves so many different personnel and specialties that the caregiver must have an understanding and working knowledge of other professional endeavours, including the role of diagnostic evaluation. Basically, laboratory and diagnostic tests are tools by and of themselves, they are not therapeutic. Medical Laboratory Technology is a basic course that equips the student with the most essential knowledge and skill pertaining to medical laboratories such as: Importance of laboratory services, Role of medical laboratory technologist, Use of laboratory wares, instruments and sterilization techniques, Prevention and control of laboratory accidents and, Institution of quality control system. This pathological services have made disease treatment is more targeted and more accurate due to their correct diagnosis nature. The students with this Medical Laboratory Technology knowledge shall able to perform various pathological tests to help in disease diagnosis.

T.Y.B.Sc. Microbiology Applied Component Syllabus

(General Outline)

SEMESTER V

Course Code	Unit	Topics	Credits	Lec / Week
USACMT501		**Techniques and Automation In MLT**	**2**	
	I	Introduction to diagnostic microbiology		1
	II	Automation and newer approaches in MLT		1
	III	Haematology		1
	IV	Clinical Biochemistry		1
USACMT5P1		**Practicals based on above course in theory**	**2**	**4**

SEMESTER VI

Course Code	Unit	Topics	Credits	Lec / Week
USACMT601		**Microbiology ,Clinical Pathology and Histopathology**	**2**	
	I	Bacteriology		1
	II	Mycology, Parasitology, and Virology		1
	III	Organ Function Tests		1
	IV	Clinical Pathology and Histopathology		1
USACMT6P1		**Practicals based on above course in theory**	**2**	**4**

Syllabus for T.Y.B.Sc. Microbiology Applied Component Semester V

from the year 2023-24

Name of the Course	Techniques and Automation in MLT
Course Code	USACMT501
Class	T.Y.B.Sc.
Semester	V
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Introduction to Medical Laboratory Technology is a basic course that equips the student with the most essential knowledge and skill pertaining to medical laboratories such as: Importance of laboratory services, Role of medical laboratory technologist, Use of laboratory wares, instruments and sterilization techniques, Prevention and control of laboratory accidents and, Institution of quality control system. Moreover, this course is extremely important for the student as it paves the ways to easily understand various professional courses such as Haematology, Bacteriology, Urinalysis, Parasitology, and others. Hence, great emphasis should be given to this subject matter so as to train qualified, competent and task oriented medical laboratory technologists.

Nomenclature: Techniques and Automation in MLT

Course Outcomes:

1. The learner will understand the safety and precautions in clinical microbiology.
2. The student will know the identification system for bacteria.
3. The student will understand the branch of hematology and will learn the process of blood collection.
4. The learner will know the concept in clinical biochemistry. This module will also make them understand the diagnostic tests.

Curriculum:

USACMT501 - Techniques and Automation in MLT			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Introduction to diagnostic microbiology**	**1.1** Safety and special precautions in clinical microbiologylab, Legislative and regulatory control, Infectious wastemanagement, Methods of sterilization, Classification ofbio hazardous agents. **1.2** Antimicrobial susceptibility testing: Selection of antimicrobial agents, Disc diffusion test, Dilutionantimicrobial susceptibility test, E test, commercial systems. **1.3** Serodiagnostic tests: a) Types of antigen antibody reactions used in diagnostic serology – precipitin reactions, CFT, Haemaglutination inhibition, agglutination reactions, flocculation. b) Solid phase immunoassay methods – Enzyme immunoassay for antibody and antigen detection. c) Immunofluorescent techniques for antibody and antigen detection.	**15L**
II	**Automation and newer approaches in MLT**	**2.1** Automation: Semiautomated and automated identification systems for Enterobacteriaceae, Non fermentors, Mycobacteria, Staphylococci, Anaerobes **2.2** Newer approaches: use of molecular techniques indiagnosis a) Signal amplification methods – Nucleic acid probes, in situ hybridization b) PCR and modifications of PCR c) Post amplification analysis – DNA sequencing, microarray analysis d) Strain typing – Pulse field gel electrophoresis, PCR-RFLP	**15L**
III	**Haematology**	**3.1** Introduction to haematology – composition of blood, serum and plasma, structure, function and life span of blood cells, Haematopoiesis and factors required for the same,hemoglobin: structure, types-normal &abnormal,glycosylatcdHb, HbCo, Hi, SHb, Hbs, HbC, HbD, lIbE,HbH. **3.2** Collection of blood- Capillary blood by skin puncture, Venous blood by venipuncture	**15L**

		3.3 Anticoagulants: types and mechanism of action. **3.4** Anemia: Types – Sickle cell anemia, thalassemia, iron deficiency, aplastic, hemolytic, megaloblastic (only a brief outline). **3.5** Abnormal forms of RBC: microcytes, macrocytes – hypochromic, spherocytes, target cell, stomatocytes, anisocytes, poikilocytes, sickle cells. Abnormalities of WBC's: toxic granulation, vacuoles, hypersegmentation,hypo segmentation. **3.6** Haemostatisis& coagulation: vascular response, platelet plug formation, coagulation. **3.7** Automation in haematology: Introduction- the automated full blood count impedance cell counters, optical cell counters, automated blood cell morphology. **3.8** Blood bank: blood ABO (H), Rh, secretor and Lewis systems, lsoagglutinins& their titre, concept of universal donor & universal recipient blood transfusion: cross matching, transfusion reactions blood collection:screening of donor criteria for rejecting donor,registration of donor, blood collection procedure, transportation of blood, storage of blood. Preparation & use of blood components: whole blood, packed red cells, FFP, platelet concentrate.	
IV	**Clinical Biochemistry**	**4.1** Blood sugar level - Glucose tolerance curve and its interpretation. Evaluation methods of blood glucose – o toluidine, Glucose oxidase - peroxidase. Diabetes and its types. **4.2** Enzymes in diagnostics – determination of enzymes, AST, ALT, ALP, ACP, LDH, GGT, serum lipase. **4.3** Thyroid tests – Introduction – function of thyroid hormones, determination of T-3, T-4, TSH **4.4** Automation in clinical biochemistry - Introduction, classification of automated systems, steps of automation in biochemical analysis, computers in clinical lab with its drawbacks. Commonly used automated analyzers of biochemical laboratories – autoanalysers, clinicon, R X L system. **4.5** Cancer marker - Introduction, clinical application, enzymes as tumor markers ALP, CK, LDH, PAP, prostate specific antigens, hormones, oncofetalantigens, carbohydrates, bladder specific, breast tumor markers. **4.6** Pregnancy test – Role of hCG and testing.	**15L**

Learning Resources recommended:

1. Koneman'sColor Atlas and Textbook of Diagnostic Microbiology, 6th edition, Washington Winn, jr and others. Lippincott Williams & Wilkins.
2. Practical Medical Microbiology, Mackie and McCartney.
3. Medical Microbiology, B.S. Nagoba and Asha Pichare.
4. Essentials of Diagnostic Microbiology, 1998. Lisa Anne Shimeld, Anne T. Rodgers. Delmar Publishers.
5. Text book of medical laboratory technology, 2nd edition, Balani Publishing House. Authors: PrafulGodkar and DarshanGodkar.
6. Introduction to MLT 6th edF.J.Baker&R.E.SilvertonButterworths.
7. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume I. Kanai Mukherjee. Tata McGraw Hill
8. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II. Kanai Mukherjee. Tata McGraw Hill
9. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume III. Kanai Mukherjee. Tata McGraw Hill
10. Hand book of MLT -Vellore ed-Dr (Mrs) C. Bharucha, Wesley press, Mysore
11. A medical lab for developing countries- Maurice King-ELBS & Oxford uni press
12. Bailey & Scott's - Diagnostic microbiology, 11th ed., Betty Forbes, Daniel, Alice Weissfield. Mosby publisher
13. Atlas of Medical Helminthology and Protozoology, 4th ed. P. L. Chiodini, A. H. Moody, D. W. Manser. Churchill Livingstone
14. A hand book of medical laboratory technology, V. H. Talib 2nd ed.
15. Fundamentals of Biochemistry. New central book agency. Author: A. C. Deb

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practicals of USACMT501
Course Code	USACMT5P1
Class	T.Y.B.Sc.
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	In the era of modern technology, health care delivery system involves so many different personnel and specialties that the caregiver must have an understanding and working knowledge of other professional endeavours, including the role of diagnostic evaluation. Basically, laboratory and diagnostic tests are tools by and of themselves, they are not therapeutic. In conjunction with a pertinent history and physical examination, these tests can confirm a diagnosis or provide valuable information about a patient status and response to therapy. In addition to these, laboratory findings are essential for epidemiological surveillance and research purposes. If the entire network of a laboratory service is to be effectively utilized and contribute to health care and disease prevention, every member of its work force need to: Follow professional ethics and code of conduct, Experience job satisfaction and have professional loyalty.

Nomenclature: Practicals of USACMT5P1

Course Outcomes:

1 – The learner will acquire the practical skills of laboratory based on antibiotic susceptibility test, blood grouping etc.
2 – The student will gain the knowledge in processing of blood samples with regard to check sugar levels.
3 – The learner shall understand the parts of instruments like hot air oven, microscope and incubator. Learner will also get trained to handle this instruments.

Curriculum:

USACMT5P1 - Practicals of USACMT501		
Title	**Learning Points**	**No of Lectures**
Techniques and Automation In MLT	1.Parts and functions of microscope 2. Study of hot air oven 3. Study of autoclave 4. Study of incubator 5. Widal test 6. VDRL test 7. ASO test 8. Disc diffusion method 9. Blood collection :capillary & venous 10. Hemoglobin estimation: acid hematin and drabkin'smethod 11. Total RBC &WBC count, Differential WBC count12. ESR 13. PCV 14. Red cell indices 15. Bleeding time & clotting time 16. Blood grouping ABO and Rh typing 17. Cross matching 18. Estimation of blood glucose	**60L (02)**

Learning Resources recommended:

1.Practical Medical Microbiology, Mackie and McCartney.

2.Text book of medical laboratory technology, 2nd edition, Balani Publishing House.

Authors: PrafulGodkar and DarshanGodkar.

3.Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II and III Kanai Mukherjee. Tata McGraw Hill.

4. A hand book of medical laboratory technology, V. H. Talib 2nd ed.

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

B. Semester End Evaluation (Practical Exam)

Question No	Marks
1	20
2	10
3	20
4	10
Total	**60**

Syllabus for T. Y. B. Sc. Microbiology Applied Component Semester VI

from the year 2023-24

Name of the Course	Microbiology, Clinical Pathology and Histopathology
Course Code	USACMT601
Class	T.Y.B.Sc.
Semester	VI
No of Credits	04
Nature	Theory
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Effective delivery of healthcare services depends largely on the nature of education, training and appropriate orientation towards community health of all categories of health personnel, and their Capacity to function as an integrated team. The course has been designed with a focus on performance-based outcomes pertaining to different levels. The learning goals and objectives of the undergraduate and graduate education program will be based on the performance expectations. Using the framework, students will learn to integrate their knowledge, skills and abilities in a hands-on manner in a professional healthcare setting. These learning goals are divided into different key areas, though the degree of required involvement may differ across various levels of qualification and professional cadres: Clinical care, Communication, Ethics and accountability at all levels (clinical, professional, personal and social), Scientific attitude and scholarship.

Nomenclature: Microbiology, Clinical Pathology and Histopathology

Course Outcomes:

1. The learner will understand the steps involved in specimen collection.
2. The students should be able to correlate virulence factors and other features of the pathogen.
3. The learner will get the knowledge of Parasitology, Mycology and Virology.
4. The student should be able to understand various organ function test.
5. The students shall understand the examination of biological specimens.

Curriculum:

USACMT601 - Microbiology, Clinical Pathology and Histopathology			
Unit	**Title**	**Learning Points**	**No of Lectures**
I	**Bacteriology**	Guidelines for collection, transport, processing, analysis and reporting of cultures from specific specimen sources for the following infections- **1.1** Infections of the respiratory tract. **1.2** Infections of the gastrointestinal tract. **1.3** Urinary tract infections. **1.4** Infections of the genital tract. **1.5** Infections of the bones and joints. **1.6** Infections of the CNS. **1.7** Wounds, abscesses and cellulites. **1.8** Eye infections. **1.9** Infections of the blood.	**15L**
II	**Mycology, Parasitology, and Virology**	**2.1** Mycology: a) Laboratory approach for diagnosis of fungal infections- Specimen collection and transport, processing, direct examination, preparation of mounts for study, selection and inoculation of culture media, incubation of fungal cultures. b) Identification of dermatophytes and Candida. **2.2** Parasitology: Collection, transport and processing of specimens a) Fecal specimens- Preservation of clinical specimens, visual examination, processing fresh stool specimens for ova and parasitic examination. b) Examination of intestinal specimens other than stool. c) Examination of extra intestinal specimens- sputum, blood d) Overview of life cycles of parasites of human importance. **2.3** Virology: a) Collection of specimens for diagnosis, b) Transportation and storage of specimens, c) Methods for diagnosis of viral infections (Tabulation),	**15L**

		d) Detection of HIV, Hepatitis B viral infections in clinical specimens.	
III	**Organ Function Tests**	**3.1** Cardiac Profile Test – Introduction, Functions of heart, Ischemic heart diseases and their manifestation; Groups in CPT, Lipid profile tests – total lipids, serum cholesterol, triglycerides, phospholipids, lipoproteins. **3.2** Gastric function Tests – Introduction, gastric analysis, tests involved and gastrointestinal hormones. **3.3** Liver function tests – Introduction to liver function, types of jaundice; abnormalities of bile pigment and bile acid, change in enzyme and plasma proteins and their determination **3.4** Kidney function test – Introduction- kidney function; groups in KFT; test to determine renal blood flow; creatinine clearance; urea clearance; diseases of kidney – acute and chronic glomerulonephritis; acute and chronic pyelonephritis, acute renal failure	**15L**
IV	**Clinical Pathology and Histopathology**	**4.1** Routine urine analysis – Physiology of urine formation, composition of normal urine, collection of urine specimens, routine examination of urine – physical, chemical & microscopic **4.2** Routine stool analysis – Importance of stool examination, collection of fecal specimen physical examination – color& consistency, odor, presence of blood mucus & pus. Study of some common ova found in stool – Hookworm, *Ascaris, Trichuris, Taenia, Schistosomamansoni, Enterobius, Strongyloides*. Study of some protozoa found in stool – *E. histolytica, E.coli,Giardialamblia,Trichromonashominis*. Other findings in stool microscopic examinations – fecal fat, blood cells, Crystals, occult blood test, measuring the pH & testing for Lactose **4.3** Examination of C.S.F. – Formation of C.S.F.,collection – lumbar puncture (in brief), C.S.F. analysis : color, cells, Pandy's test, stained films, C.S.F. proteins, C.S.F. sugar,	**15L**

		Trypanosomes., abnormalities of the C.S.F. suppurative, viral, Tuberculous meningitis. **4.4** Semen analysis, clinical significance, specimen collection, laboratory investigations: physical examination, microscopic examination, sperm morphology – normal & abnormal, chemical examination **4.5** Laboratory examination of miscellaneous body fluids – A brief account of the following body fluids w.r.t. clinical significance, specimen collection. Lab Investigations – Physical, chemical, microscopic examination, serous, synovial, ascitic fluids, & gastric juice **4.6** Lab examination of sputum – Collection, examination: quantity, consistency, Colour, odor, examination of stained/unstained sputum, chemical examination, parasites **4.7** Basic histopathology techniques – Basic steps for tissue processing: fixing, embedding, microtomy , staining, mounting (to be covered in brief), cytological techniques (brief idea)	

Learning Resources recommended:

1. Koneman'sColor Atlas and Textbook of Diagnostic Microbiology, 6th edition, Washington Winn, jr and others. Lippincott Williams & Wilkins.
2. Practical Medical Microbiology, Mackie and McCartney.
3. Medical Microbiology, B.S. Nagoba and Asha Pichare.
4. Essentials of Diagnostic Microbiology, 1998. Lisa Anne Shimeld, Anne T. Rodgers. Delmar Publishers.
5. Text book of medical laboratory technology, 2nd edition, Balani Publishing House. Authors: PrafulGodkar and DarshanGodkar.
6. Introduction to MLT 6th edF.J.Baker&R.E.SilvertonButterworths.
7. Medical laboratory technology, A procedure manual for routine diagnostic tests, VolumeI. Kanai Mukherjee. Tata McGraw Hill
8. Medical laboratory technology, A procedure manual for routine diagnostic tests, VolumeII. Kanai Mukherjee. Tata McGraw Hill
9. Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume III. Kanai Mukherjee. Tata McGraw Hill
10. Hand book of MLT -Vellore ed-Dr (Mrs) C. Bharucha, Wesley press, Mysore
11. A medical lab for developing countries- Maurice King-ELBS & Oxford uni press
12. Bailey & Scott's - Diagnostic microbiology, 11th ed., Betty Forbes, Daniel, Alice Weissfield. Mosby publisher

13. Atlas of Medical Helminthology and Protozoology, 4th ed. P. L. Chiodini, A. H. Moody, D.W. Manser. Churchill Livingstone
14. A hand book of medical laboratory technology, V. H. Talib 2nd ed.
15. Fundamentals of Biochemistry. New central book agency. Author: A. C. Deb

Evaluation Pattern

A. Internal Evaluation

Method	**Marks**
Class Test	20
Assignment	10
Attendance &Class performance	10
Total	**40**

B. Semester End Evaluation (Paper Pattern)

Question No	**Unit**	**Marks**
1	Unit 1,2,3,4	12
2	Unit 1	12
3	Unit 2	12
4	Unit 3	12
5	Unit 4	12
Total		**60**

Name of the Course	Practicals of USACMT601
Course Code	USACMT6P1
Class	T.Y.B.Sc
Semester	V
No of Credits	02
Nature	Practical
Type	Core
Highlight revision specific to employability/ entrepreneurship/ skill development	Using a practical-centered approach and best evidence, each student will organize and implement the prescribed preventive, investigative and management plans; and will offer appropriate follow-up services. Program objectives should enable the students to: Apply the principles of basic science and evidence-based practice, Use relevant investigations as needed, Identify the indications for basic procedures and perform them in an appropriate manner, etc. The student will also learn how to communicate with patients, care-givers, other health professionals and other members of the community effectively and appropriately. Communication is a fundamental requirement in the provision of health care services. Program objectives should enable the students to: Clearly discuss the diagnosis and options with the patient, and negotiate appropriate treatment plans in a sensitive manner that is in the patient‘s and society‘s best interests. Students will understand core concepts of clinical ethics and law so that they may apply these to their practice as healthcare service providers. This include the students to employ professional accountability for the initiation, maintenance and termination of patient-provider relationships

Nomenclature: Practicals of USACMT601

Course Outcomes:

1 - The learner will acquire the practical skills of laboratory based on identification of microorganisms.

2 - The learner shall understand the use of different media for isolation of bacteria.

3 - The student will learn the staining techniques to study bacteria.

Curriculum:

USACMT6P1- Practicals of USACMT601		
Title	**Learning Points**	**No of Lectures**
Microbiology, Clinical Pathology and Histopathology	1. Gram's staining. 2. Albert's staining. 3. Acid fast staining. 4. Identification of Dermatophytes (Demonstration of permanent slides). 5. Identification of *Candida albicans*. 6. Identification of Malarial parasitic forms in blood smears. 7. Study of Nutrient agar, SIBA, MacConkey's agar, XLD,CLED, Salt Mannitol, Tinsdale agar Cetrimide agar 8. Study of transport media. 9. Isolation and characterization pf bacterial pathogens- - *S. aureus* - *S. pyogenes* - *E.coli* - *K.pneumoniae* - *Salmonella spps* - *Proteus spps* - *Pseudomonas spp* 10. Physical, Chemical, Microscopic examination of a. Urine b.Sputum 11. Pap's staining for the demo of Barr bodies 12. Embedding of tissue in paraffin wax 13. Estimation of SGPT/ALT 14. Estimation of SGOT/AST 15. Estimation of Cholesterol- total, HDL, LDL 16. Estimation of total bilirubin 17. Estimation of creatinine in serum and urine 18. Estimation of blood urea 19.Report Writing: For various analyzed pathological samples(CBC, Complete Haemogram, Urine, Stool, C.S.F, Semen and Sputum)	**60L (02)**

Learning Resources recommended:

1.Practical Medical Microbiology, Mackie and McCartney.

2.Text book of medical laboratory technology, 2nd edition, Balani Publishing House.
Authors: PrafulGodkar and DarshanGodkar.

3.Medical laboratory technology, A procedure manual for routine diagnostic tests, Volume II and III Kanai Mukherjee. Tata McGraw Hill.
4. A hand book of medical laboratory technology, V. H. Talib 2nd ed.

Evaluation Pattern

C. Internal Evaluation

Method	**Marks**
Journal	20
Viva	10
Class performance	10
Total	**40**

D. Semester End Evaluation (Practical Exam)

Question No	**Marks**
1	20
2	10
3	20
4	10
Total	**60**

Chairperson,
(Dr. Nitin Potdar)
BoS, Microbiology